FAC 1111 Fixed-Wing Runway, Surfaced

FY25 SUC:	$3.76 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

1. Maintenance and repair (M&R) cost from PAVER is based on maintaining a Pavement Condition Index (PCI) of 70 is $1.92 per square yard (SY) per year. This value was derived using the PAVER 7.0.10 default cost tables and an average deterioration rate of 1.5 points per year for Portland cement concrete and an average deterioration rate of 2.5 points per year for asphaltic concrete.

2. PCI Survey Cost per year:
   a. Cost for PCI surveys at all active duty Air Force and Air Force Reserve bases for all airfield pavements including shoulders (140,389,373 SY) to be inspected every 5 years. Per AFI32-1041, PCI surveys are conducted at minimum every 5 years for main operating bases and auxiliary fields.
      i. Average cost per SY for PCI Surveys is $0.160
      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
      ii. $5,092,460 / 28,077,875 SY = $0.18 per SY per year

3. Rubber Removal and Paint Striping Cost per year:
   a. Rubber removal every 2.5 years is $0.35 per SY per year
   b. Partial marking removal every 2.5 years is $0.06 per SY per year
   c. Complete marking removal every 10 years is $0.13 per SY per year
   d. Remarking every 2.5 years is $0.25 per SY per year
   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
   f. Apron and taxiway marking removal and remarking cost is $0.44 per SY per year

4. Total Cost factors for runways, aprons, and taxiways:
   a. Runways: $1.92 + $0.79 + $0.18 = **$2.89 per SY per year (applies to FAC 1111)**
   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000’ long by 150’ wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000’ ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1112 Rotary-Wing Landing Area, Surfaced

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

1. Maintenance and repair (M&R) cost from PAVER is based on maintaining a Pavement Condition Index (PCI) of 70 is $1.92 per square yard (SY) per year. This value was derived using the PAVER 7.0.10 default cost tables and an average deterioration rate of 1.5 points per year for Portland cement concrete and an average deterioration rate of 2.5 points per year for asphaltic concrete.

2. PCI Survey Cost per year:
   a. Cost for PCI surveys at all active duty Air Force and Air Force Reserve bases for all airfield pavements including shoulders (140,389,373 SY) to be inspected every 5 years. Per AFI32-1041, PCI surveys are conducted at minimum every 5 years for main operating bases and auxiliary fields.
      i. Average cost per SY for PCI Surveys is $0.160
      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
      ii. $5,092,460 / 28,077,875 SY = $0.18 per SY per year

3. Rubber Removal and Paint Striping Cost per year:
   a. Rubber removal every 2.5 years is $0.35 per SY per year
   b. Partial marking removal every 2.5 years is $0.06 per SY per year
   c. Complete marking removal every 10 years is $0.13 per SY per year
   d. Remarking every 2.5 years is $0.25 per SY per year
   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
   f. Apron and taxiway marking removal and remarking cost is $0.44 per SY per year

4. Total Cost factors for runways, aprons, and taxiways:
   a. Runways: $1.92 + $0.79 + $0.18 = **$2.89 per SY per year (applies to FAC 1111)**
   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000' long by 150' wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000' ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1113 Runway Overrun Area, Surfaced

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

1. Maintenance and repair (M&R) cost from PAVER is based on maintaining a Pavement Condition Index (PCI) of 70 is $1.92 per square yard (SY) per year. This value was derived using the PAVER 7.0.10 default cost tables and an average deterioration rate of 1.5 points per year for Portland cement concrete and an average deterioration rate of 2.5 points per year for asphaltic concrete.

2. PCI Survey Cost per year:
   a. Cost for PCI surveys at all active duty Air Force and Air Force Reserve bases for all airfield pavements including shoulders (140,389,373 SY) to be inspected every 5 years. Per AFI32-1041, PCI surveys are conducted at minimum every 5 years for main operating bases and auxiliary fields.
      i. Average cost per SY for PCI Surveys is $0.160
      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
      ii. $5,092,460 / 28,077,875 SY = $0.18 per SY per year

3. Rubber Removal and Paint Striping Cost per year:
   a. Rubber removal every 2.5 years is $0.35 per SY per year
   b. Partial marking removal every 2.5 years is $0.06 per SY per year
   c. Complete marking removal every 10 years is $0.13 per SY per year
   d. Remarking every 2.5 years is $0.25 per SY per year
   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
   f. Apron and taxiway marking removal and remarking cost is $0.44 per SY per year

4. Total Cost factors for runways, aprons, and taxiways:
   a. Runways: $1.92 + $0.79 + $0.18 = **$2.89 per SY per year (applies to FAC 1111)**
   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000’ long by 150’ wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000’ ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1114 Runway, Unsurfaced

FY25 SUC:	$2.13 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Army Staff-directed study, 2011

Unpaved Runway Sustainment Funding

25 Aug 2011

PURPOSE

To provide information and considerations related to sustainment of Unpaved Runways

Overarching Considerations

- Factors that determine current sustainment funds must be reviewed for accuracy. Fuel, material, and labor costs have all increased recently.
- Incumbent on installations to ensure unpaved surface amounts are correctly reflected in real property inventories
- Should initially focus on sustainment and follow with restoration
- Fixing algorithm must be initial priority
- Can not solicit input from other installations until initial package is complete.
- Payment for use should be considered as a future option.
- Must define path ahead and required ACSIM data points to address/champion issue.
- Landing frequency spans from 92/year to 1500/year for canvassed installations
- **Analysis to this point indicates a cost spread of .85 to 2.05 per square yard with an average of $1.34 to sustain** and **3.38 to 4.61 per square yard for restoration.**

DAMO TRS Guidance

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF, G-3/5/7
400 ARMY PENTAGON
WASHINGTON, DC 20310-0400

REPLY TO ATTENTION OF

DAMO-TRS 30 August 2007

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Range and Training Land Complex Maintenance

1. Reference: AR 350-19, Sustainable Range Program 30 Aug 2005

2. The goal of the Sustainable Range Program is to maximize the capability, availability, and accessibility of ranges and training land by minimizing restrictions brought about by external factors. To maximize this availability requires maintaining the facility and components to the highest standards providing the greatest capability to training Soldiers and units.

3. Funding responsibilities for improvement and maintenance of ranges and training areas can fall in several programs.

a. The Facility Sustainment Model System calculates range maintenance and repair requirements for each facility. The installation DPW receives an annual allocation of SRM (funded through MDEP QRPA) based on the facility (real property) inventory and these funds should be used to maintain these ranges. SRM also includes facility improvements to meet ISR Infrastructure standards.

b. The Facilities Operations Model (FOM) supports range mowing operations in/around targets, etc. and is classified as Improved or Unimproved Grounds Maintenance (Service 40 or 41). The installation DPW requirement (funded through MDEP QDPW) to provide this service is identified in the FOM. DPWs will perform all Improved and Unimproved Grounds Maintenance for their installation.

c. The range operations program (funded through MDEP VSCW) is responsible for maintaining the targetry and operating systems on those ranges not supported through a MDEP WCLS contracted facility. When funds are available, this program will also provide for minor construction to upgrade ranges to current TC 25-8 standards.

d. The Integrated Training Area Management (ITAM) program (funded through MDEP TATM) is responsible for the repair of maneuver damage through land rehabilitation and maintenance projects. ITAM funds can not be used to perform routine range maintenance, range modifications or other SRM responsibilities. ITAM funds may not be used to support environmental conservation or environmental compliance requirements.

1-1

DAMO-TRS
SUBJECT: Range and Training Land Complex Maintenance

e. U.S. ARMY PEO STRI, Program Manager Field Operations & Support provides instrumentation and targetry for digital and urban ranges. Those facilities supported by this support contract (funded through MDEP WCLS) will provide maintenance of this instrumentation and targetry.

4. The Army G-3/5/7 point of contact is Mr. Dan Smith (DAMO-TRS) at (703) 692-6412 DSN 222 or e-mail: daniel.smith2@hqda.army.mil.

Thomas E. Macia
Chief, Training Support
Systems Division

Encl:
1. Target Graphic

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-2-

Locally Applied Nomenclature vs CATCD

Local Facility Nomenclature

Flight Landing Strip (FLS) – Not found in DA PAM 415-28
Aircraft Landing Strip (ALS) – Not found in DA PAM 415-28
Assault Landing Zone (ALZ) – Not found in DA PAM 415-28

Commonly used CATCD

CATCD: 11111
Long title: FIXED WING RUNWAY, UNPAVED
Short title: FW RUNWAY UNPAV
Facility type: Structure
UM1: SY
UM2: LF
Program UM: SY
FAC: 1114
FCG: F11111
Proponent: DCS, G-3
GLAC: 1740
Investment code: 01
Description: An unpaved prepared surface for training, emergency, and other special takeoff and landing operations for fixed wing aircraft. It can also accommodate rotary wing aircraft. For inventory purposes, include only the prepared runway surface.

FAC 1114 and 1166 in DA PAM 415-28

Table F–1
FAC crosswalk table, by FAC

FAC	FCG	FCG description	UM	CATCD	CATCD short title	P UM
1111	F11110	RUNWAYS, FW	SY	11110	FW RUNWAY PAVE	SY
1112	F11120	RUNWAYS, RW	SY	11120	RW RUNWAY PAVE	SY
1112	F11120	RUNWAYS, RW	SY	11130	RW LAND PAD PAV	SY
1113	F11151	RUNWAY OVERRUN	SY	11151	RUNWAY OVERRUN	SY
1114	F11111	RUNWAY, UNSURF	SY	11111	FW RUNWAY UNPAV	SY
1114	F11111	RUNWAY, UNSURF	SY	11121	RW RUNWAY UNPAV	SY
1121	F11210	TAXIWAYS, FW	SY	11212	FW TAXIWAY PAVE	SY
1122	F11220	TAXIWAYS, RW	SY	11221	RW TAXIWAY PAVE	SY
1131	F11310	PARKING, FW	SY	11310	FW PK APRN PAVE	SY
1131	F11320	PARKING, RW	SY	11320	RW PK APRN PAVE	SY
1131	F11330	MNT APRON, ACFT	SY	11330	AC MNT APR PAVE	SY
1131	F11340	ACC APRON, HGR	SY	11340	HGR ACC APR PAV	SY
1131	F11350	HOLD APRN, ACFT	SY	11350	AC HLD APRN PAV	SY
1131	F11380	LOAD APRN, ACFT	SY	11380	AC LD APRN PAVE	SY
1161	F11610	SWING BS, ACFT	SY	11610	COMP SWING BASE	SY
1163	F11370	WASH APRN, ACFT	SY	11370	AC WSH APRN PAV	SY
1166	F11131	MISC AFLD PVMTS	SY	11131	RW LAND PAD UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11213	FW TAXIWAY UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11222	RW TAXIWAY UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11311	FW PK APRN UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11321	RW PK APRN UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11331	AC MNT APR UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11341	HGR ACC APR UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11351	AC HLD APRN UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11371	AC WSH APRN UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11383	AC LD APRN UNP	SY

ACSIM ANALYIS

										13,576,510.60										$2,726,337.43		$0.201 per SY	
SERVICE	FMM_MNGCMD	REGION	FXM_INST	MAINT_UIC	SITE_CODE	RPUID	FACNO	FAC	CATCODE	FSM_QUANTITY	PREDOMINANT_CATCODE	RPA_OPERATIONAL_STATUS	CONST_TYPE	RPA_TYPE	FY	FSM	SUST_ORG	SUST_FUND	SUST_ACF	SUST_RQMT	FMM	RM_ORG	RM_FUND
A	ARACT		37225		37225	289826	OLZ17	1166	11131	389620	11131	ACT	P	S	2011	Y	00	03	0.89	78210.04	Y	00	01
A	ARACT		37225		37225	288763	OLZ18	1166	11131	502779.2	11131	ACT	P	S	2011	Y	00	03	0.89	100924.96	Y	00	01
A	ARACT		37225		37225	296311	OLZ01	1166	11131	729291.2	11131	ACT	P	S	2011	Y	00	03	0.89	146393.66	Y	00	01
A	ARACT		37225		37225	296665	OLZ05	1166	11131	290206.4	11131	ACT	P	S	2011	Y	00	03	0.89	58254.34	Y	00	01
A	ARACT		37225		37225	289529	OLZ19	1166	11131	455056.8	11131	ACT	P	S	2011	Y	00	03	0.89	91345.44	Y	00	01
A	ARACT		37225		37225	297098	OLZ22	1166	11131	453024	11131	ACT	P	S	2011	Y	00	03	0.89	90937.39	Y	00	01
A	ARACT		37225		37225	297467	OLZ24	1166	11131	490195.2	11131	ACT	P	S	2011	Y	00	03	0.89	98398.92	Y	00	01
A	ARACT		22725		22725	189192	M0160	1114	11111	82000	11111	ACT	T	S	2011	Y	00	03	0.88	16275.26	Y	00	01
A	ARACT		51290		51290	277949	F0001	1114	11121	56667	11121	ACT	T	S	2011	Y	00	03	0.95	12141.86	Y	00	01
A	ARACT		37225		37225	289743	OLZ21	1166	11131	473013.2	11131	ACT	P	S	2011	Y	00	03	0.89	94949.91	Y	00	01
A	ARACT		37225		37225	296401	OLZ15	1166	11131	384102.4	11131	ACT	P	S	2011	Y	00	03	0.89	77102.47	Y	00	01
A	ARACT		37225		37225	298629	OLZ14	1166	11131	394895.6	11131	ACT	P	S	2011	Y	00	03	0.89	79269.04	Y	00	01
A	ARACT		37225		37225	296688	OLZ07	1166	11131	872506.8	11131	ACT	P	S	2011	Y	00	03	0.89	175141.92	Y	00	01
A	ARACT		37225		37225	293113	OLZ06	1166	11131	723725.2	11131	ACT	P	S	2011	Y	00	03	0.89	145276.37	Y	00	01
A	ARACT		22725		22725	292913	OSELF	1166	11213	2333	11121	ACT	T	S	2011	Y	00	03	0.88	463.05	Y	00	01
A	ARACT		22725		22725	292913	OSELF	1114	11121	54666	11121	ACT	T	S	2011	Y	00	03	0.88	10850.04	Y	00	01
A	ARACT		37225		37225	297321	OLZ23	1166	11131	661870	11131	ACT	P	S	2011	Y	00	03	0.89	132859.92	Y	00	01
A	ARACT		37225		37225	288198	OLZ10	1166	11131	493244.4	11131	ACT	P	S	2011	Y	00	03	0.89	99011	Y	00	01
A	ARACT		37225		37225	288202	OLZ11	1166	11131	550162.8	11131	ACT	P	S	2011	Y	00	03	0.89	110436.47	Y	00	01
A	ARACT		37225		37225	289553	OLZ20	1166	11131	452152.8	11131	ACT	P	S	2011	Y	00	03	0.89	90762.51	Y	00	01
A	ARACT		37225		37225	296471	OLZ03	1166	11131	215283.2	11131	ACT	P	S	2011	Y	00	03	0.89	43214.69	Y	00	01
A	ARACT		37225		37225	296484	OLZ04	1166	11131	489711.2	11131	ACT	P	S	2011	Y	00	03	0.89	98301.77	Y	00	01
A	ARACT		22725		22725	189176	M0161	1166	11311	60833	11311	ACT	T	S	2011	Y	00	03	0.88	12074.06	Y	00	01
A	ARACT		37225		37225	297504	OLZ25	1166	11131	172110.4	11131	ACT	P	S	2011	Y	00	03	0.89	34548.44	Y	00	01
A	ARACT		37225		37225	288403	OLZ12	1166	11131	1162713.2	11131	ACT	P	S	2011	Y	00	03	0.89	233396.26	Y	00	1
A	ARACT		37225		37225	291138	OLZ08	1166	11131	192438.4	11131	ACT	P	S	2011	Y	00	03	0.89	38628.96	Y	00	01
A	ARACT		37225		37225	288190	OLZ09	1166	11131	302500	11131	ACT	P	S	2011	Y	00	03	0.89	60722.08	Y	00	01
A	ARACT		37225		37225	296899	OLZ13	1166	11131	1012237.6	11131	ACT	P	S	2011	Y	00	03	0.89	203190.66	Y	00	01
A	ARACT		51290		51290	272037	AIRDZ	1114	11111	55556	11111	ACT	P	S	2011	Y	00	03	0.95	11903.81	Y	00	01
A	ARACT		37225		37225	296470	OLZ02	1166	11131	1017464.8	11131	ACT	P	S	2011	Y	00	03	0.89	204239.94	Y	00	01
A	ARACT		37225		37225	296105	OLZ16	1166	11131	384150.8	11131	ACT	P	S	2011	Y	00	03	0.89	77112.19	Y	00	01

FAC 1114 V13 Sustainment Unit Cost

References:
TM 5-626
COE WES Technical Report GL-98-12 *Determination of Semi-Prepared Airfield Pavement Structural Requirements for Supporting C-17 Aircraft Gear*
Based on: The C-17 can take off and land on runways as short as 3,500 feet (1,064 meters) and only 90 feet wide (27.4 meters)
Fringe and overhead from Circular A-76, Attachment C, Para B2f and B5
Engineered Performance Standards Handbook, Book 11, Army TB -- 420-33, NAVFAC P -- 716.0, Air Force manual -- 85-56 NAVFAC P-710.
R.S. Means Facilities Maintenance and Repair Cost Data

U/M: SY

Mean inventory = 150,733.31 square yards = 126,031.99 square meters
Median inventory = 41,194 square yards = 34,443.849 square meters

Cost Source: R.S. Means Facilities Maintenance and Repair 2010

Cost Elements
1. Perform “windshield inspection” once per quarter
2. Detailed inspection of sample units annually
3. Correct drainage, corrugations, dust, potholes, ruts or loose aggregate as needed

Perform “windshield inspection” once per quarter

- GS-12 Hourly Rate: Basic rate 40.66/hr x 1.325 (fringe) x 1.12 (overhead) = $60.34
- 1 hour prep time + 1 hour inspection x 4 times per year = $482.72
- Per unit = $482.72/150.733.31 = $0.003/SY

Detailed Annual Inspection of Sample Units:
- Average sample = 231 square meters = 2500 SF = 278 SY
- Time requirement = .5 hr prep, 1 hr field inspection, 1 hr report preparation
- 2.5 hr x $60.34 = $150.85 per sample
- Number of samples (assume C-17 minimum) = (90’ x 3500’)/2500 SF = 126 samples
- Annual cost = $150.85 x 126 = $19,007
- Per unit = $19,007/150,733.31 = $0.126/SY

Correct drainage, corrugations, dust, potholes, ruts or loose aggregate as needed:

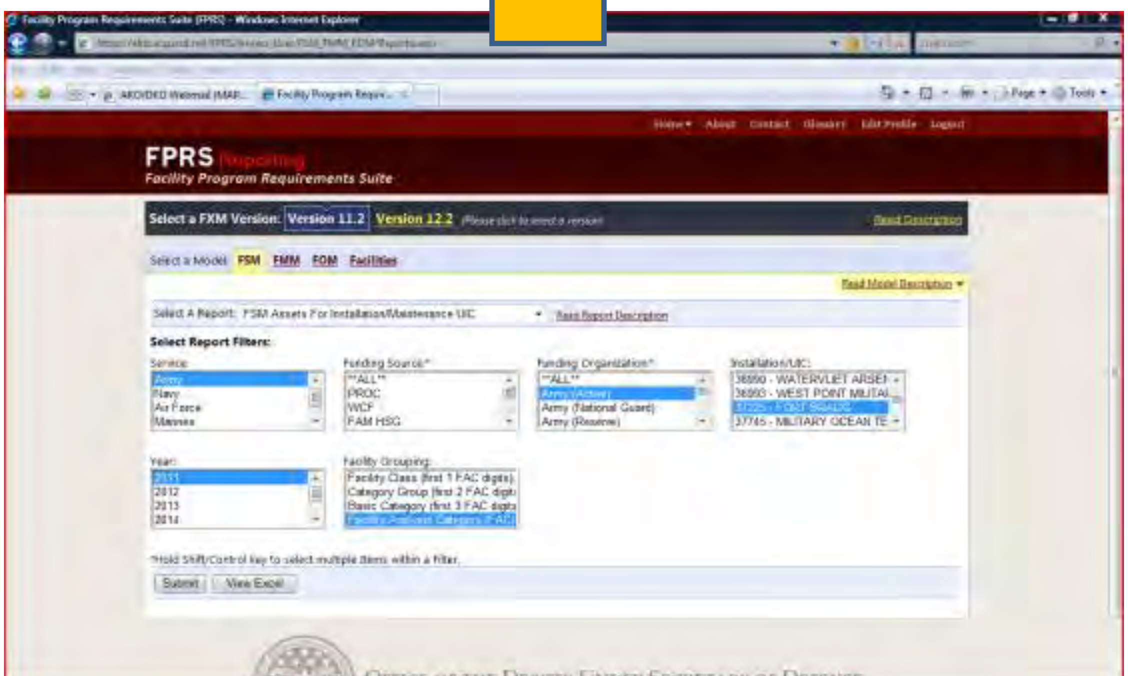
FAC 1114	**Runway, Unsurfaced**		**Mean Size**		**SY**	**150,733.31**
		Width FT	Length FT	% Repaired		
	Area to be repaired	90	3500	5%		15750
		New Material Area %	Depth			
	Assumed new material to be placed	1%	0.5		CY	2.92
			Task Time		Task Units	Hours
	spread material with grader & bulldozer		0.03149		CY	0.092
	grade using motor grader		0.0474	15000	SF	0.04977
	oil surface with oil truck & spray nozzle		0.00021		SF	3.3075
	rough roll		0.0011		SF	17.325
	finish roll with roller, broom and water down		0.00055		SF	8.6625
TOTAL Hrs						29.44
Crew	B-32C: 1 foreman, 2 laborers, 3 equipment operators, 1 grader, 1 tandem roller, 1 dozer			8	HR	$ 4,744.12
	Adjustment for Arlington VA			0.928		$ 4,402.54
TOTAL Cost						$ 16,199.50
Per Unit						0.10747125

Total:

- Perform “windshield inspection” once per quarter $0.003
- Detailed Annual Inspection of Sample Units $0.126
- Correct drainage, corrugations, dust, potholes, ruts $0.107
- Total $0.236

Facility Support Model (FSM) Comparison (V11.2)

Installation	Reported FAC	UM/SY	Sustainment Cost	Cost/SY
AP HILL	1114 Unpaved Runway	112,223.54	$24,046	$0.21
FBNC	1166 Misc Airfield Pavements	13,264,445.6	$2,662,629	$0.20
FPLA	1114 Unpaved Runway 1166 Misc Airfield Pavements	136,666 63,166	$27,537 $12,537	$0.20 $0.19



Note 1 : FAC 1166 contains multiple unpaved surface CATCDs.
Note 2. Minor differences in Cost/SY due to local area cost factors.

AP HILL

Task Analysis (AP Hill)

Task	Materials	Material Costs	Labor	Equipment Lease Costs	Fuel Costs
Routine Grading	0	0	3370.56	4320	2450
Repair Grading	#10 Stone Dust	41600	7302.88	2880	1575
Water Distributor	0	0	6179.36	2640	1925
Roller Compaction	0	0	6179.36	3300	1344
Inspection	0	0	421.32	0	0
Annual Estimated Costs Depending on Usage					

.32 sq ft = 2.88 sq yd combined cost for FY09, FY10 and FY11 to date.
That equates to 176,091.84 in sustainment for this period.
For the annual sustainment I broke the period down into 33 months.
176,091.84 divided by 33 months x 12 = 64,033 annual sustainment with an annual sq yd figure of **1.05 per sq yd.**

Totals	
Materials	$41,600.00
Fuel	$7,294.00
Equipment Lease	$13,140.00
Labor	$23,453.48
Total	$85,487.48

Landing Strip		Surface Type
ALZ		
AF1		
Pender		

FAPH ALZA Utilization

MISSION DATE	UNIT	TYPE OF AIRCRAFT	# OF LANDING	# TAKE OFF	FULL STOP	TOUCH & GO	LOW APPROACH	# Jumper
6-7 Dec 10	437th Aw Charleston, SC	C-17					6	
7-Dec-10	USACATT	CASA 212	4	4	4			56
8-Dec-10	USACTT	CASA 212	6	6	6			56
8-Dec-10	USACATT(VMGR 254 AW)	C-30	4	4	4			90
8-Dec-10	437th Aw Charleston, SC	C-17 (2)					8	
10-Dec-10	AWG (Gary)	Twin Otter	6	6	6			
14-Dec-10	914th AW Cancelled mission due to WX							
14-Dec-10	440th AW, Pope AFB	C-130	10	10				2 LZSO
21-Dec-10	914th AW	C-130	1	1				
22-Jan-11	450th CAB (135th AW Support)	C-130			Drop Only		9	90
31-Jan-11	AWG (Gary)	Twin Otter	1	1			2	

FAPH ALZA Utilization

MISSION DATE	UNIT	TYPE OF AIRCRAFT	# OF LANDING	# TAKE OFF	FULL STOP	TOUCH & GO	LOW APPROACH	# Jumper
6-14 Apr 2011	Semi-Annual Maintenance							
19-20 May 2011	NVESD	C-208	8	8	8		4 each day	
23-26 May 2011	NVESD	C-208	16	16	16		4 each day	
14 June 2011	USACATT	C-7	10	10	10			144
15 June 2011	USACATT	C-7	12	12	12			114
20 June 2011	2nd MAW	C-130	1	1	1			
23 June 2011	18th Abn Corps JFEX C-17 (2) 437th AW	C-17 (2)	2	2	2			
	C-17 10186 McCord	C-17	1	1	1			
	C-17 27159 Dover	C-17	5	5	5			
24 June 2011	C-17 Dover	C-17	5	5	5		Night Opns	18

Total Landings

C17	13
C130	12
C30	4
C7	22
C208	24
CASA 212	10
Twin Otter	7
GRAND TOTAL	**92**

FAPH Unpaved Runway Inventory

- FAPH ALZA C130, C17, Twin Otter, DHC-4
  - 4400 Ln ft stone surface
- FAPH AF1- Casa 212, 235, Twin Otter
  - Grass strip
- FAPH PENDER AF- Twin Otter
  - Grass strip
- FAPH COOKE AF- Current ops rotary wing only
  - Grass strip

FAPH ALZA RPID 272037 – FCC 11111

FAPH AF1 RPID 272838 – FCC 11111

FAPH Cooke AF RPID 272839 – FCC 11111

FAPH Pender AF RPID 272842 – FCC 11111

AP Hill Erosion Example - C17 Turnabout

AP Hill Erosion Example - C17 Rutting

AP Hill Erosion Example C17 Ruts edge of runway night ops

AP Hill Erosion Example - Typical C17 Effects

AP Hill Erosion Example - Average ruts 7.5 to 9.5 inches

AP Hill Sustainment

Aggregates Used in Construction/Maintenance:

Base: #21A

Mid-Level: S-5 Blend (Very small aggregate with no dust)

Top: #10 Dust.

All aggregate is watered and compacted utilizing a vibratory roller.

Maintenance Cost Per Square Foot: **$0.32* or $1.05 per SQYD**

*Based on costs incurred over the last three fiscal years to include FY11 to date. Cost will fluctuate based on type of aircraft and usage.

FORT POLK


UNITED STATES ARMY
FORT POLK
JOINT READINESS TRAINING CENTER

Fort Polk Cost per SQ YD

FLS Estimates

Self FLS

6" Cement Stabo	$1,286,130.00	14.109/sqyd	All totals include 6" Soil Stabilization, Soil Test Team, 10% Select Fill, Boundry and Survey Markers and 5 man Survey team.
6" Asphalt Stabo	$942,476.00	10.339/sqyd	
6" Lime Stabo	$987,142.00	10.829/sqyd	
91,155 sq yd = 18.8336 ac			

Geronimo FLS

6" Cement Stabo	$1,104,436.00	14.124/sqyd	All totals include 6" Soil Stabilization, Soil Test Team, 10% Select Fill, Boundry and Survey Markers and 5 man Survey team.
6" Asphalt Stabo	$809,637.00	10.353/sqyd	
6" Lime Stabo	$847,953.00	10.844/sqyd	
78,196 sq yd = 16.1561 ac			

Peason FLS

6" Cement Stabo	$857,238.00	14.154/sqyd	All totals include 6" Soil Stabilization, Soil Test Team, 10% Select Fill, Boundry and Survey Markers and 5 man Survey team.
6" Asphalt Stabo	$628,908.00	10.384/sqyd	
6" Lime Stabo	$658,584.00	10.874/sqyd	
60,565 sq yd = 12.5134 ac			

This sustainment occurs every three years. This results of an annual cost per square yard average from **$3.38 to $4.61** depending on stabilization technique/materials used.

Fort Polk Comments

1. We acknowledge the Real Property data is not correct.

2. Attached is our latest calculations based on sqyds

3**. Our plan conducts in-depth repairs on a three year cycle.** So dollar figures total could be divided by three for annual costs.

4. Attached are aerial photos with areas that require sustainment. We have it broken down by surface and/or design standard.

5. We also included an overall area, we call "Sustainable Area" realizing that drainage and surrounding terrain (within reason ~ 200') need maintenance annually. This is not currently discussed in any document that we've seen. Limiting the funding to "surfaced" square yards leaves a burden on installation.

Observation: Plan seems to employ a “restoration” methodology.

Fort Polk Utilization

MISSION DATE	ALS	TYPE OF AIRCRAFT	# OF LANDING	# TAKE OFF	FULL STOP	TOUCH & GO	LOW APPROACH	# Jumper

From Mr. Keith Morrow (HQ JRTC and Ft Polk G3 Air Officer)

- Based off a conversation with the AF CCT this is a high and low number of landing per month and year
- Looking at around 5 (low) to 15 (high) landings per day for a 7-10 period times around 10 rotations for the year
- **The low number would be 500 landings a year**
- **The high number would be around 1500 a year**
- That's for both C130 and C17 use; there is no log on how may each does

FPLA - SELF AIRSTRIP ALS

FPLA – Peason Ridge FLS

FPLA – Geronimo ALS

FORT BRAGG


Fort Bragg
Home Of
The Airborne
And
Special Operations Forces

Fort Bragg Facts

- A 500,000lb aircraft landing at 120kts/2Gs causes significant runway damage as do 4 engines each producing 14,400lb of thrust.

- While this is an Army-wide issue, FBNC provides an excellent case study:

  – Fort Bragg is facing significant challenges sustaining Flight Landing Strips for C17, C130, and CASA aircraft.

  – Seventy percent of runway use is in direct support of 82nd ABN DIV training.

  – Affected facilities are Holland (C17, C130), Sicily (C130), St Mere (CASA). Luzon.(C130/C17).

  – Associated Sustainment funds are insufficient. Historical annual costs (over 10 years) average $350-450K dollars per year.

  – Primary cost is purchase of sand / clay material

  – Combat Engineers are used when possible to reduce costs and simultaneously provide training venue. (Less than 20% of the time)

  – Frequent deployment of Combat Engineers requires use of Range Maintenance (In contradiction of CLS and without proper training/certification) and or contracted labor to conduct work.

  – Reduced 82nd ABN DIV deployment OPTEMPO will increase annual use of these facilities

  – Air Force personnel request sole use of these facilities 30% of the time – and are always Joint use with Army units.

Task Analysis (Bragg)

Task	Materials	Material Costs	Labor	Equipment Lease Costs	Fuel Costs
Grade		375,000	40,000		28,000
Compact			12,940		6,800
Inspect			500		200
RCR Coordination			1,560		

- **Holland FLS: 105,495 SYs at $1.42 per SY**
- **Rhine Luzon: 107,306 SYs at $1.16 per SY**
- **Sicily FLS: 72,330 SYs at $2.07 per SY**
- **ST Mere FLS: 47,058 SYs at 0.85 per SY**

RESULTANT AVERAGE = $1.39 SY

Totals	
Materials	$375,000.00
Fuel	$35,000.00
Equipment Lease	$0.00
Labor	$55,000.00
Total	$465,000.00

Landing Strip		Surface Type
Sicily		
Holland		
St Mere		
Luzon		

Fort Bragg Utilization

MISSION DATE	ALS	TYPE OF AIRCRAFT	# OF LANDING	# TAKE OFF	FULL STOP	TOUCH & GO	LOW APPROACH	# Jumper

Sicily:
C130,109 landings, 109 takeoffs;
CASA, 68 landings, 68 takeoffs.
Holland:
C130 29 landings, 29 takeoffs;
CASA, 10 landings, 10 takeoffs
(Holland was closed for 9 months of FY10).
St Mere:
CASA, 237 landings, 237 takeoffs.
Luzon:
C17, 6 landings, 6 takeoffs
C130, 15 landings, 15 takeoffs
CASA, 35 landings, 35 takeoffs
(Luzon was down for 10 months / C17 stuck on turnaround caused substantial damage)

Total Landings/Takeoffs	
C17	6
C130	153
CASA	340
Grand Total	**509**

Holland Overview

Primary Users: C130/C17

Runway Sustainment:

- REQUIRES QUARTERLY MAINTENANCE AND OPERATIONAL REPAIR DURING JFEX/JOAX
- WILL NEED TOTAL UPGRADE EVERY 10 YEARS $4-5M (BASED ON CURRENT DAY COST) CURRENTLY UNDERGOING UPGRADE.

Annual Maintenance Costs

Sand/Clay: $125K (ESTIMATED

Labor: $15K (ESTIMATED)

Misc: $10K Fuel/Equipment

Repair (ESTIMATED)

Rhine Luzon Overview

Primary Users: C130/C17

Runway Sustainment:

- REQUIRES QUARTERLY MAINTENANCE AND OPERATIONAL REPAIR DURING JFEX/JOAX
- WILL NEED TOTAL UPGRADE EVERY 10 YEARS $4-5M (BASED ON CURRENT DAY COST).

Annual Maintenance Costs:

Sand/Clay: $100 (ESTIMATED)

Labor: $15K (ESTIMATED)

Misc: FUEL/EQUIPMENT REPAIR $10K (ESTIMATED)

Sicily Overview

Primary User:C130

Runway Sustainment:

- REQUIRES QUARTERLY MAINTENANCE AND OPERATIONAL REPAIR DURING JFEX/JOAX
- WILL NEED TOTAL UPGRADE EVERY 10 YEARS $4-5M (BASED ON CURRENT DAY COST)

Annual Maintenance Costs:

Sand/Clay: $125K (ESTIMATED

Labor: $15K (ESTIMATED)

Misc: FUEL/EQUIPMENT REPAIR $10K (ESTIMATED)

St Mere Overview

Primary Users: RW AND SOF STOL AIRCRAFT

Runway Sustainment:

- MAINTENANCE REQUIRES QUARTLERY GRADING AND PACKING .
- REQUIRES TOTAL UPGRADE EVERY 10-12 YEARS .

Annual Maintenance Costs:

Sand/Clay: 2,500 CUBIC YARDS $25,000 (Estimated)

Labor: $10,000 (Estimated)

Misc: FUEL/EQUIPMENT REPAIR $5K (Estimated)

Fort Bragg Erosion Examples

Fort Bragg Erosion Examples

Fort Bragg Erosion Examples

Fort Bragg Erosion Examples

Fort Bragg Erosion Examples

Recommendations

- Ensure installations have unpaved runways correctly annotated in real property inventory and on Facility Sustainment Model (FSM). Also, ensure all other unpaved resources are annotated (i.e., taxiways, aprons).
- Assess damage immediately after C17/C130 landings. Estimate annual damage repair costs. Incorporate into SRM funding computations.
- Compare/contrast actual annual maintenance costs (per square yard) to amount programmed to establish delta.
- Evaluate current cost factor computation factors for relevance /currency.
- Refine CATCD to better identify/describe purpose, configuration, and primary use of ALZ / ALS / FLS facilities.
- **Adjust cost factors to provide realistic sustainment funding to installations.**
- Utilize Air Force Redhorse Engineers to assist with maintenance and repair of unpaved runways that support Air Force training.
- Establish a landing fee for Air Force training when not in support of Army training.

Questions

FAC 1115 Unmanned Aerial Vehicle (UAV) Runway and Launch/Recovery Site

FY25 SUC:	$1.44 / SY
Source:	Set to FAC 8511

FAC 1121 Taxiway, Surfaced

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

1. Maintenance and repair (M&R) cost from PAVER is based on maintaining a Pavement Condition Index (PCI) of 70 is $1.92 per square yard (SY) per year. This value was derived using the PAVER 7.0.10 default cost tables and an average deterioration rate of 1.5 points per year for Portland cement concrete and an average deterioration rate of 2.5 points per year for asphaltic concrete.

2. PCI Survey Cost per year:
   a. Cost for PCI surveys at all active duty Air Force and Air Force Reserve bases for all airfield pavements including shoulders (140,389,373 SY) to be inspected every 5 years. Per AFI32-1041, PCI surveys are conducted at minimum every 5 years for main operating bases and auxiliary fields.
      i. Average cost per SY for PCI Surveys is $0.160
      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
      ii. $5,092,460 / 28,077,875 SY = $0.18 per SY per year

3. Rubber Removal and Paint Striping Cost per year:
   a. Rubber removal every 2.5 years is $0.35 per SY per year
   b. Partial marking removal every 2.5 years is $0.06 per SY per year
   c. Complete marking removal every 10 years is $0.13 per SY per year
   d. Remarking every 2.5 years is $0.25 per SY per year
   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
   f. Apron and taxiway marking removal and remarking cost is $0.44 per SY per year

4. Total Cost factors for runways, aprons, and taxiways:
   a. Runways: $1.92 + $0.79 + $0.18 = **$2.89 per SY per year (applies to FAC 1111)**
   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000’ long by 150’ wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000’ ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1122 Rotary-Wing Taxiway, Surfaced

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
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October 2019

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      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
      ii. $5,092,460 / 28,077,875 SY = $0.18 per SY per year

3. Rubber Removal and Paint Striping Cost per year:
   a. Rubber removal every 2.5 years is $0.35 per SY per year
   b. Partial marking removal every 2.5 years is $0.06 per SY per year
   c. Complete marking removal every 10 years is $0.13 per SY per year
   d. Remarking every 2.5 years is $0.25 per SY per year
   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
   f. Apron and taxiway marking removal and remarking cost is $0.44 per SY per year

4. Total Cost factors for runways, aprons, and taxiways:
   a. Runways: $1.92 + $0.79 + $0.18 = **$2.89 per SY per year (applies to FAC 1111)**
   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000’ long by 150’ wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000’ ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1131 Aircraft Apron, Surfaced

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

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      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
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      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
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   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
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5. Average Runway Size is 10,000' long by 150' wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000' ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1161 Compass Calibration Pad, Surfaced

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

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2. PCI Survey Cost per year:
   a. Cost for PCI surveys at all active duty Air Force and Air Force Reserve bases for all airfield pavements including shoulders (140,389,373 SY) to be inspected every 5 years. Per AFI32-1041, PCI surveys are conducted at minimum every 5 years for main operating bases and auxiliary fields.
      i. Average cost per SY for PCI Surveys is $0.160
      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
      ii. $5,092,460 / 28,077,875 SY = $0.18 per SY per year

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   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000’ long by 150’ wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000’ ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1162 Missile Launching Pad, Surfaced

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
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October 2019

1. Maintenance and repair (M&R) cost from PAVER is based on maintaining a Pavement Condition Index (PCI) of 70 is $1.92 per square yard (SY) per year. This value was derived using the PAVER 7.0.10 default cost tables and an average deterioration rate of 1.5 points per year for Portland cement concrete and an average deterioration rate of 2.5 points per year for asphaltic concrete.

2. PCI Survey Cost per year:
   a. Cost for PCI surveys at all active duty Air Force and Air Force Reserve bases for all airfield pavements including shoulders (140,389,373 SY) to be inspected every 5 years. Per AFI32-1041, PCI surveys are conducted at minimum every 5 years for main operating bases and auxiliary fields.
      i. Average cost per SY for PCI Surveys is $0.160
      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
      ii. $5,092,460 / 28,077,875 SY = $0.18 per SY per year

3. Rubber Removal and Paint Striping Cost per year:
   a. Rubber removal every 2.5 years is $0.35 per SY per year
   b. Partial marking removal every 2.5 years is $0.06 per SY per year
   c. Complete marking removal every 10 years is $0.13 per SY per year
   d. Remarking every 2.5 years is $0.25 per SY per year
   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
   f. Apron and taxiway marking removal and remarking cost is $0.44 per SY per year

4. Total Cost factors for runways, aprons, and taxiways:
   a. Runways: $1.92 + $0.79 + $0.18 = **$2.89 per SY per year (applies to FAC 1111)**
   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000' long by 150' wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000' ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1163 Aircraft Washing Pad, Surfaced

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

1. Maintenance and repair (M&R) cost from PAVER is based on maintaining a Pavement Condition Index (PCI) of 70 is $1.92 per square yard (SY) per year. This value was derived using the PAVER 7.0.10 default cost tables and an average deterioration rate of 1.5 points per year for Portland cement concrete and an average deterioration rate of 2.5 points per year for asphaltic concrete.

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      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
      ii. $5,092,460 / 28,077,875 SY = $0.18 per SY per year

3. Rubber Removal and Paint Striping Cost per year:
   a. Rubber removal every 2.5 years is $0.35 per SY per year
   b. Partial marking removal every 2.5 years is $0.06 per SY per year
   c. Complete marking removal every 10 years is $0.13 per SY per year
   d. Remarking every 2.5 years is $0.25 per SY per year
   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
   f. Apron and taxiway marking removal and remarking cost is $0.44 per SY per year

4. Total Cost factors for runways, aprons, and taxiways:
   a. Runways: $1.92 + $0.79 + $0.18 = **$2.89 per SY per year (applies to FAC 1111)**
   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000’ long by 150’ wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000’ ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1164 Miscellaneous Airfield Pavement, Surfaced

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

1. Maintenance and repair (M&R) cost from PAVER is based on maintaining a Pavement Condition Index (PCI) of 70 is $1.92 per square yard (SY) per year. This value was derived using the PAVER 7.0.10 default cost tables and an average deterioration rate of 1.5 points per year for Portland cement concrete and an average deterioration rate of 2.5 points per year for asphaltic concrete.

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      i. Average cost per SY for PCI Surveys is $0.160
      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
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   a. Rubber removal every 2.5 years is $0.35 per SY per year
   b. Partial marking removal every 2.5 years is $0.06 per SY per year
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   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
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5. Average Runway Size is 10,000' long by 150' wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000' ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1165 Aircraft Pavement Shoulder

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

1. Maintenance and repair (M&R) cost from PAVER is based on maintaining a Pavement Condition Index (PCI) of 70 is $1.92 per square yard (SY) per year. This value was derived using the PAVER 7.0.10 default cost tables and an average deterioration rate of 1.5 points per year for Portland cement concrete and an average deterioration rate of 2.5 points per year for asphaltic concrete.

2. PCI Survey Cost per year:
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   a. Rubber removal every 2.5 years is $0.35 per SY per year
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   c. Complete marking removal every 10 years is $0.13 per SY per year
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   f. Apron and taxiway marking removal and remarking cost is $0.44 per SY per year

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   a. Runways: $1.92 + $0.79 + $0.18 = **$2.89 per SY per year (applies to FAC 1111)**
   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000’ long by 150’ wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000’ ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1166 Miscellaneous Airfield Pavement, Unsurfaced

FY25 SUC:	$2.13 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Army Staff-directed study, 2011

Unpaved Runway Sustainment Funding

25 Aug 2011

PURPOSE

To provide information and considerations related to sustainment of Unpaved Runways

Overarching Considerations

- Factors that determine current sustainment funds must be reviewed for accuracy. Fuel, material, and labor costs have all increased recently.
- Incumbent on installations to ensure unpaved surface amounts are correctly reflected in real property inventories
- Should initially focus on sustainment and follow with restoration
- Fixing algorithm must be initial priority
- Can not solicit input from other installations until initial package is complete.
- Payment for use should be considered as a future option.
- Must define path ahead and required ACSIM data points to address/champion issue.
- Landing frequency spans from 92/year to 1500/year for canvassed installations
- **Analysis to this point indicates a cost spread of .85 to 2.05 per square yard with an average of $1.34 to sustain** and **3.38 to 4.61 per square yard for restoration.**

DAMO TRS Guidance

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF, G-3/5/7
400 ARMY PENTAGON
WASHINGTON, DC 20310-0400

REPLY TO ATTENTION OF

DAMO-TRS 30 August 2007

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Range and Training Land Complex Maintenance

1. Reference: AR 350-19, Sustainable Range Program 30 Aug 2005

2. The goal of the Sustainable Range Program is to maximize the capability, availability, and accessibility of ranges and training land by minimizing restrictions brought about by external factors. To maximize this availability requires maintaining the facility and components to the highest standards providing the greatest capability to training Soldiers and units.

3. Funding responsibilities for improvement and maintenance of ranges and training areas can fall in several programs.

a. The Facility Sustainment Model System calculates range maintenance and repair requirements for each facility. The installation DPW receives an annual allocation of SRM (funded through MDEP QRPA) based on the facility (real property) inventory and these funds should be used to maintain these ranges. SRM also includes facility improvements to meet ISR Infrastructure standards.

b. The Facilities Operations Model (FOM) supports range mowing operations in/around targets, etc. and is classified as Improved or Unimproved Grounds Maintenance (Service 40 or 41). The installation DPW requirement (funded through MDEP QDPW) to provide this service is identified in the FOM. DPWs will perform all Improved and Unimproved Grounds Maintenance for their installation.

c. The range operations program (funded through MDEP VSCW) is responsible for maintaining the targetry and operating systems on those ranges not supported through a MDEP WCLS contracted facility. When funds are available, this program will also provide for minor construction to upgrade ranges to current TC 25-8 standards.

d. The Integrated Training Area Management (ITAM) program (funded through MDEP TATM) is responsible for the repair of maneuver damage through land rehabilitation and maintenance projects. ITAM funds can not be used to perform routine range maintenance, range modifications or other SRM responsibilities. ITAM funds may not be used to support environmental conservation or environmental compliance requirements.

1-1

DAMO-TRS
SUBJECT: Range and Training Land Complex Maintenance

e. U.S. ARMY PEO STRI, Program Manager Field Operations & Support provides instrumentation and targetry for digital and urban ranges. Those facilities supported by this support contract (funded through MDEP WCLS) will provide maintenance of this instrumentation and targetry.

4. The Army G-3/5/7 point of contact is Mr. Dan Smith (DAMO-TRS) at (703) 692-6412 DSN 222 or e-mail: daniel.smith2@hqda.army.mil.

Thomas E. Macia
Chief, Training Support
Systems Division

Encl:
1. Target Graphic

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-2-

Locally Applied Nomenclature vs CATCD

Local Facility Nomenclature

Flight Landing Strip (FLS) – Not found in DA PAM 415-28
Aircraft Landing Strip (ALS) – Not found in DA PAM 415-28
Assault Landing Zone (ALZ) – Not found in DA PAM 415-28

Commonly used CATCD

CATCD: 11111
Long title: FIXED WING RUNWAY, UNPAVED
Short title: FW RUNWAY UNPAV
Facility type: Structure
UM1: SY
UM2: LF
Program UM: SY
FAC: 1114
FCG: F11111
Proponent: DCS, G-3
GLAC: 1740
Investment code: 01
Description: An unpaved prepared surface for training, emergency, and other special takeoff and landing operations for fixed wing aircraft. It can also accommodate rotary wing aircraft. For inventory purposes, include only the prepared runway surface.

FAC 1114 and 1166 in DA PAM 415-28

Table F–1
FAC crosswalk table, by FAC

FAC	FCG	FCG description	UM	CATCD	CATCD short title	P UM
1111	F11110	RUNWAYS, FW	SY	11110	FW RUNWAY PAVE	SY
1112	F11120	RUNWAYS, RW	SY	11120	RW RUNWAY PAVE	SY
1112	F11120	RUNWAYS, RW	SY	11130	RW LAND PAD PAV	SY
1113	F11151	RUNWAY OVERRUN	SY	11151	RUNWAY OVERRUN	SY
1114	F11111	RUNWAY, UNSURF	SY	11111	FW RUNWAY UNPAV	SY
1114	F11111	RUNWAY, UNSURF	SY	11121	RW RUNWAY UNPAV	SY
1121	F11210	TAXIWAYS, FW	SY	11212	FW TAXIWAY PAVE	SY
1122	F11220	TAXIWAYS, RW	SY	11221	RW TAXIWAY PAVE	SY
1131	F11310	PARKING, FW	SY	11310	FW PK APRN PAVE	SY
1131	F11320	PARKING, RW	SY	11320	RW PK APRN PAVE	SY
1131	F11330	MNT APRON, ACFT	SY	11330	AC MNT APR PAVE	SY
1131	F11340	ACC APRON, HGR	SY	11340	HGR ACC APR PAV	SY
1131	F11350	HOLD APRN, ACFT	SY	11350	AC HLD APRN PAV	SY
1131	F11380	LOAD APRN, ACFT	SY	11380	AC LD APRN PAVE	SY
1161	F11610	SWING BS, ACFT	SY	11610	COMP SWING BASE	SY
1163	F11370	WASH APRN, ACFT	SY	11370	AC WSH APRN PAV	SY
1166	F11131	MISC AFLD PVMTS	SY	11131	RW LAND PAD UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11213	FW TAXIWAY UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11222	RW TAXIWAY UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11311	FW PK APRN UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11321	RW PK APRN UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11331	AC MNT APR UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11341	HGR ACC APR UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11351	AC HLD APRN UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11371	AC WSH APRN UNP	SY
1166	F11131	MISC AFLD PVMTS	SY	11383	AC LD APRN UNP	SY

ACSIM ANALYIS

SERVICE	FMM_MNGCMD	REGION	FXM_INST	MAINT_UIC	SITE_CODE	RPUID	FACNO	FAC	CATCODE	FSM_QUANTITY	PREDOMINANT_CATCODE	RPA_OPERATIONAL_STATUS	CONST_TYPE	RPA_TYPE	FY	FSM	SUST_ORG	SUST_FUND	SUST_ACF	SUST_RQMT	FMM	RM_ORG	RM_FUND
										13,576,510.60										$2,726,337.43		$0.201	per SY
A	ARACT		37225		37225	289826	OLZ17	1166	11131	389620	11131	ACT	P	S	2011	Y	00	03	0.89	78210.04	Y	00	01
A	ARACT		37225		37225	288763	OLZ18	1166	11131	502779.2	11131	ACT	P	S	2011	Y	00	03	0.89	100924.96	Y	00	01
A	ARACT		37225		37225	296311	OLZ01	1166	11131	729291.2	11131	ACT	P	S	2011	Y	00	03	0.89	146393.66	Y	00	01
A	ARACT		37225		37225	296665	OLZ05	1166	11131	290206.4	11131	ACT	P	S	2011	Y	00	03	0.89	58254.34	Y	00	01
A	ARACT		37225		37225	289529	OLZ19	1166	11131	455056.8	11131	ACT	P	S	2011	Y	00	03	0.89	91345.44	Y	00	01
A	ARACT		37225		37225	297098	OLZ22	1166	11131	453024	11131	ACT	P	S	2011	Y	00	03	0.89	90937.39	Y	00	01
A	ARACT		37225		37225	297467	OLZ24	1166	11131	490195.2	11131	ACT	P	S	2011	Y	00	03	0.89	98398.92	Y	00	01
A	ARACT		22725		22725	189192	M0160	1114	11111	82000	11111	ACT	T	S	2011	Y	00	03	0.88	16275.26	Y	00	01
A	ARACT		51290		51290	277949	F0001	1114	11121	56667	11121	ACT	T	S	2011	Y	00	03	0.95	12141.86	Y	00	01
A	ARACT		37225		37225	289743	OLZ21	1166	11131	473013.2	11131	ACT	P	S	2011	Y	00	03	0.89	94949.91	Y	00	01
A	ARACT		37225		37225	296401	OLZ15	1166	11131	384102.4	11131	ACT	P	S	2011	Y	00	03	0.89	77102.47	Y	00	01
A	ARACT		37225		37225	298629	OLZ14	1166	11131	394895.6	11131	ACT	P	S	2011	Y	00	03	0.89	79269.04	Y	00	01
A	ARACT		37225		37225	296688	OLZ07	1166	11131	872506.8	11131	ACT	P	S	2011	Y	00	03	0.89	175141.92	Y	00	01
A	ARACT		37225		37225	293113	OLZ06	1166	11131	723725.2	11131	ACT	P	S	2011	Y	00	03	0.89	145276.37	Y	00	01
A	ARACT		22725		22725	292913	OSELF	1166	11213	2333	11121	ACT	T	S	2011	Y	00	03	0.88	463.05	Y	00	01
A	ARACT		22725		22725	292913	OSELF	1114	11121	54666	11121	ACT	T	S	2011	Y	00	03	0.88	10850.04	Y	00	01
A	ARACT		37225		37225	297321	OLZ23	1166	11131	661870	11131	ACT	P	S	2011	Y	00	03	0.89	132859.92	Y	00	01
A	ARACT		37225		37225	288198	OLZ10	1166	11131	493244.4	11131	ACT	P	S	2011	Y	00	03	0.89	99011	Y	00	01
A	ARACT		37225		37225	288202	OLZ11	1166	11131	550162.8	11131	ACT	P	S	2011	Y	00	03	0.89	110436.47	Y	00	01
A	ARACT		37225		37225	289553	OLZ20	1166	11131	452152.8	11131	ACT	P	S	2011	Y	00	03	0.89	90762.51	Y	00	01
A	ARACT		37225		37225	296471	OLZ03	1166	11131	215283.2	11131	ACT	P	S	2011	Y	00	03	0.89	43214.69	Y	00	01
A	ARACT		37225		37225	296484	OLZ04	1166	11131	489711.2	11131	ACT	P	S	2011	Y	00	03	0.89	98301.77	Y	00	01
A	ARACT		22725		22725	189176	M0161	1166	11311	60833	11311	ACT	T	S	2011	Y	00	03	0.88	12074.06	Y	00	01
A	ARACT		37225		37225	297504	OLZ25	1166	11131	172110.4	11131	ACT	P	S	2011	Y	00	03	0.89	34548.44	Y	00	01
A	ARACT		37225		37225	288403	OLZ12	1166	11131	1162713.2	11131	ACT	P	S	2011	Y	00	03	0.89	233396.26	Y	00	1
A	ARACT		37225		37225	291138	OLZ08	1166	11131	192438.4	11131	ACT	P	S	2011	Y	00	03	0.89	38628.96	Y	00	01
A	ARACT		37225		37225	288190	OLZ09	1166	11131	302500	11131	ACT	P	S	2011	Y	00	03	0.89	60722.08	Y	00	01
A	ARACT		37225		37225	296899	OLZ13	1166	11131	1012237.6	11131	ACT	P	S	2011	Y	00	03	0.89	203190.66	Y	00	01
A	ARACT		51290		51290	272037	AIRDZ	1114	11111	55556	11111	ACT	P	S	2011	Y	00	03	0.95	11903.81	Y	00	01
A	ARACT		37225		37225	296470	OLZ02	1166	11131	1017464.8	11131	ACT	P	S	2011	Y	00	03	0.89	204239.94	Y	00	01
A	ARACT		37225		37225	296105	OLZ16	1166	11131	384150.8	11131	ACT	P	S	2011	Y	00	03	0.89	77112.19	Y	00	01

FAC 1114 V13 Sustainment Unit Cost

References:
TM 5-626
COE WES Technical Report GL-98-12 *Determination of Semi-Prepared Airfield Pavement Structural Requirements for Supporting C-17 Aircraft Gear*
Based on: The C-17 can take off and land on runways as short as 3,500 feet (1,064 meters) and only 90 feet wide (27.4 meters)
Fringe and overhead from Circular A-76, Attachment C, Para B2f and B5
Engineered Performance Standards Handbook, Book 11, Army TB -- 420-33, NAVFAC P -- 716.0, Air Force manual -- 85-56 NAVFAC P-710.
R.S. Means Facilities Maintenance and Repair Cost Data

U/M: SY

Mean inventory = 150,733.31 square yards = 126,031.99 square meters
Median inventory = 41,194 square yards = 34,443.849 square meters

Cost Source: R.S. Means Facilities Maintenance and Repair 2010

Cost Elements
1. Perform "windshield inspection" once per quarter
2. Detailed inspection of sample units annually
3. Correct drainage, corrugations, dust, potholes, ruts or loose aggregate as needed

Perform "windshield inspection" once per quarter

- GS-12 Hourly Rate: Basic rate 40.66/hr x 1.325 (fringe) x 1.12 (overhead) = $60.34
- 1 hour prep time + 1 hour inspection x 4 times per year = $482.72
- Per unit = $482.72/150.733.31 = $0.003/SY

Detailed Annual Inspection of Sample Units:
- Average sample = 231 square meters = 2500 SF = 278 SY
- Time requirement = .5 hr prep, 1 hr field inspection, 1 hr report preparation
- 2.5 hr x $60.34 = $150.85 per sample
- Number of samples (assume C-17 minimum) = (90' x 3500')/2500 SF = 126 samples
- Annual cost = $150.85 x 126 = $19,007
- Per unit = $19,007/150,733.31 = $0.126/SY

Correct drainage, corrugations, dust, potholes, ruts or loose aggregate as needed:

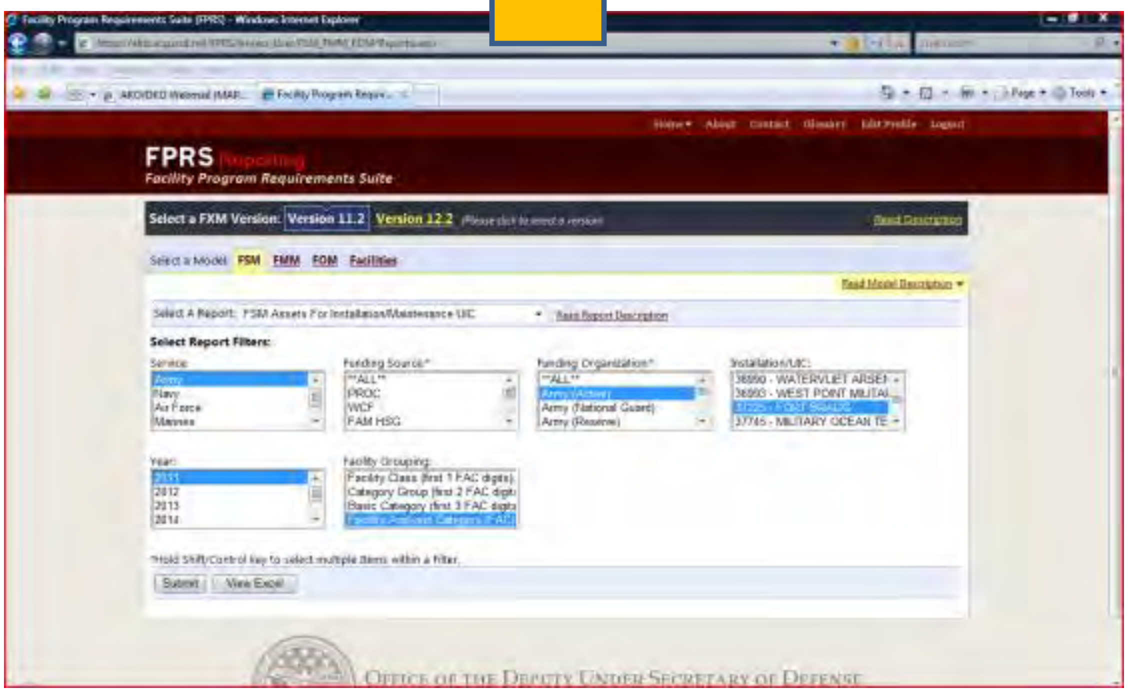
FAC 1114	**Runway, Unsurfaced**		**Mean Size**		**SY**	**150,733.31**
		Width FT	Length FT	% Repaired		
	Area to be repaired	90	3500	5%		15750
		New Material Area %	Depth			
	Assumed new material to be placed	1%	0.5		CY	2.92
			Task Time		Task Units	Hours
	spread material with grader & bulldozer		0.03149		CY	0.092
	grade using motor grader		0.0474	15000	SF	0.04977
	oil surface with oil truck & spray nozzle		0.00021		SF	3.3075
	rough roll		0.0011		SF	17.325
	finish roll with roller, broom and water down		0.00055		SF	8.6625
TOTAL Hrs						29.44
Crew	B-32C: 1 foreman, 2 laborers, 3 equipment operators, 1 grader, 1 tandem roller, 1 dozer			8	HR	$ 4,744.12
	Adjustment for Arlington VA			0.928		$ 4,402.54
TOTAL Cost						$ 16,199.50
Per Unit						0.10747125

Total:

- Perform "windshield inspection" once per quarter $0.003
- Detailed Annual Inspection of Sample Units $0.126
- Correct drainage, corrugations, dust, potholes, ruts $0.107
- Total $0.236

Facility Support Model (FSM) Comparison (V11.2)

Installation	Reported FAC	UM/SY	Sustainment Cost	Cost/SY
AP HILL	1114 Unpaved Runway	112,223.54	$24,046	$0.21
FBNC	1166 Misc Airfield Pavements	13,264,445.6	$2,662,629	$0.20
FPLA	1114 Unpaved Runway 1166 Misc Airfield Pavements	136,666 63,166	$27,537 $12,537	$0.20 $0.19



Note 1 : FAC 1166 contains multiple unpaved surface CATCDs.

Note 2. Minor differences in Cost/SY due to local area cost factors.

AP HILL

Task Analysis (AP Hill)

Task	Materials	Material Costs	Labor	Equipment Lease Costs	Fuel Costs
Routine Grading	0	0	3370.56	4320	2450
Repair Grading	#10 Stone Dust	41600	7302.88	2880	1575
Water Distributor	0	0	6179.36	2640	1925
Roller Compaction	0	0	6179.36	3300	1344
Inspection	0	0	421.32	0	0
Annual Estimated Costs Depending on Usage					

.32 sq ft = 2.88 sq yd combined cost for FY09, FY10 and FY11 to date.
That equates to 176,091.84 in sustainment for this period.
For the annual sustainment I broke the period down into 33 months.
176,091.84 divided by 33 months x 12 = 64,033 annual sustainment with an annual sq yd figure of **1.05 per sq yd.**

Totals	
Materials	$41,600.00
Fuel	$7,294.00
Equipment Lease	$13,140.00
Labor	$23,453.48
Total	$85,487.48

Landing Strip		Surface Type
ALZ		
AF1		
Pender		

FAPH ALZA Utilization

MISSION DATE	UNIT	TYPE OF AIRCRAFT	# OF LANDING	# TAKE OFF	FULL STOP	TOUCH & GO	LOW APPROACH	# Jumper
6-7 Dec 10	437th Aw Charleston, SC	C-17					6	
7-Dec-10	USACATT	CASA 212	4	4	4			56
8-Dec-10	USACTT	CASA 212	6	6	6			56
8-Dec-10	USACATT(VMGR 254 AW)	C-30	4	4	4			90
8-Dec-10	437th Aw Charleston, SC	C-17 (2)					8	
10-Dec-10	AWG (Gary)	Twin Otter	6	6	6			
14-Dec-10	914th AW Cancelled mission due to WX							
14-Dec-10	440th AW, Pope AFB	C-130	10	10				2 LZSO
21-Dec-10	914th AW	C-130	1	1				
22-Jan-11	450th CAB (135th AW Support)	C-130			Drop Only		9	90
31-Jan-11	AWG (Gary)	Twin Otter	1	1			2	

FAPH ALZA Utilization

MISSION DATE	UNIT	TYPE OF AIRCRAFT	# OF LANDING	# TAKE OFF	FULL STOP	TOUCH & GO	LOW APPROACH	# Jumper
6-14 Apr 2011	Semi-Annual Maintenance							
19-20 May 2011	NVESD	C-208	8	8	8		4 each day	
23-26 May 2011	NVESD	C-208	16	16	16		4 each day	
14 June 2011	USACATT	C-7	10	10	10			144
15 June 2011	USACATT	C-7	12	12	12			114
20 June 2011	2nd MAW	C-130	1	1	1			
23 June 2011	18th Abn Corps JFEX C-17 (2) 437th AW	C-17 (2)	2	2	2			
	C-17 10186 McCord	C-17	1	1	1			
	C-17 27159 Dover	C-17	5	5	5			
24 June 2011	C-17 Dover	C-17	5	5	5		Night Opns	18

Total Landings	
C17	13
C130	12
C30	4
C7	22
C208	24
CASA 212	10
Twin Otter	7
GRAND TOTAL	**92**

FAPH Unpaved Runway Inventory

- FAPH ALZA C130, C17, Twin Otter, DHC-4
  - 4400 Ln ft stone surface
- FAPH AF1- Casa 212, 235, Twin Otter
  - Grass strip
- FAPH PENDER AF- Twin Otter
  - Grass strip
- FAPH COOKE AF- Current ops rotary wing only
  - Grass strip

FAPH ALZA RPID 272037 – FCC 11111

FAPH AF1 RPID 272838 – FCC 11111

FAPH Cooke AF RPID 272839 – FCC 11111

FAPH Pender AF RPID 272842 – FCC 11111

AP Hill Erosion Example - C17 Turnabout

AP Hill Erosion Example - C17 Rutting

AP Hill Erosion Example C17 Ruts edge of runway night ops

AP Hill Erosion Example - Typical C17 Effects

AP Hill Erosion Example - Average ruts 7.5 to 9.5 inches

AP Hill Sustainment

Aggregates Used in Construction/Maintenance:

Base: #21A

Mid-Level: S-5 Blend (Very small aggregate with no dust)

Top: #10 Dust.

All aggregate is watered and compacted utilizing a vibratory roller.

Maintenance Cost Per Square Foot: **$0.32* or $1.05 per SQYD**

*Based on costs incurred over the last three fiscal years to include FY11 to date. Cost will fluctuate based on type of aircraft and usage.

FORT POLK


UNITED STATES ARMY
FORT POLK
JOINT READINESS TRAINING CENTER

Fort Polk Cost per SQ YD

FLS Estimates

Self FLS

6" Cement Stabo	$1,286,130.00	14.109/sqyd	All totals include 6" Soil Stabilization, Soil Test Team, 10% Select Fill, Boundry and Survey Markers and 5 man Survey team.
6" Asphalt Stabo	$942,476.00	10.339/sqyd	
6" Lime Stabo	$987,142.00	10.829/sqyd	
91,155 sq yd = 18.8336 ac			

Geronimo FLS

6" Cement Stabo	$1,104,436.00	14.124/sqyd	All totals include 6" Soil Stabilization, Soil Test Team, 10% Select Fill, Boundry and Survey Markers and 5 man Survey team.
6" Asphalt Stabo	$809,637.00	10.353/sqyd	
6" Lime Stabo	$847,953.00	10.844/sqyd	
78,196 sq yd = 16.1561 ac			

Peason FLS

6" Cement Stabo	$857,238.00	14.154/sqyd	All totals include 6" Soil Stabilization, Soil Test Team, 10% Select Fill, Boundry and Survey Markers and 5 man Survey team.
6" Asphalt Stabo	$628,908.00	10.384/sqyd	
6" Lime Stabo	$658,584.00	10.874/sqyd	
60,565 sq yd = 12.5134 ac			

This sustainment occurs every three years. This results of an annual cost per square yard average from **$3.38 to $4.61** depending on stabilization technique/materials used.

Fort Polk Comments

1. We acknowledge the Real Property data is not correct.

2. Attached is our latest calculations based on sqyds

3**. Our plan conducts in-depth repairs on a three year cycle.** So dollar figures total could be divided by three for annual costs.

4. Attached are aerial photos with areas that require sustainment. We have it broken down by surface and/or design standard.

5. We also included an overall area, we call "Sustainable Area" realizing that drainage and surrounding terrain (within reason ~ 200') need maintenance annually. This is not currently discussed in any document that we've seen. Limiting the funding to "surfaced" square yards leaves a burden on installation.

Observation: Plan seems to employ a "restoration" methodology.

Fort Polk Utilization

MISSION DATE	ALS	TYPE OF AIRCRAFT	# OF LANDING	# TAKE OFF	FULL STOP	TOUCH & GO	LOW APPROACH	# Jumper

From Mr. Keith Morrow (HQ JRTC and Ft Polk G3 Air Officer)

- Based off a conversation with the AF CCT this is a high and low number of landing per month and year
- Looking at around 5 (low) to 15 (high) landings per day for a 7-10 period times around 10 rotations for the year
- **The low number would be 500 landings a year**
- **The high number would be around 1500 a year**
- That's for both C130 and C17 use; there is no log on how may each does

FPLA - SELF AIRSTRIP ALS

FPLA – Peason Ridge FLS

FPLA – Geronimo ALS

FORT BRAGG


Fort Bragg
Home Of
The Airborne
And
Special Operations Forces

Fort Bragg Facts

- A 500,000lb aircraft landing at 120kts/2Gs causes significant runway damage as do 4 engines each producing 14,400lb of thrust.

- While this is an Army-wide issue, FBNC provides an excellent case study:

  – Fort Bragg is facing significant challenges sustaining Flight Landing Strips for C17, C130, and CASA aircraft.

  – Seventy percent of runway use is in direct support of 82nd ABN DIV training.

  – Affected facilities are Holland (C17, C130), Sicily (C130), St Mere (CASA). Luzon.(C130/C17).

  – Associated Sustainment funds are insufficient. Historical annual costs (over 10 years) average $350-450K dollars per year.

  – Primary cost is purchase of sand / clay material

  – Combat Engineers are used when possible to reduce costs and simultaneously provide training venue. (Less than 20% of the time)

  – Frequent deployment of Combat Engineers requires use of Range Maintenance (In contradiction of CLS and without proper training/certification) and or contracted labor to conduct work.

  – Reduced 82nd ABN DIV deployment OPTEMPO will increase annual use of these facilities

  – Air Force personnel request sole use of these facilities 30% of the time – and are always Joint use with Army units.

Task Analysis (Bragg)

Task	Materials	Material Costs	Labor	Equipment Lease Costs	Fuel Costs
Grade		375,000	40,000		28,000
Compact			12,940		6,800
Inspect			500		200
RCR Coordination			1,560		

- **Holland FLS: 105,495 SYs at $1.42 per SY**
- **Rhine Luzon: 107,306 SYs at $1.16 per SY**
- **Sicily FLS: 72,330 SYs at $2.07 per SY**
- **ST Mere FLS: 47,058 SYs at 0.85 per SY**

RESULTANT AVERAGE = $1.39 SY

Totals	
Materials	$375,000.00
Fuel	$35,000.00
Equipment Lease	$0.00
Labor	$55,000.00
Total	$465,000.00

Landing Strip		Surface Type
Sicily		
Holland		
St Mere		
Luzon		

Fort Bragg Utilization

MISSION DATE	ALS	TYPE OF AIRCRAFT	# OF LANDING	# TAKE OFF	FULL STOP	TOUCH & GO	LOW APPROACH	# Jumper

Sicily:
C130,109 landings, 109 takeoffs;
CASA, 68 landings, 68 takeoffs.
Holland:
C130 29 landings, 29 takeoffs;
CASA, 10 landings, 10 takeoffs
(Holland was closed for 9 months of FY10).
St Mere:
CASA, 237 landings, 237 takeoffs.
Luzon:
C17, 6 landings, 6 takeoffs
C130, 15 landings, 15 takeoffs
CASA, 35 landings, 35 takeoffs
(Luzon was down for 10 months / C17 stuck on turnaround caused substantial damage)

Total Landings/Takeoffs	
C17	6
C130	153
CASA	340
Grand Total	**509**

Holland Overview

Primary Users: C130/C17

Runway Sustainment:

- REQUIRES QUARTERLY MAINTENANCE AND OPERATIONAL REPAIR DURING JFEX/JOAX
- WILL NEED TOTAL UPGRADE EVERY 10 YEARS $4-5M (BASED ON CURRENT DAY COST) CURRENTLY UNDERGOING UPGRADE.

Annual Maintenance Costs

Sand/Clay: $125K (ESTIMATED

Labor: $15K (ESTIMATED)

Misc: $10K Fuel/Equipment Repair (ESTIMATED)

Rhine Luzon Overview

Primary Users: C130/C17

Runway Sustainment:

- REQUIRES QUARTERLY MAINTENANCE AND OPERATIONAL REPAIR DURING JFEX/JOAX
- WILL NEED TOTAL UPGRADE EVERY 10 YEARS $4-5M (BASED ON CURRENT DAY COST).

Annual Maintenance Costs:

Sand/Clay: $100 (ESTIMATED)

Labor: $15K (ESTIMATED)

Misc: FUEL/EQUIPMENT REPAIR $10K (ESTIMATED)

Sicily Overview

Primary User:C130

Runway Sustainment:

- REQUIRES QUARTERLY MAINTENANCE AND OPERATIONAL REPAIR DURING JFEX/JOAX
- WILL NEED TOTAL UPGRADE EVERY 10 YEARS $4-5M (BASED ON CURRENT DAY COST)

Annual Maintenance Costs:

Sand/Clay: $125K (ESTIMATED

Labor: $15K (ESTIMATED)

Misc: FUEL/EQUIPMENT REPAIR $10K (ESTIMATED)

St Mere Overview

Primary Users: RW AND SOF STOL AIRCRAFT

Runway Sustainment:

- MAINTENANCE REQUIRES QUARTLERY GRADING AND PACKING .
- REQUIRES TOTAL UPGRADE EVERY 10-12 YEARS .

Annual Maintenance Costs:

Sand/Clay: 2,500 CUBIC YARDS $25,000 (Estimated)

Labor: $10,000 (Estimated)

Misc: FUEL/EQUIPMENT REPAIR $5K (Estimated)

Fort Bragg Erosion Examples

Fort Bragg Erosion Examples

Fort Bragg Erosion Examples

Fort Bragg Erosion Examples

Fort Bragg Erosion Examples

Recommendations

- Ensure installations have unpaved runways correctly annotated in real property inventory and on Facility Sustainment Model (FSM). Also, ensure all other unpaved resources are annotated (i.e., taxiways, aprons).
- Assess damage immediately after C17/C130 landings. Estimate annual damage repair costs. Incorporate into SRM funding computations.
- Compare/contrast actual annual maintenance costs (per square yard) to amount programmed to establish delta.
- Evaluate current cost factor computation factors for relevance /currency.
- Refine CATCD to better identify/describe purpose, configuration, and primary use of ALZ / ALS / FLS facilities.
- **Adjust cost factors to provide realistic sustainment funding to installations.**
- Utilize Air Force Redhorse Engineers to assist with maintenance and repair of unpaved runways that support Air Force training.
- Establish a landing fee for Air Force training when not in support of Army training.

Questions

FAC 1167 Aircraft Rinse Facility

FY25 SUC:	$3.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force Civil Engineer Center (AFC EC) study, 2019, which updated the cost associated with airfield pavement maintenance and repair, marking, rubber removal, etc.

Sustainment Unit Cost Factor Computation
Airfield Pavement SUCs
Provided by Air Force Civil Engineer Center (AFCEC)
October 2019

1. Maintenance and repair (M&R) cost from PAVER is based on maintaining a Pavement Condition Index (PCI) of 70 is $1.92 per square yard (SY) per year. This value was derived using the PAVER 7.0.10 default cost tables and an average deterioration rate of 1.5 points per year for Portland cement concrete and an average deterioration rate of 2.5 points per year for asphaltic concrete.

2. PCI Survey Cost per year:
   a. Cost for PCI surveys at all active duty Air Force and Air Force Reserve bases for all airfield pavements including shoulders (140,389,373 SY) to be inspected every 5 years. Per AFI32-1041, PCI surveys are conducted at minimum every 5 years for main operating bases and auxiliary fields.
      i. Average cost per SY for PCI Surveys is $0.160
      ii. 140,389,373 SY / 5 years = 28,077,875 SY per year
      iii. 28,077,875 SY * $0.16 = $4,492,460 per year
   b. Cost for PCI surveys for all Air National Guard bases
      i. $200k per year
   c. Database management, PAVER maintenance and upgrade cost is $400K per year
   d. Total PCI survey cost factor
      i. Total cost per year is $4,492,460+$200,000+$400,000 = $5,092,460
      ii. $5,092,460 / 28,077,875 SY = $0.18 per SY per year

3. Rubber Removal and Paint Striping Cost per year:
   a. Rubber removal every 2.5 years is $0.35 per SY per year
   b. Partial marking removal every 2.5 years is $0.06 per SY per year
   c. Complete marking removal every 10 years is $0.13 per SY per year
   d. Remarking every 2.5 years is $0.25 per SY per year
   e. Runway total rubber removal and paint striping cost is $0.79 per SY per year
   f. Apron and taxiway marking removal and remarking cost is $0.44 per SY per year

4. Total Cost factors for runways, aprons, and taxiways:
   a. Runways: $1.92 + $0.79 + $0.18 = **$2.89 per SY per year (applies to FAC 1111)**
   b. Aprons and Taxiways: $1.92 + $0.44 + $0.18 = **$2.54 per SY per year (applies to FACs 1112, 1113, 1121, 1122, 1131, 1161, 1162, 1163, 1164, 1165, and 1167)**

5. Average Runway Size is 10,000’ long by 150’ wide.

6. Maintenance and repair costs of airfield pavement (i.e. spall repair, joint/crack sealing) is based on data in PAVER, a consolidated Pavement Condition Index (PCI) database that contains actual cost data from inspections from most Active and Reserve Air Force installations (some data outliers were eliminated)

7. An average runway is designed with 1000’ ends of concrete and interior of asphalt. Aprons and Taxiways are a mix of asphalt and concrete. However, actual cost data is used from PAVER that provides an average value that incorporates all pavement types.

FAC 1211 Aircraft Direct Fueling Facility

FY25 SUC:	$4,447.16 / OL
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Study of Fuel Facilities

Original Source: DLA 2018 Study of Fuel Facilities. Calculation below:

RMMR = Recurring Maintenance and Minor Repair program

Design Life and Representative Size	30	Years	6	OL	
Component	Frequency	Estimated Cost per Occurrence	Occurences in design life	Occurrences rounded	Design Life Cost
Hydrant					
Automatic Control Valves, replace	15	$ 41,688.00	2.0	2.0	$ 83,376.00
Hydrant Repair	15	$ 94,275.00	2.0	2.0	$ 188,550.00
Pre-Post Cost	15	$ 42,166.00	2.0	2.0	$ 84,332.00
Additional Costs					
Planning Studies I & II	1	$ 1,403.46	30	30.0	$ 42,103.80
SIOH	1	$ 186.82	30	30.0	$ 5,604.60
RMMR	1	$ 3,100.00	30	30.0	$ 93,000.00
Cathodic Protection	1	$ 2,580.00	30	30.0	$ 77,400.00
Operator Maintenance	1	$ 939.95	30	30.0	$ 28,198.50
Total					$ 602,564.90
Annual SUC Per UM					$ 3,347.58

FAC 1221 Marine Fueling Facility

FY25 SUC:	$1,104.53 / OL
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Study of Fuel Facilities

DLA 2018 Study of Fuel Facilities.

MLA = Marine Loading Arm

API = American Petroleum Institute

RMMR = Recurring Maintenance and Minor Repair program

Design Life and Representative Size	35	Years	5	OL	
Component	Frequency	Estimated Cost per Occurrence	Occurences in design life	Occurrences rounded	Design Life Cost
Outlets					
Recoating MLA (Weighting Factor of 0.167	20	$ 214,906.12	1.8	1.0	$ 35,979.76
Pipeline					
API 570 Inspection (200 LF @ $17.96)	10	$ 3,592.00	3.5	3.0	$ 10,776.00
Recoating (200 LF@26.99)	10	$ 5,398.00	3.5	3.0	$ 16,194.00
Cathodic Protection	1	$ 54.00	35.0	35.0	$ 1,890.00
Additional Costs					
Planning Studies I & II	1	$ 1,169.55	35.0	35.0	$ 40,934.25
SIOH	1	$ 820.38	35.0	35.0	$ 28,713.30
RMMR	1	$ 160.00	35.0	35.0	$ 5,600.00
Operator Maintenance	1	$ 154.66	35.0	35.0	$ 5,413.10
Total					$ 145,500
Annual SUC Per UM					$ 831.43

FAC 1231 Vehicle Fueling Facility

FY25 SUC:	$7,602.66 / OL
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Study of Fuel Facilities

DLA 2018 Study of Fuel Facilities.
RMMR = Recurring Maintenance and Minor Repair program

FAC 1231 Vehicle Fueling Facility					
Design Life and Representative Size	25	Years	2	OL	
Component	Frequency	Estimated Cost per Occurrence	Occurrences in design life	Occurrences rounded	Design Life Cost
Outlets					
Hose Repair/Replace	15	$ 2,172.00	1.7	1.0	$ 2,172
Valve Repair/Replace	15	$ 2,483.00	1.7	1.0	$ 2,483
Dispenser repair/replace	15	$ 38,795.00	1.7	1.0	$ 38,795
Asset Maintenance	15	$ 89,721.00	1.7	1.0	$ 89,721
Pre-Post Cost	15	$ 9,857.00	1.7	1.0	$ 9,857
Additional Costs					
Planning Studies I & II	1	$ 467.82	25.0	25.0	$ 11,696
SIOH	1	$ 161.50	25.0	25.0	$ 4,038
RMMR	1	$ 5,035.00	25.0	25.0	$ 125,875
Operator Maintenance	1	$ 60.26	25.0	25.0	$ 1,507
Total					$ 286,143
Annual SUC Per UM					$ 5,722.85

FAC 1241 Aircraft Operating Fuel Storage

FY25 SUC:	$2.13 / GA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Study of Fuel Facilities

DLA 2018 Study of Fuel Facilities.
RMMR = Recurring Maintenance and Minor Repair program.

FAC 1241 Aircraft Operating Fuel Storage					
Design Life	**40**	**Years**			
Representative Size	**60,000**	**GA**			
Component	**Frequency**	**Estimated Cost per Occurrence**	**Occurrences in Design Life**	**Occurrences Rounded**	**Design Life Cost**
Exterior Inspection Cost Total	5	$ 18,093.08	8.0	8.0	$ 144,744.68
Internal Inspection Cost Total	10	$ 165,042.79	4.0	4.0	$ 660,171.15
Internal Tank Repair Totals	10	$ 278,567.87	4.0	4.0	$ 1,114,271.47
External Tank Repair Totals	5	$ 143,622.65	8.0	8.0	$ 1,148,981.21
Pre-Post Cost Total	10	$ 125,053.38	4.0	4.0	$ 500,213.53
RMMR	1	$ 385.00	40.0	40.0	$ 15,400.00
SIOH	1	$ 300.00	40.0	40.0	$ 12,000.00
Cathodic Protection	1	$ 191.27	40.0	40.0	$ 7,650.72
Operator Maintenance	1	$ 6,350.01	40.0	40.0	$ 254,000.40
Total					$ 3,857,433.15
Per Year					$ 96,435.83
Annual SUC Per UM					$ 1.61

FAC 1242 Marine Operating Fuel Storage

FY25 SUC:	$2.13 / GA
Source:	Set to FAC 1241; 2018 DLA Study of Fuel Facilities

FAC 1243 Vehicle Operating Fuel Storage

FY25 SUC:	$1.32 / GA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Study of Fuel Facilities

DLA 2018 Study of Fuel Facilities

RMMR = Recurring Maintenance and Minor Repair program

Design Life	**35**	**Years**			
Representative Size	**10000**	**GA**			
Component	**Frequency**	**Estimated Cost per Occurrence**	**Occurrences in Design Life**	**Occurrences Rounded**	**Design Life Cost**
Inspection Cost Total	10	$ 31,051.80	3.5	3.0	$ 93,155.40
Repair Cost Total	10	$ 48,994.31	3.5	3.0	$ 146,982.93
Pre-Post Cost Total	10	$ 25,802.36	3.5	3.0	$ 77,407.08
RMMR	1	$ 75.00	35.0	35.0	$ 2,625.00
SIOH	1	$ 50.00	35.0	35.0	$ 1,750.00
Cathodic Protection	1	$ 31.88	35.0	35.0	$ 1,115.80
Operator Maintenance	1	$ 738.81	35.0	35.0	$ 25,858.35
Total					$ 348,894.56
Per Year					$ 9,968.42
Annual SUC Per UM					$ 1.00

FAC 1244 Other Operating Fuel Storage

FY25 SUC:	$2.57 / GA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Energy Study of Fuel Facilities

DLA 2018 Study of Fuel Facilities.
RMMR = Recurring Maintenance and Minor Repair program.

Design Life	**35**	**Years**			
Representative Size	**7,700**	**GA**			
Component	**Frequency**	**Estimated Cost per Occurrence**	**Occurrences in Design Life**	**Occurrences Rounded**	**Design Life Cost**
Inspection Cost Total	10	$ 27,236.23	3.5	3.0	$ 81,708.69
Repair Cost Total	10	$ 132,855.88	3.5	3.0	$ 398,567.64
Pre-Post Cost Total	10	$ 3,975.72	3.5	3.0	$ 11,927.16
RMMR	1	$ 49	35.0	35.0	$ 1,715.00
SIOH	1	$ 39	35.0	35.0	$ 1,347.50
Cathodic Protection	1	$ 24.55	35.0	35.0	$ 859.25
Operator Maintenance	1	$ 738.81	35.0	35.0	$ 25,858.35
Total					$ 521,983.59
Per Year					$ 14,913.82
Annual SUC Per UM					$ 1.94

FAC 1251 POL Pipeline

FY25 SUC:	$12.57 / LF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Study of Fuel Facilities

FAC 1251 POL PIPELINE

DLA 2018 Study of Fuel Facilities.

API = American Petroleum Institute.

RMMR = Recurring Maintenance and Minor Repair program.

Design Life	**45**	**Years**			
Representative Size	**1**	**FT**			
Component	**Frequency**	**Estimated Cost per Occurrence**	**Occurrences in Design Life**	**Occurrences Rounded**	**Design Life Cost**
Repairs					
Large Section Replacement, Major Repair (20)	20	$ 36.86	2.3	2.0	$ 73.72
Minor Valve Repairs (5)	10	$ 21.42	4.5	4.0	$ 85.68
Minor Pipe Repairs (5)	10	$ 15.75	4.5	4.0	$ 63.00
Inspection					
API 570 Inspection (UFC 3-460-03) (5)	10	$ 17.96	4.5	4.0	$ 71.84
Coating					
Exterior cleaning and recoating (10)	10	$ 26.99	4.5	4.0	$ 107.96
Pre-Post Cost	10	$ 0.81	4.5	4.0	$ 3.24
RMMR	1	$ 0.01	45.0	45.0	$ 0.45
SIOH	1	$ 0.01	45.0	45.0	$ 0.45
Cathodic Protection	1	$ 0.27	45.0	45.0	$ 12.15
Operator Maintenance	1	$ 0.16	45.0	45.0	$ 7.20
Total					$ 425.69
Annual SUC Per UM					$ 9.46

FAC 1252 POL Piping

FY25 SUC:	$12.57 / LF
Source:	Set to FAC 1251; 2018 DLA Study of Fuel Facilities

FAC 1261 Liquid Fuel Loading/Unloading Facility

FY25 SUC:	$7,912.23 / OL
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Energy Study Hybrid with CostWorks Components

FAC 1261 LIQUID FUEL LOADING / UNLOADING FACILITY

DLA 2018 Study of Fuel Facilities; calculation below.

RMMR = Recurring Maintenance and Minor Repair program.

Design Life	30	Years			
Representative Size	3	OL			
Component	**Frequency**	**Estimated Cost per Occurrence**	**Occurrences in Design Life**	**Occurrences Rounded**	**Design Life Cost**
RS Means Cost Works					
Clean separator strainer	10	$2,613.66	3.0	3.0	$7,840.98
Maintenance and repair motor starter, up to 600 V	5	$720.54	6.0	6.0	$4,323.24
Maintenance and repair breaker, molded case, 480 V, 3 pole	20	$245.76	1.5	1.0	$245.76
Maintenance and inspection circuit breaker, molded case, 480 V, 3 pole	1	$110.58	60.0	60.0	$6,634.80
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	$138.24	3.8	3.0	$414.72
Maintenance and repair electrical service ground	25	$103.36	1.2	1.0	$103.36
Maintenance and repair of general wiring lightning protection system	1	$111.47	30.0	30.0	$3,344.10
Replace lightning ground rod	25	$793.35	1.2	1.0	$793.35
Maintenance and repair special ground system	4	$73.74	7.5	7.0	$516.18
Replace 400W H.P.S. pole-mounted fixture w/ lamp and ballast	20	$6,200.12	1.5	1.0	$6,200.12
Costs Captured Through DLA Study					
Pipeline Repairs	20	$84,426.80	1.5	1.0	$84,426.80
Valve Repairs	20	$39,117.87	1.5	1.0	$39,117.87
Truck Stand Repairs	20	$177,362.09	1.5	1.0	$177,362.09
Pre-Post Costs	20	$11,556.39	1.5	1.0	$11,556.39
Additional Costs					
Planning Studies I & II	1	$701.73	30.0	30.0	$21,051.90
SIOH	1	$421.46	30.0	30.0	$12,643.80
RMMR	1	$2,817.00	30.0	30.0	$84,510.00
Operator Maintenance	1	$2,498.15	30.0	30.0	$74,944.50
Total					$536,029.96
Annual SUC Per UM					$5,955.89

FAC 1262 POL Pump Station

FY25 SUC:	$18.23 / GM
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1311 Communications Building

FY25 SUC:	$9.26 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1312 Satellite Communications Building

FY25 SUC:	$17.34 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1321 Communications Facility/Tower

FY25 SUC:	$941.95 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1331 Aircraft Navigation Building

FY25 SUC:	$8.86 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1341 Aircraft Navigation Facility

FY25 SUC:	$159.09 / EA
Source:	Set to FAC 1403: Cost Works Model; UM conversion factor = 20 SF

FAC 1351 Communications Lines

FY25 SUC:	$538.37 / MI
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1352 Communications Cabling, Fiber/Copper Above Ground

FY25 SUC:	$650.07 / MI
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1352 Communications Cabling, Fiber/Copper Above Ground

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $650.07
UM: MI
Expected Service Life: 30
Model Size: 1

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair telephone cable, #22-4 conductor	8	5.28 M.L.F.	$324.11	$398.10	3.7500	3	3	$1,194.31	$1,194.31
Maintenance and repair special ground system	4	0.25 Ea.	$5.81	$7.29	7.5000	7	7	$51.04	$51.04
Cable inspection overhead service, splice	5	5.28 M.L.F.	$264.49	$331.80	6.0000	6	6	$1,990.79	$1,990.79
Replace service cable overhead service, splice	30	1.12 M.L.F.	$10,097.86	$11,715.65	1.0000	1	1	$11,715.65	$11,715.65
Replace light pole, 2 fixtures, concrete base not included	10	0.10 Ea.	$1,302.99	$1,516.79	3.0000	3	3	$4,550.36	$4,550.36
			$11,995.26	$13,969.63				MR Subtotal:	$19,502.15
								MR Per Year:	$650.07
								PM Total:	$0.00
								Subtotal:	$650.07
								Total Per Unit:	$650.07

FAC 1352 Communications Cabling, Fiber/Copper Above Ground

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $650.07
UM: MI
Expected Service Life: 30
Model Size: 1

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
						$0.00	$0.00	$0.00

FAC 1353 Communications Cabling, Fiber/Copper Below Ground

FY25 SUC:	$914.78 / MI
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1353 Communications Cabling, Fiber/Copper Below Ground

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $914.78
UM: MI
Expected Service Life: 30
Model Size: 1

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	12.00 S.F.	$488.21	$594.60	2.0000	2	2	$1,189.21	$1,189.21
Replace pipe, 4" pipe and fittings, PVC	30	131.00 L.F.	$12,274.50	$15,021.75	1.0000	1	1	$15,021.75	$15,021.75
Clean floor drain w/o bucket	4	4.00 Ea.	$494.51	$619.35	7.5000	7	7	$4,335.43	$4,335.43
Repair telephone cable, #22-4 conductor	8	5.28 M.L.F.	$324.11	$398.10	3.7500	3	3	$1,194.31	$1,194.31
Maintenance and repair special ground system	4	4.00 Ea.	$92.99	$116.65	7.5000	7	7	$816.57	$816.57
Maintenance and inspection patch panel	0.5	0.25 Ea.	$23.13	$29.01	60.0000	60	60	$1,740.63	$1,740.63
Raise MH or catch basin frame and cover	10	2.00 Ea.	$860.25	$1,048.47	3.0000	3	3	$3,145.41	$3,145.41
			$14,557.70	$17,827.93				MR Subtotal:	$27,443.31
								MR Per Year:	$914.78
								PM Total:	$0.00
								Subtotal:	$914.78
								Total Per Unit:	$914.78

FAC 1353 Communications Cabling, Fiber/Copper Below Ground

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $914.78
UM: MI
Expected Service Life: 30
Model Size: 1

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
						$0.00	$0.00	$0.00

FAC 1354 Communications Cabling, Underwater/Marinized

FY25 SUC:	$3,857.27 / MI
Source:	Multiple Industry Studies

Study	Cost to Repair / Incident	Frequency / Mile / Year	Publication Date	Escalation to FY25 (ENR)	Adjusted Cost
ICPC, Veverka, 2014 Proceedings SubOptic 1997, Shapiro, et al	$2,000,000.00	0.000708	2014	1.6791	$2,377.89
			Annual Maintenance Cost per Capital Cost	**PRV / Mile (FY25$)**	
IEEE, Wang, et al 2019			4%	$133,416.31	$5,336.65
				Average	$3,857.27

Under the Sea, Veverka, Dean, International Cable Protection Committee, 2014

Threats to Submarine Cables, Shapiro, el al, Proceedings SubOptic 1997, San Francisco

Cost-Effective Path Planning for Submarine Cable Network Extension, Wang, et al, IEEE 2019

FAC 1361 Airfield Pavement Lighting

FY25 SUC:	$10.80 / LF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	PACES 1.4, FY22

FAC 1361 AIRFIELD PAVEMENT LIGHTING

PACES 1.4 FY22

Program: PACES SUC Calculations for FY22

Project: FAC 1361 SUC FY22 AIRFIELD PVMNT LIGHTING

17 Nov 2021

5:22 PM

Assembly		Quantity UOM	Unit Cost	Material	Labor	Equipment	SubBid	Total Cost
Facility: Runway/Taxiway			**Type: Primary Facilities**					
			Size: 10,000					
Assembly		**Quantity UOM**	**Unit Cost**	**Material**	**Labor**	**Equipment**	**SubBid**	**Total Cost**
G2060042613	Runway Edge Lights	0.20 KLF	$217,532.14	$25,868.49	$17,348.77	$289.17	$0.00	$43,506.43
G2060042614	Runway Centerline Lights	0.10 KLF	$245,277.89	$32,233.65	$16,574.07	$247.86	$0.00	$49,055.58
							Total	$ 92,562.01
							Per UM	$ 9.26

Based on 10,000 LF paved runway.

FAC 1362 Airfield Lighting

FY25 SUC:	$144.50 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	PACES 1.2, FY19.

FAC 1362 AIRFIELD LIGHTING

PACES 1.2, FY19.

Model Size	10,000									
ESL	20									
FAC 1362 - Airfield Lighting										
Assembly	**Description**	**Freq**	**Qty**	**UM**	**Material**	**Labor**	**Equipment**	**Total w/OP**	**Occ**	**Total for Assembly**
G2060042610	Runway Approach Lighting	10	2	EA	$681,750.72	$64,618.24	$2,049.75	$1,496,837.42	2	$2,993,674.84
G2060042611	End Of Runway Lighting	10	2	EA	$300,524.74	$124,491.97	$7,686.63	$865,406.67	2	$1,730,813.34
G2060042612	Touchdown Zone	10	2	EA	$289,402.38	$35,286.17	$2,196.16	$653,769.43	2	$1,307,538.86
G2060042620	Taxiway Edge Lights	5	0.28	KLF	$79,555.18	$10,005.66	$805.26	$2,530,250.77	4	$10,121,003.08
G2060042621	Taxiway Centerline Lights	5	0.14	KLF	$60,834.91	$10,766.89	$658.85	$1,011,649.06	4	$4,046,596.24
G2060042630	Aircraft Parking Area Perimeter Lighting	5	0.92	KLF	$34,350.73	$7,524.65	$439.23	$389,294.37	4	$1,557,177.48
									Total M&R	$21,756,803.84
									M&R per Year	$1,087,840.19
									SUC	$108.78

FAC 1371 Ship Navigation Building

FY25 SUC:	$6.59 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1381 Ship Navigation Facility

FY25 SUC:	$374.49 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1402 Air Defense Operations Building

FY25 SUC:	$5.99 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1403 Missile Operations Building

FY25 SUC:	$7.95 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1404 Emergency Operations Center

FY25 SUC:	$6.26 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1404 Emergency Operations Center

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $6.26
UM: SF
Expected Service Life: 45
Model Size: 12444

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	350.00 S.F.	$14,239.53	$17,342.62	3.0000	3	3	$52,027.86	$52,027.86
Replace hardboard panels, 1st floor	12	20.00 C.S.F.	$7,810.51	$9,424.23	3.7500	3	3	$28,272.69	$28,272.69
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	7.00 S.F.	$95.56	$112.20	45.0000	45	45	$5,049.19	$5,049.19
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	36.00 Ea.	$5,813.93	$6,928.41	2.2500	2	2	$13,856.82	$13,856.82
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	3.2143	3	3	$8,286.91	$8,286.91
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	11.2500	11	11	$1,938.83	$1,938.83
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	1.0000	1	1	$2,569.71	$2,569.71
Replace tempered glass - (3% of glass) steel painted door	1	0.10 S.F.	$3.29	$3.89	45.0000	45	45	$175.02	$175.02
Prepare and refinish 3'-0" x 7'-0" steel painted. door	4	2.00 Ea.	$179.33	$221.31	11.2500	11	11	$2,434.38	$2,434.38
Replace 3'-0" x 7'-0" steel, with wire glass, door	45	2.00 Ea.	$3,355.81	$3,892.63	1.0000	1	1	$3,892.63	$3,892.63
Non - destructive moisture inspection, thermosetting	5	1.00 M.S.F.	$126.41	$154.38	9.0000	9	9	$1,389.41	$1,389.41
Minor membrane repairs, 2% of roof area, thermoset	1	0.03 Sq.	$9.73	$11.59	45.0000	45	45	$521.62	$521.62
Total EPDM roof replacement	25	124.00 Sq.	$101,692.06	$119,677.53	1.8000	1	1	$119,677.53	$119,677.53
Repair 8" concrete block wall - (2% of walls) painted	25	5.30 C.S.F.	$6,444.47	$7,740.77	1.8000	1	1	$7,740.77	$7,740.77
Refinish concrete block wall painted	4	53.00 C.S.F.	$7,269.11	$8,739.01	11.2500	11	11	$96,129.08	$96,129.08
Repair steel painted interior door	14	4.00 Ea.	$1,187.40	$1,385.29	3.2143	3	3	$4,155.86	$4,155.86
Refinish 3'-0" x 7'-0" steel painted interior door	4	4.00 Ea.	$240.81	$296.10	11.2500	11	11	$3,257.08	$3,257.08
Repair solid core wood door, interior	11	13.00 Ea.	$3,859.05	$4,502.18	4.0909	4	4	$18,008.73	$18,008.73
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	13.00 Ea.	$710.86	$864.79	11.2500	11	10	$9,512.65	$8,647.87
Replace 3'-0" x 7'-0" solid core wood door, interior	40	13.00 Ea.	$8,369.11	$9,649.91	1.1250	1	1	$9,649.91	$9,649.91
Repair fabric wall finish fabric interior	9	125.00 S.Y.	$4,812.27	$5,736.36	5.0000	5	5	$28,681.80	$28,681.80
Repair 5/8" drywall - (2% of walls)	20	418.80 S.F.	$782.32	$951.57	2.2500	2	2	$1,903.15	$1,903.15
Refinish drywall	4	9,600.00 S.F.	$6,931.75	$8,499.88	11.2500	11	11	$93,498.66	$93,498.66
Office painting, 10' x 12', 10' high walls	5	14.00 Ea.	$3,649.48	$4,458.37	9.0000	9	9	$40,125.35	$40,125.35
Replace vinyl tile flooring	18	19.10 S.Y.	$1,080.26	$1,322.28	2.5000	2	2	$2,644.55	$2,644.55
Replace rubber cove base	9	1,200.00 L.F.	$4,475.20	$5,338.73	5.0000	5	5	$26,693.66	$26,693.66
Terrazzo floor repairs - (2% of floors)	15	18.50 S.F.	$345.55	$412.68	3.0000	3	3	$1,238.04	$1,238.04
Replace carpet	8	260.00 S.Y.	$14,481.61	$16,746.81	5.6250	5	5	$83,734.06	$83,734.06
Replace gypsum board ceiling, up to 12' high	40	6.20 C.S.F.	$2,596.99	$3,185.42	1.1250	1	1	$3,185.42	$3,185.42
Acoustic tile repairs - (2% of ceilings)	9	2.64 C.S.F.	$3,037.88	$3,520.93	5.0000	5	5	$17,604.65	$17,604.65
Replace acoustic tile ceiling, fire-rated	20	90.00 C.S.F.	$56,222.34	$66,117.21	2.2500	2	2	$132,234.42	$132,234.42
Replace flush valve diaphragm tankless water closet	10	10.00 Ea.	$275.90	$342.76	4.5000	4	4	$1,371.05	$1,371.05
Rebuild flush valve tankless water closet	20	10.00 Ea.	$1,932.71	$2,329.54	2.2500	2	2	$4,659.08	$4,659.08
Unplug clogged line tankless water closet	5	10.00 Ea.	$2,297.81	$2,877.88	9.0000	9	9	$25,900.91	$25,900.91
Replace tankless water closet	35	10.00 Ea.	$13,766.57	$15,931.96	1.2857	1	1	$15,931.96	$15,931.96
Replace tankless flush valve	25	10.00 Ea.	$2,726.55	$3,200.28	1.8000	1	1	$3,200.28	$3,200.28
Replace wax ring gasket for tankless water closet	5	10.00 Ea.	$1,497.55	$1,873.82	9.0000	9	9	$16,864.38	$16,864.38
Replace flush valve diaphragm for a urinal	7	3.00 Ea.	$82.77	$102.83	6.4286	6	6	$616.97	$616.97
Rebuild flush valve for a urinal	20	3.00 Ea.	$579.81	$698.86	2.2500	2	2	$1,397.72	$1,397.72
Unplug line urinal	5	3.00 Ea.	$458.71	$574.51	9.0000	9	9	$5,170.58	$5,170.58
Replace wall-hung urinal	35	3.00 Ea.	$3,276.87	$3,943.16	1.2857	1	1	$3,943.16	$3,943.16
Replace washer in spud connection lavatory, vitreous china	7	12.00 Ea.	$208.72	$254.80	6.4286	6	6	$1,528.83	$1,528.83
Replace washer in faucet lavatory, vitreous china	2	12.00 Ea.	$163.17	$203.55	22.5000	22	22	$4,478.19	$4,478.19
Replace faucets lavatory, vitreous china	10	12.00 Ea.	$2,383.47	$2,865.40	4.5000	4	4	$11,461.61	$11,461.61
Clean out strainer and P trap lavatory, vitreous china	2	12.00 Ea.	$445.06	$557.41	22.5000	22	22	$12,263.06	$12,263.06
Replace lavatory, vitreous china	35	12.00 Ea.	$9,016.51	$10,810.62	1.2857	1	1	$10,810.62	$10,810.62
Check / minor repairs drinking fountain	1	2.00 Ea.	$103.89	$130.11	45.0000	45	45	$5,855.17	$5,855.17
Repair internal leaks drinking fountain	4	2.00 Ea.	$95.58	$119.71	11.2500	11	11	$1,316.76	$1,316.76
Correct water pressure drinking fountain	2	2.00 Ea.	$88.31	$110.60	22.5000	22	22	$2,433.15	$2,433.15
Replace refrigerant drinking fountain	2	2.00 Ea.	$73.54	$85.99	22.5000	22	22	$1,891.88	$1,891.88
Repair drain leak drinking fountain	4	2.00 Ea.	$61.02	$73.62	11.2500	11	9	$809.79	$662.55
Replace fountain drinking fountain	10	2.00 Ea.	$3,046.79	$3,588.88	4.5000	4	4	$14,355.52	$14,355.52
Drain and flush water heater, electric, 120 gallon	7	2.00 Ea.	$621.26	$778.09	6.4286	6	6	$4,668.52	$4,668.52
Check operation water heater, electric, 120 gallon	3	2.00 Ea.	$5.44	$6.82	15.0000	15	15	$102.27	$102.27
Replace water heater, electric, 120 gallon	15	1.00 Ea.	$15,946.05	$18,237.49	3.0000	3	3	$54,712.47	$54,712.47
Unclog floor drain, PVC	20	4.00 Ea.	$201.54	$252.42	2.2500	2	2	$504.85	$504.85
General maintenance & repair drain: roof, scupper, area	1	1.00 Ea.	$39.22	$49.12	45.0000	45	45	$2,210.33	$2,210.33
Replace drain: roof, scupper, area	40	1.00 Ea.	$1,096.36	$1,265.22	1.1250	1	1	$1,265.22	$1,265.22
Repair boiler, gas, 250 MBH	7	1.00 Ea.	$2,552.63	$2,989.56	6.4286	6	5	$17,937.36	$14,947.80
Replace boiler, gas, 250 MBH	30	1.00 Ea.	$1,636.25	$2,049.31	1.5000	1	1	$2,049.31	$2,049.31
Repair fan coil unit, 20 ton	10	2.00 Ea.	$3,522.95	$4,075.46	4.5000	4	3	$16,301.85	$12,226.38
Replace fan coil unit, 20 ton	15	2.00 Ea.	$18,926.39	$22,213.46	3.0000	3	3	$66,640.38	$66,640.38
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	1.00 Ea.	$4,344.36	$5,039.65	2.2500	2	2	$10,079.30	$10,079.30
Repair circulator pump, 1/12 - 3/4 H.P.	5	1.00 Ea.	$104.83	$123.65	9.0000	9	6	$1,112.82	$741.88
Replace circulator pump, 1/12 - 3/4 H.P.	15	1.00 Ea.	$3,687.87	$4,253.96	3.0000	3	3	$12,761.87	$12,761.87
Repair computer room air conditioner, air cooled, 5 ton	10	1.00 Ea.	$4,758.71	$5,661.71	4.5000	4	4	$22,646.84	$22,646.84
Replace computer room air conditioner, air cooled, 5 ton	20	1.00 Ea.	$40,439.57	$46,356.83	2.2500	2	2	$92,713.67	$92,713.67
Replace multi-zone variable volume, 50 ton	15	1.00 Ea.	$141,742.49	$164,363.22	3.0000	3	3	$493,089.65	$493,089.65
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	45.0000	45	45	$2,043.45	$2,043.45
Replace sprinkler head	20	90.00 Ea.	$8,252.16	$10,169.75	2.2500	2	2	$20,339.50	$20,339.50
Repair switchgear 1200 A mainframe	5	1.00 Ea.	$2,068.68	$2,420.08	9.0000	9	7	$21,780.68	$16,940.53
Maintenance and inspection switchgear, mainframe	1	1.00 Ea.	$69.98	$87.79	45.0000	45	45	$3,950.77	$3,950.77
Replace switchgear 1200 A mainframe	20	1.00 Ea.	$4,508.06	$5,431.65	2.2500	2	2	$10,863.30	$10,863.30
Maintenance and repair motor starter, up to 600 V	5	2.00 Ea.	$699.10	$837.86	9.0000	9	9	$7,540.73	$7,540.73
Maintenance and inspection motor starter, up to 600 V	0.5	2.00 Ea.	$116.84	$146.58	90.0000	90	90	$13,192.14	$13,192.14
Replace starter motor starter, up to 600 V	18	2.00 Ea.	$1,637.91	$1,954.90	2.5000	2	2	$3,909.80	$3,909.80
Maintenance and inspection lighting panel, indoor	3	4.00 Ea.	$175.26	$219.87	15.0000	15	15	$3,298.03	$3,298.03
Repair failed breaker, enclosed, 600 V, 3 pole	4	8.00 Ea.	$9,637.90	$11,125.86	11.2500	11	11	$122,384.42	$122,384.42
Maintenance and inspection circuit breaker, enclosed, 600 V, 3 pole	0.33	8.00 Ea.	$277.50	$348.13	136.3636	136	136	$47,345.12	$47,345.12
Maintenance and repair receptacles and plugs	20	68.00 Ea.	$3,111.62	$3,887.92	2.2500	2	2	$7,775.84	$7,775.84
Maintenance and repair wiring devices, switches	10	68.00 Ea.	$3,111.62	$3,887.92	4.5000	4	4	$15,551.69	$15,551.69
Replace wiring devices, switches	15	42.00 Ea.	$2,920.45	$3,636.53	3.0000	3	3	$10,909.60	$10,909.60
Maintenance and repair incandescent lighting fixtures	10	10.00 Ea.	$743.31	$885.15	4.5000	4	2	$3,540.60	$1,770.30
Replace incandescent lighting fixture lamp	5	10.00 Ea.	$136.33	$163.89	9.0000	9	9	$1,475.00	$1,475.00
Replace incandescent lighting fixture	20	10.00 Ea.	$1,478.87	$1,791.70	2.2500	2	2	$3,583.39	$3,583.39
Replace fluorescent light fixture ballast, 80 W	10	90.00 Ea.	$9,803.88	$12,089.46	4.5000	4	4	$48,357.83	$48,357.83
Replace lamps (2 lamps), 4', 34 W energy saver	10	90.00 Ea.	$2,443.65	$3,064.16	4.5000	4	4	$12,256.62	$12,256.62
Repair smoke detector	10	23.00 Ea.	$1,397.60	$1,729.72	4.5000	4	3	$6,918.88	$5,189.16
Check operation smoke detector	1	23.00 Ea.	$401.71	$503.94	45.0000	45	45	$22,677.43	$22,677.43
Replace smoke detector	15	23.00 Ea.	$7,760.69	$9,234.67	3.0000	3	3	$27,704.00	$27,704.00
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	4.5000	4	3	$2,805.76	$2,104.32
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	3.0000	3	3	$4,977.08	$4,977.08
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	9.0000	9	9	$1,758.83	$1,758.83
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	90.0000	90	90	$5,221.89	$5,221.89
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.0000	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	4.00 Ea.	$801.74	$971.29	2.2500	2	2	$1,942.57	$1,942.57
Maintenance and repair of general wiring lightning protection system	1	1.00 M.L.F.	$111.32	$137.36	45.0000	45	45	$6,181.17	$6,181.17
Replace lightning protection general wiring system	25	1.00 M.L.F.	$13,424.28	$15,895.64	1.8000	1	1	$15,895.64	$15,895.64
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	45.0000	45	44	$21,479.92	$21,002.59
Replace lightning ground rod	25	4.00 Ea.	$1,031.13	$1,274.23	1.8000	1	1	$1,274.23	$1,274.23
Maintenance and repair computer ground system	4	1.00 Ea.	$23.25	$29.16	11.2500	11	11	$320.79	$320.79
Maintenance and inspection generator, diesel, 750 KW	0.08	1.00 Ea.	$69.98	$87.79	562.5000	562	562	$49,340.74	$49,340.74
Replace diesel generator component, 750 KW	25	1.00 Ea.	$267,089.75	$305,754.14	1.8000	1	1	$305,754.14	$305,754.14
Replace lamp with exit light L.E.D. retrofit kits	15	4.00 Ea.	$412.07	$474.66	3.0000	3	3	$1,423.98	$1,423.98
Maintenance and inspection UPS battery	0.17	1.00 Ea.	$69.98	$87.79	264.7059	264	264	$23,177.86	$23,177.86
Replace motor generator UPS battery	15	1.00 Ea.	$1,195.58	$1,413.61	3.0000	3	3	$4,240.84	$4,240.84
Maintenance and repair voice/data outlet	10	24.00 Ea.	$1,336.65	$1,670.76	4.5000	4	4	$6,683.02	$6,683.02
Maintenance and inspection patch panel	0.5	4.00 Ea.	$370.00	$464.17	90.0000	90	90	$41,775.11	$41,775.11
Replace patch panel	15	4.00 Ea.	$3,788.72	$4,553.23	3.0000	3	3	$13,659.68	$13,659.68
			$902,101.94	$1,053,547.03				MR Subtotal:	$2,681,017.15
								MR Per Year:	$59,578.16
								PM Total:	$18,294.71
								Subtotal:	$77,872.87
								Total Per Unit:	$6.26

FAC 1404 Emergency Operations Center

Release:	2024 Qtr 3	FY25 SUC:	$6.26
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	45
		Model Size:	12444

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Fire doors, swinging, annualized	3	1.18	$43.47	$48.22	$0.0000	91.69	110.51	131.49
Urinals, annualized	3	0.68	$20.52	$36.80	$0.0000	57.32	70.41	84.53
Toilet (vacuum breaker type), annualized	10	1.77	$91.84	$95.60	$0.0000	187.44	225.30	267.75
Lavatories, annualized	12	4.18	$92.62	$263.95	$0.0000	356.57	445.02	538.10
Drink fountain, annualized	2	1.24	$72.30	$66.83	$0.0000	139.13	166.41	197.31
Air handling unit, computer room, annualized	1	3.42	$97.70	$183.58	$0.0000	281.28	346.13	415.86
Fan coil unit, annualized	2	6.68	$171.95	$358.70	$0.0000	530.66	655.46	788.87
VAV Boxes, annualized	14	13.08	$133.36	$835.00	$0.0000	968.36	1,232.20	1,502.70
Fan, axial, up to 5,000 CFM, annually	1	0.62	$6.89	$33.42	$0.0000	40.30	51.02	62.08
Package unit, air cooled, 25 thru 50 ton, annualized	1	3.25	$165.11	$208.12	$0.0000	373.23	452.18	539.38
Package unit, computer room, annually	1	1.41	$76.21	$90.52	$0.0000	166.73	201.51	240.09
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Circuit breaker, high voltage air, annualized	2	0.94	$33.03	$66.73	$0.0000	99.77	123.09	148.06
Switch, automatic transfer, annualized	1	5.32	$16.52	$378.48	$0.0000	395.00	510.19	626.21
Panelboard, 225 A and above, annualized	4	1.76	$103.79	$125.50	$0.0000	229.29	277.32	330.53
Fire alarm annuciator system, annualized	1	11.05	$195.61	$697.20	$0.0000	892.81	1,121.53	1,360.03
Emergency diesel or gas generator, over 15 KVA, annually	1	2.11	$88.82	$133.46	$0.0000	222.29	271.21	324.57
Power stablizer, annualized	2	1.25	$21.96	$78.68	$0.0000	100.64	126.44	153.34
Uninterrupted power system, 200 KVA to 800 KVA, annualized	1	78.06	$264.47	$4,930.20	$0.0000	5,194.67	6,700.18	8,218.91
Battery system and charger, annualized	1	8.73	$21.96	$552.78	$0.0000	574.74	742.77	911.89
Light, emergency, wet cell, annualized	1	0.39	$37.42	$24.90	$0.0000	62.32	73.54	86.62
						$11,844.04	$15,022.56	$18,294.71

FAC 1405 Secure Operational, Storage, and Information Technology Building

FY25 SUC:	$8.63 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1405 Secure Operational, Storage, and Information Technology Building

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $8.63
UM: SF
Expected Service Life: 45
Model Size: 11033

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair 8" concrete block wall, 1st floor	25	4,300.00 S.F.	$115,125.61	$140,838.20	1.8000	1	1	$140,838.20	$140,838.20
Waterproof concrete block wall, 1st floor	10	43.00 C.S.F.	$8,343.85	$10,054.51	4.5000	4	4	$40,218.05	$40,218.05
Replace hardboard panels, 1st floor	12	20.00 C.S.F.	$7,810.51	$9,424.23	3.7500	3	3	$28,272.69	$28,272.69
Refinish synthetic veneer plaster, 1st floor	10	225.00 C.S.F.	$80,834.09	$95,676.77	4.5000	4	4	$382,707.09	$382,707.09
Refinish aluminum louver, 1st floor	5	2.00 Ea.	$220.97	$273.43	9.0000	9	9	$2,460.90	$2,460.90
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	3.2143	3	3	$8,286.91	$8,286.91
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	11.2500	11	11	$1,938.83	$1,938.83
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	1.0000	1	1	$2,569.71	$2,569.71
Replace door panic device	25	3.00 Ea.	$7,112.86	$8,129.08	1.8000	1	1	$8,129.08	$8,129.08
Non - destructive moisture inspection, thermosetting	5	4.30 M.S.F.	$543.56	$663.83	9.0000	9	9	$5,974.45	$5,974.45
Minor membrane repairs, 2% of roof area, thermoset	1	0.86 Sq.	$321.92	$383.41	45.0000	45	45	$17,253.46	$17,253.46
Total EPDM roof replacement	25	110.00 Sq.	$90,210.69	$106,165.55	1.8000	1	1	$106,165.55	$106,165.55
Repair 8" concrete block wall - (2% of walls) painted	25	10.60 C.S.F.	$12,888.95	$15,481.55	1.8000	1	1	$15,481.55	$15,481.55
Refinish concrete block wall painted	4	230.00 C.S.F.	$31,545.19	$37,923.99	11.2500	11	11	$417,163.92	$417,163.92
Repair steel painted interior door	14	9.00 Ea.	$2,671.65	$3,116.90	3.2143	3	3	$9,350.69	$9,350.69
Refinish 3'-0" x 7'-0" steel painted interior door	4	9.00 Ea.	$541.83	$666.22	11.2500	11	11	$7,328.42	$7,328.42
Repair solid core wood door, interior	11	4.00 Ea.	$1,187.40	$1,385.29	4.0909	4	4	$5,541.15	$5,541.15
Replace 3'-0" x 7'-0" solid core wood door, interior	40	4.00 Ea.	$2,575.11	$2,969.20	1.1250	1	1	$2,969.20	$2,969.20
Repair fabric wall finish fabric interior	9	125.00 S.Y.	$4,812.27	$5,736.36	5.0000	5	5	$28,681.80	$28,681.80
Repair 5/8" drywall - (2% of walls)	20	212.00 S.F.	$396.02	$481.69	2.2500	2	2	$963.39	$963.39
Refinish drywall	4	9,600.00 S.F.	$6,931.75	$8,499.88	11.2500	11	11	$93,498.66	$93,498.66
Office painting, 10' x 12', 10' high walls	5	14.00 Ea.	$3,649.48	$4,458.37	9.0000	9	9	$40,125.35	$40,125.35
Replace vinyl tile flooring	18	19.10 S.Y.	$1,080.26	$1,322.28	2.5000	2	2	$2,644.55	$2,644.55
Replace rubber cove base	9	1,200.00 L.F.	$4,475.20	$5,338.73	5.0000	5	5	$26,693.66	$26,693.66
Terrazzo floor repairs - (2% of floors)	15	18.50 S.F.	$345.55	$412.68	3.0000	3	3	$1,238.04	$1,238.04
Replace carpet	8	480.00 S.Y.	$26,735.29	$30,917.19	5.6250	5	5	$154,585.95	$154,585.95
Replace gypsum board ceiling, up to 12' high	40	6.20 C.S.F.	$2,596.99	$3,185.42	1.1250	1	1	$3,185.42	$3,185.42
Acoustic tile repairs - (2% of ceilings)	9	2.64 C.S.F.	$3,037.88	$3,520.93	5.0000	5	5	$17,604.65	$17,604.65
Replace acoustic tile ceiling, fire-rated	20	90.00 C.S.F.	$56,222.34	$66,117.21	2.2500	2	2	$132,234.42	$132,234.42
Replace flush valve diaphragm tankless water closet	10	9.00 Ea.	$248.31	$308.49	4.5000	4	4	$1,233.94	$1,233.94
Rebuild flush valve tankless water closet	20	9.00 Ea.	$1,739.44	$2,096.59	2.2500	2	2	$4,193.17	$4,193.17
Unplug clogged line tankless water closet	5	9.00 Ea.	$2,068.03	$2,590.09	9.0000	9	9	$23,310.82	$23,310.82
Replace wax ring gasket for tankless water closet	5	9.00 Ea.	$1,347.79	$1,686.44	9.0000	9	9	$15,177.94	$15,177.94
Replace flush valve diaphragm for a urinal	7	3.00 Ea.	$82.77	$102.83	6.4286	6	6	$616.97	$616.97
Rebuild flush valve for a urinal	20	3.00 Ea.	$579.81	$698.86	2.2500	2	2	$1,397.72	$1,397.72
Unplug line urinal	5	3.00 Ea.	$458.71	$574.51	9.0000	9	9	$5,170.58	$5,170.58
Replace wall-hung urinal	35	3.00 Ea.	$3,276.87	$3,943.16	1.2857	1	1	$3,943.16	$3,943.16
Replace washer in spud connection lavatory, vitreous china	7	10.00 Ea.	$173.93	$212.34	6.4286	6	6	$1,274.02	$1,274.02
Replace faucets lavatory, vitreous china	10	10.00 Ea.	$1,986.23	$2,387.83	4.5000	4	4	$9,551.34	$9,551.34
Clean out strainer and P trap lavatory, vitreous china	2	10.00 Ea.	$370.88	$464.51	22.5000	22	22	$10,219.22	$10,219.22
Replace lavatory, vitreous china	35	10.00 Ea.	$7,513.76	$9,008.85	1.2857	1	1	$9,008.85	$9,008.85
Check / minor repairs drinking fountain	1	2.00 Ea.	$103.89	$130.11	45.0000	45	45	$5,855.17	$5,855.17
Repair internal leaks drinking fountain	4	2.00 Ea.	$95.58	$119.71	11.2500	11	11	$1,316.76	$1,316.76
Correct water pressure drinking fountain	2	2.00 Ea.	$88.31	$110.60	22.5000	22	22	$2,433.15	$2,433.15
Replace refrigerant drinking fountain	2	2.00 Ea.	$73.54	$85.99	22.5000	22	22	$1,891.88	$1,891.88
Replace fountain drinking fountain	10	2.00 Ea.	$3,046.79	$3,588.88	4.5000	4	4	$14,355.52	$14,355.52
Drain and flush water heater, electric, 120 gallon	7	2.00 Ea.	$621.26	$778.09	6.4286	6	6	$4,668.52	$4,668.52
Check operation water heater, electric, 120 gallon	3	2.00 Ea.	$5.44	$6.82	15.0000	15	15	$102.27	$102.27
Replace water heater, electric, 120 gallon	15	1.00 Ea.	$15,946.05	$18,237.49	3.0000	3	3	$54,712.47	$54,712.47
Unclog floor drain, PVC	20	4.00 Ea.	$201.54	$252.42	2.2500	2	2	$504.85	$504.85
General maintenance & repair drain: roof, scupper, area	1	1.00 Ea.	$39.22	$49.12	45.0000	45	45	$2,210.33	$2,210.33
Replace drain: roof, scupper, area	40	1.00 Ea.	$1,096.36	$1,265.22	1.1250	1	1	$1,265.22	$1,265.22
Repair boiler, gas, 250 MBH	7	1.00 Ea.	$2,552.63	$2,989.56	6.4286	6	5	$17,937.36	$14,947.80
Replace boiler, gas, 250 MBH	30	1.00 Ea.	$1,636.25	$2,049.31	1.5000	1	1	$2,049.31	$2,049.31
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	1.00 Ea.	$4,344.36	$5,039.65	2.2500	2	2	$10,079.30	$10,079.30
Repair circulator pump, 1/12 - 3/4 H.P.	5	1.00 Ea.	$104.83	$123.65	9.0000	9	6	$1,112.82	$741.88
Replace circulator pump, 1/12 - 3/4 H.P.	15	1.00 Ea.	$3,687.87	$4,253.96	3.0000	3	3	$12,761.87	$12,761.87
Repair computer room air conditioner, air cooled, 5 ton	10	1.00 Ea.	$4,758.71	$5,661.71	4.5000	4	4	$22,646.84	$22,646.84
Replace computer room air conditioner, air cooled, 5 ton	20	1.00 Ea.	$40,439.57	$46,356.83	2.2500	2	2	$92,713.67	$92,713.67
Replace multi-zone variable volume, 50 ton	15	1.00 Ea.	$141,742.49	$164,363.22	3.0000	3	3	$493,089.65	$493,089.65
Repair central station A.H.U., 1300 CFM	10	1.00 Ea.	$601.37	$713.88	4.5000	4	3	$2,855.54	$2,141.65
Replace central station A.H.U., 1300 CFM	15	1.00 Ea.	$10,673.04	$12,341.31	3.0000	3	3	$37,023.92	$37,023.92
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	45.0000	45	45	$2,043.45	$2,043.45
Replace sprinkler head	20	90.00 Ea.	$8,252.16	$10,169.75	2.2500	2	2	$20,339.50	$20,339.50
Repair switchgear 1200 A mainframe	5	1.00 Ea.	$2,068.68	$2,420.08	9.0000	9	7	$21,780.68	$16,940.53
Maintenance and inspection switchgear, mainframe	1	1.00 Ea.	$69.98	$87.79	45.0000	45	45	$3,950.77	$3,950.77
Replace switchgear 1200 A mainframe	20	1.00 Ea.	$4,508.06	$5,431.65	2.2500	2	2	$10,863.30	$10,863.30
Maintenance and inspection lighting panel, indoor	3	4.00 Ea.	$175.26	$219.87	15.0000	15	15	$3,298.03	$3,298.03
Replace wireway, 8" x 8"	20	320.00 L.F.	$26,352.75	$31,752.26	2.2500	2	2	$63,504.52	$63,504.52
Repair failed breaker, enclosed, 600 V, 3 pole	4	4.00 Ea.	$4,818.95	$5,562.93	11.2500	11	11	$61,192.21	$61,192.21
Maintenance and inspection circuit breaker, enclosed, 600 V, 3 pole	0.33	4.00 Ea.	$138.75	$174.06	136.3636	136	136	$23,672.56	$23,672.56
Maintenance and repair receptacles and plugs	20	84.00 Ea.	$3,843.77	$4,802.73	2.2500	2	2	$9,605.45	$9,605.45
Maintenance and repair wiring devices, switches	10	84.00 Ea.	$3,843.77	$4,802.73	4.5000	4	4	$19,210.91	$19,210.91
Replace wiring devices, switches	15	42.00 Ea.	$2,920.45	$3,636.53	3.0000	3	3	$10,909.60	$10,909.60
Maintenance and repair incandescent lighting fixtures	10	10.00 Ea.	$743.31	$885.15	4.5000	4	4	$3,540.60	$3,540.60
Replace incandescent lighting fixture lamp	5	10.00 Ea.	$136.33	$163.89	9.0000	9	9	$1,475.00	$1,475.00
Replace fluorescent light fixture ballast, 80 W	10	68.00 Ea.	$7,407.38	$9,134.26	4.5000	4	4	$36,537.03	$36,537.03
Replace lamps (2 lamps), 4', 34 W energy saver	10	68.00 Ea.	$1,846.31	$2,315.14	4.5000	4	4	$9,260.56	$9,260.56
Inspect intercom master station	0.5	1.00 Ea.	$185.00	$232.08	90.0000	90	90	$20,887.55	$20,887.55
Replace intercom master station	15	1.00 Ea.	$3,301.15	$3,849.50	3.0000	3	3	$11,548.49	$11,548.49
Inspect intercom remote station	1	2.00 Ea.	$55.99	$70.24	45.0000	45	45	$3,160.62	$3,160.62
Replace intercom remote station	15	2.00 Ea.	$1,374.18	$1,589.03	3.0000	3	3	$4,767.10	$4,767.10
Repair smoke detector	10	23.00 Ea.	$1,397.60	$1,729.72	4.5000	4	3	$6,918.88	$5,189.16
Replace smoke detector	15	23.00 Ea.	$7,760.69	$9,234.67	3.0000	3	3	$27,704.00	$27,704.00
Check and repair manual pull station	10	4.00 Ea.	$379.95	$467.63	4.5000	4	3	$1,870.51	$1,402.88
Replace manual pull station	15	4.00 Ea.	$920.30	$1,106.02	3.0000	3	3	$3,318.05	$3,318.05
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	9.0000	9	9	$1,758.83	$1,758.83
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	90.0000	90	90	$5,221.89	$5,221.89
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.0000	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	4.00 Ea.	$801.74	$971.29	2.2500	2	2	$1,942.57	$1,942.57
Maintenance and repair of general wiring lightning protection system	1	1.00 M.L.F.	$111.32	$137.36	45.0000	45	45	$6,181.17	$6,181.17
Replace lightning protection general wiring system	25	1.00 M.L.F.	$13,424.28	$15,895.64	1.8000	1	1	$15,895.64	$15,895.64
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	45.0000	45	44	$21,479.92	$21,002.59
Replace lightning ground rod	25	4.00 Ea.	$1,031.13	$1,274.23	1.8000	1	1	$1,274.23	$1,274.23
Maintenance and repair computer ground system	4	1.00 Ea.	$23.25	$29.16	11.2500	11	11	$320.79	$320.79
Maintenance and inspection generator, diesel, 750 KW	0.08	1.00 Ea.	$69.98	$87.79	562.5000	562	562	$49,340.74	$49,340.74
Replace diesel generator component, 750 KW	25	1.00 Ea.	$267,089.75	$305,754.14	1.8000	1	1	$305,754.14	$305,754.14
Replace lamp with exit light L.E.D. retrofit kits	15	4.00 Ea.	$412.07	$474.66	3.0000	3	3	$1,423.98	$1,423.98
Maintenance and inspection UPS battery	0.17	2.00 Ea.	$139.97	$175.59	264.7059	264	264	$46,355.71	$46,355.71
Replace motor generator UPS battery	15	2.00 Ea.	$2,391.16	$2,827.23	3.0000	3	3	$8,481.69	$8,481.69
Maintenance and repair voice/data outlet	10	84.00 Ea.	$4,678.27	$5,847.64	4.5000	4	4	$23,390.58	$23,390.58
Maintenance and inspection patch panel	0.5	4.00 Ea.	$370.00	$464.17	90.0000	90	90	$41,775.11	$41,775.11
Replace patch panel	15	4.00 Ea.	$3,788.72	$4,553.23	3.0000	3	3	$13,659.68	$13,659.68
			$1,108,399.39	$1,303,190.63				MR Subtotal:	$3,493,340.90
								MR Per Year:	$77,629.80
								PM Total:	$17,572.25
								Subtotal:	$95,202.05
								Total Per Unit:	$8.63

FAC 1405 Secure Operational, Storage, and Information Technology Building

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM
FY25 SUC: $8.63
UM: SF
Expected Service Life: 45
Model Size: 11033

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	3	0.78	$47.47	$35.20	$0.0000	82.67	97.97	115.65
Fire doors, swinging, annualized	3	1.18	$43.47	$48.22	$0.0000	91.69	110.51	131.49
Urinals, annualized	3	0.68	$20.52	$36.80	$0.0000	57.32	70.41	84.53
Toilet (vacuum breaker type), annualized	9	1.59	$82.65	$86.04	$0.0000	168.69	202.77	240.98
Lavatories, annualized	8	2.78	$61.75	$175.97	$0.0000	237.71	296.68	358.73
Drink fountain, annualized	2	1.24	$72.30	$66.83	$0.0000	139.13	166.41	197.31
Air handling unit, computer room, annualized	1	3.42	$97.70	$183.58	$0.0000	281.28	346.13	415.86
VAV Boxes, annualized	8	7.47	$76.21	$477.14	$0.0000	553.35	704.11	858.69
Fan, axial, up to 5,000 CFM, annually	1	0.62	$6.89	$33.42	$0.0000	40.30	51.02	62.08
Package unit, air cooled, 25 thru 50 ton, annualized	1	3.25	$165.11	$208.12	$0.0000	373.23	452.18	539.38
Package unit, computer room, annually	1	1.41	$76.21	$90.52	$0.0000	166.73	201.51	240.09
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Extinguishing system, dry chemical, annualized	1	5.61	$4.18	$300.33	$0.0000	304.51	395.03	485.75
Circuit breaker, high voltage air, annualized	6	2.82	$99.10	$200.20	$0.0000	299.30	369.27	444.19
Switch, automatic transfer, annualized	1	5.32	$16.52	$378.48	$0.0000	395.00	510.19	626.21
Panelboard, 225 A and above, annualized	4	1.76	$103.79	$125.50	$0.0000	229.29	277.32	330.53
Fire alarm annuciator system, annualized	1	11.05	$195.61	$697.20	$0.0000	892.81	1,121.53	1,360.03
Emergency diesel or gas generator, over 15 KVA, annually	1	2.11	$88.82	$133.46	$0.0000	222.29	271.21	324.57
Power stablizer, annualized	2	1.25	$21.96	$78.68	$0.0000	100.64	126.44	153.34
Uninterrupted power system, 200 KVA to 800 KVA, annualized	1	78.06	$264.47	$4,930.20	$0.0000	5,194.67	6,700.18	8,218.91
Battery system and charger, annualized	1	8.73	$21.96	$552.78	$0.0000	574.74	742.77	911.89
Light, emergency, wet cell, annualized	3	1.17	$112.28	$74.70	$0.0000	186.98	220.61	259.86
						$11,361.91	$14,423.76	$17,572.25

FAC 1411 Airfield Fire And Rescue Station

FY25 SUC:	$4.88 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1411 Airfield Fire And Rescue Station

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.88
UM: SF
Expected Service Life: 45
Model Size: 9732

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurences	Adjusted Occurences	Life Cost	Adjusted Cost
Repair clay brick wall, 1st floor	25	550.00 S.F.	$26,196.88	$32,140.65	1.8000	1	1	$32,140.65	$32,140.65
Replace glass - 1st floor. (1% of glass) - alum. window	1	1.44 S.F.	$19.66	$23.08	45.0000	45	45	$1,038.69	$1,038.69
Repair 3' x 4' aluminum window - 1st floor	20	12.00 Ea.	$3,616.92	$4,250.89	2.2500	2	2	$8,501.78	$8,501.78
Replace glass - 2nd floor. (1% of glass) - alum. window	1	2.76 S.F.	$51.79	$61.80	45.0000	45	45	$2,780.78	$2,780.78
Repair 3' x 4' aluminum window - 2nd floor	20	14.00 Ea.	$4,935.59	$5,849.82	2.2500	2	2	$11,699.65	$11,699.65
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	3.48 S.F.	$47.51	$55.78	45.0000	45	45	$2,510.17	$2,510.17
Repair aluminum storefront door	12	2.00 Ea.	$1,099.17	$1,310.67	3.7500	3	3	$3,932.01	$3,932.01
Replace insulating glass - (3% of glass) aluminum storefront door	1	2.00 S.F.	$135.21	$157.45	45.0000	45	45	$7,085.31	$7,085.31
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	3.2143	3	3	$11,049.22	$11,049.22
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.00 Ea.	$191.97	$235.01	11.2500	11	11	$2,585.11	$2,585.11
Replace 3'-0" x 7'-0" steel, painted, door	45	4.00 Ea.	$2,943.44	$3,426.28	1.0000	1	1	$3,426.28	$3,426.28
Replace tempered glass - (3% of glass) steel painted door	1	2.52 S.F.	$83.03	$98.01	45.0000	45	45	$4,410.56	$4,410.56
Repair 12' x 24' aluminum double roll-up door	10	8.00 Ea.	$17,680.25	$20,561.64	4.5000	4	4	$82,246.58	$82,246.58
Replace 12' x 24' aluminum double roll-up door	35	8.00 Ea.	$70,721.02	$82,246.58	1.2857	1	1	$82,246.58	$82,246.58
Debris removal by hand & visual inspection,modified bitum/thermoplstc	1	6.20 M.S.F.	$252.11	$307.89	45.0000	45	45	$13,855.03	$13,855.03
Minor thermoplastic membrane repairs, 2% of roof area	1	1.24 Sq.	$430.66	$513.18	45.0000	45	45	$23,093.31	$23,093.31
Flashing repairs, 2 S.F. per sq. repaired, modified bitumen/thermoplastic	1	124.00 S.F.	$513.68	$615.75	45.0000	45	45	$27,708.59	$27,708.59
Membrane replacement-(25% of roof area),modified bitum/thermoplastic	20	15.50 Sq.	$14,034.77	$16,721.16	2.2500	2	2	$33,442.32	$33,442.32
Total roof replacement, modified bituminous / thermoplastic	25	62.00 Sq.	$46,099.63	$54,570.72	1.8000	1	1	$54,570.72	$54,570.72
Repair steel painted interior door	14	4.00 Ea.	$1,187.40	$1,385.29	3.2143	3	3	$4,155.86	$4,155.86
Refinish 3'-0" x 7'-0" steel painted interior door	4	1.00 Ea.	$60.20	$74.02	11.2500	11	11	$814.27	$814.27
Safety glass replacement, (3% of glass) steel painted interior door	1	0.63 S.F.	$16.18	$19.08	45.0000	45	45	$858.75	$858.75
Repair hollow core wood door, interior	7	8.00 Ea.	$2,374.80	$2,770.57	6.4286	6	6	$16,623.45	$16,623.45
Replace 3'-0" x 7'-0" hollow core wood door, interior	30	8.00 Ea.	$2,749.75	$3,237.91	1.5000	1	1	$3,237.91	$3,237.91
Repair solid core wood door, interior	11	5.00 Ea.	$1,484.25	$1,731.61	4.0909	4	4	$6,926.44	$6,926.44
Replace 3'-0" x 7'-0" solid core wood door, interior	40	5.00 Ea.	$3,218.89	$3,711.50	1.1250	1	1	$3,711.50	$3,711.50
Repair concrete steps	15	83.00 S.F.	$2,560.06	$2,953.19	3.0000	3	3	$8,859.57	$8,859.57
Replace metal stair railing, interior	45	53.00 L.F.	$2,537.58	$2,970.93	1.0000	1	1	$2,970.93	$2,970.93
Repair fabric wall finish fabric interior	9	107.00 S.Y.	$4,119.31	$4,910.32	5.0000	5	5	$24,551.62	$24,551.62
Repair 5/8" drywall - (2% of walls)	20	513.68 S.F.	$959.56	$1,167.15	2.2500	2	2	$2,334.31	$2,334.31
Refinish drywall	4	82.00 S.F.	$59.21	$72.60	11.2500	11	11	$798.63	$798.63
Refinish concrete floor finished	25	48.00 C.S.F.	$22,008.60	$26,441.95	1.8000	1	1	$26,441.95	$26,441.95
Replace vinyl tile flooring	18	112.00 S.Y.	$6,334.53	$7,753.66	2.5000	2	2	$15,507.31	$15,507.31
Ceramic tile floor repairs - (2% of floors)	15	5.20 C.S.F.	$3,622.47	$4,516.40	3.0000	3	3	$13,549.19	$13,549.19
Terrazzo floor repairs - (2% of floors)	15	8.84 S.F.	$165.12	$197.19	3.0000	3	3	$591.58	$591.58
Replace carpet	8	56.00 S.Y.	$3,119.12	$3,607.01	5.6250	5	5	$18,035.03	$18,035.03
Repair gypsum board ceiling - (2% of ceilings)	20	0.71 C.S.F.	$291.37	$357.26	2.2500	2	2	$714.53	$714.53
Refinish gypsum board ceiling, up to 12' high	20	8.60 C.S.F.	$1,308.38	$1,608.58	2.2500	2	1	$3,217.15	$1,608.58
Replace gypsum board ceiling, up to 12' high	40	8.60 C.S.F.	$3,602.27	$4,418.49	1.1250	1	1	$4,418.49	$4,418.49
Replace acoustic tile ceiling, fire-rated	20	12.20 C.S.F.	$7,621.25	$8,962.56	2.2500	2	2	$17,925.11	$17,925.11
Replace flush valve diaphragm tankless water closet	10	5.00 Ea.	$137.95	$171.38	4.5000	4	4	$685.52	$685.52
Rebuild flush valve tankless water closet	20	5.00 Ea.	$966.36	$1,164.77	2.2500	2	2	$2,329.54	$2,329.54
Replace tankless water closet	35	5.00 Ea.	$6,883.28	$7,965.98	1.2857	1	1	$7,965.98	$7,965.98
Replace tankless flush valve	25	5.00 Ea.	$1,363.28	$1,600.14	1.8000	1	1	$1,600.14	$1,600.14
Replace wax ring gasket for tankless water closet	5	5.00 Ea.	$748.77	$936.91	9.0000	9	9	$8,432.19	$8,432.19
Replace flush valve diaphragm for a urinal	7	4.00 Ea.	$110.36	$137.10	6.4286	6	6	$822.63	$822.63
Rebuild flush valve for a urinal	20	4.00 Ea.	$773.08	$931.82	2.2500	2	2	$1,863.63	$1,863.63
Unplug line urinal	5	4.00 Ea.	$611.61	$766.01	9.0000	9	9	$6,894.11	$6,894.11
Replace wall-hung urinal	35	4.00 Ea.	$4,369.16	$5,257.55	1.2857	1	1	$5,257.55	$5,257.55
Replace washer in spud connection lavatory, vitreous china	7	6.00 Ea.	$104.36	$127.40	6.4286	6	6	$764.41	$764.41
Replace washer in faucet lavatory, vitreous china	2	6.00 Ea.	$81.59	$101.78	22.5000	22	22	$2,239.10	$2,239.10
Replace faucets lavatory, vitreous china	10	6.00 Ea.	$1,191.74	$1,432.70	4.5000	4	4	$5,730.80	$5,730.80
Clean out strainer and P trap lavatory, vitreous china	2	6.00 Ea.	$222.53	$278.71	22.5000	22	22	$6,131.53	$6,131.53
Replace lavatory, vitreous china	35	6.00 Ea.	$4,508.25	$5,405.31	1.2857	1	1	$5,405.31	$5,405.31
Replace faucet washer sink, iron enamel	2	2.00 Ea.	$27.01	$33.69	22.5000	22	22	$741.21	$741.21
Clean trap sink, iron enamel	3	2.00 Ea.	$18.04	$22.59	15.0000	15	15	$338.82	$338.82
Replace faucets sink, iron enamel	10	2.00 Ea.	$397.25	$477.57	4.5000	4	4	$1,910.27	$1,910.27
Unstop sink, iron enamel	2	2.00 Ea.	$88.31	$110.60	22.5000	22	22	$2,433.15	$2,433.15
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	2.00 Ea.	$1,820.34	$2,141.40	4.5000	4	4	$8,565.61	$8,565.61
Inspect / clean shower head fiberglass	3	4.00 Ea.	$208.23	$260.80	15.0000	15	15	$3,912.03	$3,912.03
Replace mixing valve shower, fiberglass	10	4.00 Ea.	$1,175.30	$1,430.08	4.5000	4	4	$5,720.30	$5,720.30
Replace shower and fittings, fiberglass	20	4.00 Ea.	$4,754.07	$5,649.81	2.2500	2	2	$11,299.61	$11,299.61
Check / minor repairs drinking fountain	1	1.00 Ea.	$51.94	$65.06	45.0000	45	45	$2,927.58	$2,927.58
Repair internal leaks drinking fountain	4	1.00 Ea.	$47.79	$59.85	11.2500	11	11	$658.38	$658.38
Replace refrigerant drinking fountain	2	1.00 Ea.	$36.77	$43.00	22.5000	22	22	$945.94	$945.94
Replace fountain drinking fountain	10	1.00 Ea.	$1,523.39	$1,794.44	4.5000	4	4	$7,177.76	$7,177.76
Resolder joint pipe & fittings, copper	10	2.00 Ea.	$101.81	$125.57	4.5000	4	4	$502.29	$502.29
Replace pipe and fittings, copper 3/4"	20	16.00 L.F.	$385.58	$468.64	2.2500	2	2	$937.28	$937.28
Replace pipe and fittings, copper 2"	25	16.00 L.F.	$904.99	$1,084.54	1.8000	1	1	$1,084.54	$1,084.54
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	16.00 L.F.	$165.02	$201.61	3.0000	3	3	$604.82	$604.82
Overhaul water heater, gas / oil, 70 gallon	5	1.00 Ea.	$173.21	$216.94	9.0000	9	9	$1,952.46	$1,952.46
Clean & service water heater, gas / oil, 70 gallon	1	1.00 Ea.	$206.74	$258.93	45.0000	45	45	$11,651.78	$11,651.78
Replace water heater, gas / oil, 70 gallon	12	1.00 Ea.	$5,470.45	$6,302.52	3.7500	3	3	$18,907.56	$18,907.56
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	1.00 Ea.	$8.47	$10.60	90.0000	90	90	$954.39	$954.39
Replace pump / motor assembly circulation pump, 1/12 HP	10	1.00 Ea.	$1,265.32	$1,479.95	4.5000	4	4	$5,919.80	$5,919.80
Unclog main drain pipe & fittings, cast iron	10	1.00 Ea.	$48.83	$61.15	4.5000	4	4	$244.62	$244.62
Replace pipe & fittings, cast iron, 4"	40	16.00 L.F.	$975.43	$1,182.15	1.1250	1	1	$1,182.15	$1,182.15
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.2500	2	2	$126.21	$126.21
Repair joint pipe and fittings, PVC	10	1.00 Ea.	$157.21	$195.91	4.5000	4	4	$783.64	$783.64
Replace pipe, 4" pipe and fittings, PVC	30	16.00 L.F.	$1,499.18	$1,834.72	1.5000	1	1	$1,834.72	$1,834.72
General maintenance & repair drain: roof, scupper, area	1	6.00 Ea.	$235.31	$294.71	45.0000	45	45	$13,261.95	$13,261.95
Replace drain: roof, scupper, area	40	6.00 Ea.	$6,578.14	$7,591.29	1.1250	1	1	$7,591.29	$7,591.29
Install new 4" gasket, 1 per M.L.F. natural gas, steel/iron	30	1.00 Ea.	$221.12	$274.79	1.5000	1	1	$274.79	$274.79
Repair fan coil unit, 1 ton	10	2.00 Ea.	$910.96	$1,090.77	4.5000	4	3	$4,363.09	$3,272.32
Replace fan coil unit, 1 ton	15	2.00 Ea.	$2,712.98	$3,168.31	3.0000	3	3	$9,504.94	$9,504.94
Replace fan & motor, propeller exhaust, 4700 CFM exhaust fan	15	1.00 Ea.	$2,262.92	$2,633.25	3.0000	3	3	$7,899.76	$7,899.76
Repair single zone rooftop unit, 25 ton	10	1.00 Ea.	$55,072.84	$63,403.92	4.5000	4	3	$253,615.68	$190,211.76
Replace single zone rooftop unit, 25 ton	15	1.00 Ea.	$51,995.90	$60,418.81	3.0000	3	3	$181,256.43	$181,256.43
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	45.0000	45	45	$2,043.45	$2,043.45
Replace sprinkler head	20	53.00 Ea.	$4,859.60	$5,988.85	2.2500	2	2	$11,977.71	$11,977.71
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	45.0000	45	45	$40,637.38	$40,637.38
Replace fire pump / electric motor assembly 100 H.P.	25	1.00 Ea.	$46,050.08	$53,152.38	1.8000	1	1	$53,152.38	$53,152.38
Maintenance and inspection lighting panel, indoor	3	3.00 Ea.	$131.45	$164.90	15.0000	15	15	$2,473.53	$2,473.53
Repair failed breaker, molded case, 600 V, 3 pole	10	6.00 Ea.	$2,426.65	$2,887.83	4.5000	4	4	$11,551.31	$11,551.31
Maintenance and inspection circuit breaker, molded case, 600 V, 3 pole	0.33	6.00 Ea.	$208.13	$261.09	136.3636	136	136	$35,508.84	$35,508.84
Maintenance and repair receptacles and plugs	20	97.00 Ea.	$4,438.64	$5,546.01	2.2500	2	2	$11,092.01	$11,092.01
Replace receptacle/plug receptacles and plugs	20	97.00 Ea.	$7,832.09	$9,634.14	2.2500	2	2	$19,268.29	$19,268.29
Maintenance and repair wiring devices, switches	10	37.00 Ea.	$1,693.09	$2,115.49	4.5000	4	4	$8,461.95	$8,461.95
Replace wiring devices, switches	15	37.00 Ea.	$2,572.78	$3,203.61	3.0000	3	3	$9,610.83	$9,610.83
Replace fluorescent light fixture ballast, 80 W	10	27.00 Ea.	$2,941.16	$3,626.84	4.5000	4	4	$14,507.35	$14,507.35
Replace lamps (2 lamps), 4', 34 W energy saver	10	57.00 Ea.	$1,547.64	$1,940.63	4.5000	4	4	$7,762.53	$7,762.53
Inspect intercom master station	0.5	1.00 Ea.	$185.00	$232.08	90.0000	90	90	$20,887.55	$20,887.55
Replace intercom master station	15	1.00 Ea.	$3,301.15	$3,849.50	3.0000	3	3	$11,548.49	$11,548.49
Repair smoke detector	10	15.00 Ea.	$911.48	$1,128.08	4.5000	4	3	$4,512.31	$3,384.23
Check operation smoke detector	1	15.00 Ea.	$261.98	$328.66	45.0000	45	45	$14,789.63	$14,789.63
Replace smoke detector	15	15.00 Ea.	$5,061.32	$6,022.61	3.0000	3	3	$18,067.83	$18,067.83
Check and repair manual pull station	10	5.00 Ea.	$474.94	$584.53	4.5000	4	3	$2,338.13	$1,753.60
Replace manual pull station	15	5.00 Ea.	$1,150.38	$1,382.52	3.0000	3	3	$4,147.56	$4,147.56
Minor repairs to fire alarm control panel	5	2.00 Ea.	$320.55	$390.85	9.0000	9	9	$3,517.65	$3,517.65
Maintenance and inspection fire alarm control panel	0.5	2.00 Ea.	$92.50	$116.04	90.0000	90	90	$10,443.78	$10,443.78
Replace fire alarm control panel	15	2.00 Ea.	$4,670.52	$5,682.79	3.0000	3	3	$17,048.38	$17,048.38
Minor repairs to annunciation panel	5	3.00 Ea.	$480.83	$586.28	9.0000	9	9	$5,276.48	$5,276.48
Replace fire alarm bell, 6"	20	6.00 Ea.	$1,202.61	$1,456.93	2.2500	2	2	$2,913.86	$2,913.86
Maintenance and inspection generator, gasoline, 175 KW	0.08	1.00 Ea.	$69.98	$87.79	562.5000	562	562	$49,340.74	$49,340.74
Automotive equipment, compressor, electric, 5 HP, remove and replace motor	10	2.00 Ea.	$1,431.45	$1,651.37	4.5000	4	4	$6,605.50	$6,605.50
Remove and replace 50 HP pump motor	25	1.00 Ea.	$10,424.40	$11,906.01	1.8000	1	1	$11,906.01	$11,906.01
Remove and replace fire hydrant	25	1.00 Ea.	$9,025.38	$10,418.66	1.8000	1	1	$10,418.66	$10,418.66
			$539,742.83	$635,720.27				MR Subtotal:	$1,565,768.46
								MR Per Year:	$34,794.85
								PM Total:	$12,690.69
								Subtotal:	$47,485.54
								Total Per Unit:	$4.88

FAC 1411 Airfield Fire And Rescue Station

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $4.88
UM: SF
Expected Service Life: 45
Model Size: 9732

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	2	0.52	$31.64	$23.47	$0.0000	55.11	65.32	77.10
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	8	32.56	$660.96	$1,472.12	$0.0000	2,133.08	2,640.81	3,181.59
Shutter, roll up, electric, annually	2	4.10	$30.46	$184.76	$0.0000	215.22	273.69	333.69
Urinals, annualized	4	0.91	$27.36	$49.07	$0.0000	76.42	93.88	112.70
Toilet (vacuum breaker type), annualized	5	0.89	$45.92	$47.80	$0.0000	93.72	112.65	133.88
Lavatories, annualized	6	2.09	$46.31	$131.98	$0.0000	178.29	222.51	269.05
Showers, annualized	4	0.91	$56.08	$57.70	$0.0000	113.78	136.69	162.42
Drink fountain, annualized	1	0.62	$36.15	$33.42	$0.0000	69.57	83.21	98.65
Water heater, gas, to 120 gal., annualized	2	3.44	$176.84	$184.43	$0.0000	361.26	434.28	516.13
Fan coil unit, annualized	2	6.68	$171.95	$358.70	$0.0000	530.66	655.46	788.87
VAV Boxes, annualized	4	3.74	$38.10	$238.57	$0.0000	276.68	352.06	429.34
Fan, axial, up to 5,000 CFM, annualized	1	1.24	$13.78	$66.83	$0.0000	80.61	102.04	124.15
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Circuit breaker, high voltage air, annualized	4	1.88	$66.07	$133.46	$0.0000	199.53	246.18	296.13
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Security, intrusion alarm system, annualized	1	3.83	$178.64	$242.03	$0.0000	420.67	511.14	610.55
Emergency diesel or gas generator, up to 15 KVA, annualized	1	13.16	$109.78	$831.66	$0.0000	941.44	1,201.92	1,467.88
Uninterrupted power system, up to 200 KVA, annually	1	3.01	$201.60	$191.23	$0.0000	392.83	470.36	557.97
Light, emergency, hardwired system, annually	4	0.50	$27.74	$31.67	$0.0000	59.42	71.69	85.36
Crane, electric bridge, up to 5 ton, annually	1	2.92	$247.45	$113.21	$0.0000	360.66	419.37	490.45
Storage tank, ground level, annualized	1	0.72	$19.73	$39.28	$0.0000	59.01	72.77	87.51
Water flow meter, turbine, annualized	2	1.18	$39.73	$64.05	$0.0000	103.78	126.97	152.14
Pump, mixed or axial flow, annually	2	1.22	$78.09	$66.61	$0.0000	144.70	172.49	204.19
Fuel oil storage tank, above ground, annualized	2	6.55	$48.22	$355.26	$0.0000	403.49	514.89	628.70
						$8,508.95	$10,533.85	$12,690.69

FAC 1412 Aviation Operations Building

FY25 SUC:	$4.74 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1413 Air Control Tower

FY25 SUC:	$9.72 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1413 Air Control Tower

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $9.72
UM: SF
Expected Service Life: 35
Model Size: 3725

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Refinish concrete landing	3	40.00 S.F.	$69.92	$86.01	11.6667	11	11	$946.13	$946.13
Replace metal hand rail	30	22.00 L.F.	$1,355.95	$1,576.59	1.1667	1	1	$1,576.59	$1,576.59
Repair 8" concrete block wall, 1st floor	25	164.00 S.F.	$4,390.84	$5,371.50	1.4000	1	1	$5,371.50	$5,371.50
Replace steel siding - 2nd floor	35	5.60 C.S.F.	$4,258.56	$5,164.88	1.0000	1	1	$5,164.88	$5,164.88
Replace steel siding - 3rd floor	35	5.60 C.S.F.	$4,741.10	$5,765.11	1.0000	1	1	$5,765.11	$5,765.11
Spray refinish steel siding - 1st floor	20	5.60 C.S.F.	$1,750.27	$2,091.11	1.7500	1	1	$2,091.11	$2,091.11
Spray refinish steel siding - 2nd floor	20	5.60 C.S.F.	$2,357.67	$2,846.77	1.7500	1	1	$2,846.77	$2,846.77
Spray refinish steel siding - 3rd floor	20	5.60 C.S.F.	$2,838.31	$3,444.72	1.7500	1	1	$3,444.72	$3,444.72
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	2.40 S.F.	$32.76	$38.47	35.0000	35	35	$1,346.45	$1,346.45
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	16.00 Ea.	$2,583.97	$3,079.29	1.7500	1	1	$3,079.29	$3,079.29
Repair 2'-0" x 3'-0" aluminum window - 3rd floor	20	12.00 Ea.	$3,153.79	$3,821.82	1.7500	1	1	$3,821.82	$3,821.82
Replace glass block window - 3rd floor	75	48.00 S.F.	$10,240.83	$12,542.55	0.4667	0	0	$0.00	$0.00
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.00 Ea.	$191.97	$235.01	8.7500	8	8	$1,880.08	$1,880.08
Debris removal, by hand and visual inspection, metal panel roofing	1	2.40 M.S.F.	$58.98	$72.03	35.0000	35	35	$2,521.12	$2,521.12
Minor metal roof panel replacement, 2.5% of roof area	20	59.00 S.F.	$816.01	$965.24	1.7500	1	1	$965.24	$965.24
Total metal roof panel replacement	30	24.00 Sq.	$23,069.16	$27,279.92	1.1667	1	1	$27,279.92	$27,279.92
Replace round corrugated galvanized downspout, 4" diameter	25	42.00 L.F.	$555.11	$656.95	1.4000	1	1	$656.95	$656.95
Replace roof hatch and structure single unit	40	1.00 Ea.	$1,898.95	$2,184.17	0.8750	0	0	$0.00	$0.00
Repair 8" concrete block wall - (2% of walls) painted	25	0.16 C.S.F.	$194.55	$233.68	1.4000	1	1	$233.68	$233.68
Refinish concrete block wall painted	4	8.00 C.S.F.	$1,097.22	$1,319.10	8.7500	8	8	$10,552.76	$10,552.76
Refinish, 3'-0" x 7'-0" steel w/ safety glass door	4	2.00 Ea.	$120.41	$148.05	8.7500	8	8	$1,184.39	$1,184.39
Repair concrete steps	15	132.00 S.F.	$4,071.43	$4,696.64	2.3333	2	2	$9,393.27	$9,393.27
Refinish metal stair railing, interior	7	254.00 S.F.	$419.85	$516.97	5.0000	5	5	$2,584.83	$2,584.83
Repair 5/8" drywall - (2% of walls)	20	448.00 S.F.	$836.87	$1,017.92	1.7500	1	1	$1,017.92	$1,017.92
Refinish drywall	4	240.00 S.F.	$173.29	$212.50	8.7500	8	8	$1,699.98	$1,699.98
Office painting, 10' x 15', 10' high walls	5	5.00 Ea.	$1,481.54	$1,809.93	7.0000	7	7	$12,669.48	$12,669.48
Refinish concrete floor finished	25	28.00 C.S.F.	$12,838.35	$15,424.47	1.4000	1	1	$15,424.47	$15,424.47
Replace vinyl tile flooring	18	165.00 S.Y.	$9,332.11	$11,422.80	1.9444	1	1	$11,422.80	$11,422.80
Ceramic tile floor repairs - (2% of floors)	15	0.06 C.S.F.	$44.58	$55.59	2.3333	2	2	$111.17	$111.17
Acoustic tile repairs - (2% of ceilings)	9	2.60 C.S.F.	$2,991.85	$3,467.58	3.8889	3	3	$10,402.75	$10,402.75
Replace flush valve diaphragm tankless water closet	10	3.00 Ea.	$82.77	$102.83	3.5000	3	3	$308.49	$308.49
Rebuild flush valve tankless water closet	20	3.00 Ea.	$579.81	$698.86	1.7500	1	1	$698.86	$698.86
Replace tankless water closet	35	3.00 Ea.	$4,129.97	$4,779.59	1.0000	1	1	$4,779.59	$4,779.59
Replace tankless flush valve	25	3.00 Ea.	$817.97	$960.08	1.4000	1	1	$960.08	$960.08
Replace wax ring gasket for tankless water closet	5	3.00 Ea.	$449.26	$562.15	7.0000	7	7	$3,935.02	$3,935.02
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	5.0000	5	5	$342.76	$342.76
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	1.7500	1	1	$465.91	$465.91
Unplug line urinal	5	2.00 Ea.	$305.81	$383.01	7.0000	7	7	$2,681.04	$2,681.04
Replace wall-hung urinal	35	2.00 Ea.	$2,184.58	$2,628.78	1.0000	1	1	$2,628.78	$2,628.78
Replace washer in spud connection lavatory, vitreous china	7	4.00 Ea.	$69.57	$84.93	5.0000	5	5	$424.67	$424.67
Replace washer in faucet lavatory, vitreous china	2	4.00 Ea.	$54.39	$67.85	17.5000	17	17	$1,153.47	$1,153.47
Replace faucets lavatory, vitreous china	10	4.00 Ea.	$794.49	$955.13	3.5000	3	3	$2,865.40	$2,865.40
Clean out strainer and P trap lavatory, vitreous china	2	4.00 Ea.	$148.35	$185.80	17.5000	17	17	$3,158.67	$3,158.67
Replace lavatory, vitreous china	35	4.00 Ea.	$3,005.50	$3,603.54	1.0000	1	1	$3,603.54	$3,603.54
Replace faucet washer sink, service/utility	2	1.00 Ea.	$13.50	$16.85	17.5000	17	17	$286.38	$286.38
Clean trap	3	1.00 Ea.	$9.02	$11.29	11.6667	11	11	$124.23	$124.23
Replace faucets sink, service/utility	10	1.00 Ea.	$198.62	$238.78	3.5000	3	3	$716.35	$716.35
Overhaul water heater, gas / oil, 30 gallon	5	1.00 Ea.	$123.45	$154.62	7.0000	7	7	$1,082.31	$1,082.31
Clean and service water heater, gas / oil, 30 gallon	1	1.00 Ea.	$206.74	$258.93	35.0000	35	35	$9,062.50	$9,062.50
Replace water heater, gas / oil, 30 gallon	10	1.00 Ea.	$1,751.92	$2,063.20	3.5000	3	3	$6,189.59	$6,189.59
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	1.00 Ea.	$8.47	$10.60	70.0000	70	70	$742.30	$742.30
Replace pump / motor assembly circulation pump, 1/12 HP	10	1.00 Ea.	$1,265.32	$1,479.95	3.5000	3	3	$4,439.85	$4,439.85
Repair condenser, air cooled, 5 ton	10	1.00 Ea.	$729.37	$869.83	3.5000	3	3	$2,609.48	$2,609.48
Replace condenser, air cooled, 5 ton	15	1.00 Ea.	$9,376.41	$10,782.84	2.3333	2	2	$21,565.68	$21,565.68
Repair fan coil unit, 5 ton	10	1.00 Ea.	$642.62	$761.18	3.5000	3	2	$2,283.55	$1,522.36
Replace fan coil unit, 5 ton	15	1.00 Ea.	$2,936.77	$3,403.68	2.3333	2	2	$6,807.37	$6,807.37
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	3.5000	3	3	$3,523.93	$3,523.93
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	35.0000	35	35	$1,589.35	$1,589.35
Replace sprinkler head	20	16.00 Ea.	$1,467.05	$1,807.96	1.7500	1	1	$1,807.96	$1,807.96
Replace fuse	25	23.00 Ea.	$13,977.34	$16,013.31	1.4000	1	1	$16,013.31	$16,013.31
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	3.5000	3	3	$4,661.73	$4,661.73
Maintenance and repair motor starter, 600 V	3	1.00 Ea.	$744.73	$915.59	11.6667	11	11	$10,071.49	$10,071.49
Maintenance and inspection motor starter, 600 V	0.25	1.00 Ea.	$58.42	$73.29	140.0000	140	140	$10,260.55	$10,260.55
Replace starter motor starter, 600 V	18	1.00 Ea.	$6,327.44	$7,363.90	1.9444	1	1	$7,363.90	$7,363.90
Maintenance and repair secondary transformer, dry	10	2.00 Ea.	$591.02	$702.53	3.5000	3	3	$2,107.58	$2,107.58
Maintenance and inspection secondary transformer, dry	0.5	2.00 Ea.	$174.05	$218.34	70.0000	70	70	$15,283.95	$15,283.95
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	2.00 Ea.	$154.57	$193.91	1.7500	1	1	$193.91	$193.91
Maintenance and repair breaker, molded case, 480 V, 2 pole	20	4.00 Ea.	$309.15	$387.82	1.7500	1	1	$387.82	$387.82
Repair failed breaker, molded case, 600 V, 3 pole	10	3.00 Ea.	$1,213.33	$1,443.91	3.5000	3	3	$4,331.74	$4,331.74
Maintenance and inspection circuit breaker, molded case, 600 V, 3 pole	0.33	3.00 Ea.	$104.06	$130.55	106.0606	106	106	$13,838.00	$13,838.00
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	4.00 Ea.	$175.26	$219.87	4.3750	4	4	$879.48	$879.48
Maintenance and repair receptacles and plugs	20	56.00 Ea.	$2,562.51	$3,201.82	1.7500	1	1	$3,201.82	$3,201.82
Maintenance and repair wiring devices, switches	10	31.00 Ea.	$1,418.53	$1,772.44	3.5000	3	3	$5,317.31	$5,317.31
Maintenance and repair incandescent lighting fixtures	10	22.00 Ea.	$1,635.29	$1,947.33	3.5000	3	3	$5,842.00	$5,842.00
Replace incandescent lighting fixture lamp	5	22.00 Ea.	$299.92	$360.56	7.0000	7	7	$2,523.89	$2,523.89
Replace fluorescent light fixture ballast, 80 W	10	13.00 Ea.	$1,416.12	$1,746.26	3.5000	3	3	$5,238.77	$5,238.77
Replace lamps (2 lamps), 4', 34 W energy saver	10	13.00 Ea.	$352.97	$442.60	3.5000	3	3	$1,327.80	$1,327.80
Replace metal halide ballast, 175 W	10	4.00 Ea.	$686.25	$821.99	3.5000	3	2	$2,465.97	$1,643.98
Replace metal halide fixture lamp, 175 W	5	4.00 Ea.	$243.36	$295.69	7.0000	7	7	$2,069.86	$2,069.86
Replace metal halide fixture, 175 W	20	4.00 Ea.	$3,238.81	$3,811.49	1.7500	1	1	$3,811.49	$3,811.49
Maintenance and repair TV cable outlet	10	16.00 Ea.	$891.10	$1,113.84	3.5000	3	3	$3,341.51	$3,341.51
Replace TV cable outlet	20	16.00 Ea.	$1,232.02	$1,534.27	1.7500	1	1	$1,534.27	$1,534.27
Repair smoke detector	10	11.00 Ea.	$668.42	$827.26	3.5000	3	2	$2,481.77	$1,654.51
Check operation smoke detector	1	11.00 Ea.	$192.12	$241.02	35.0000	35	35	$8,435.56	$8,435.56
Replace smoke detector	15	11.00 Ea.	$3,711.64	$4,416.58	2.3333	2	2	$8,833.16	$8,833.16
Check and repair manual pull station	10	3.00 Ea.	$284.97	$350.72	3.5000	3	2	$1,052.16	$701.44
Replace manual pull station	15	3.00 Ea.	$690.23	$829.51	2.3333	2	2	$1,659.03	$1,659.03
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	7.0000	7	7	$1,367.98	$1,367.98
Maintenance and inspection annunciation panel	0.5	1.00 Ea.	$46.25	$58.02	70.0000	70	70	$4,061.47	$4,061.47
Replace fire alarm bell, 6"	20	1.00 Ea.	$200.44	$242.82	1.7500	1	1	$242.82	$242.82
Maintenance and repair building structure ground	7	0.80 M.L.F.	$76.37	$95.47	5.0000	5	5	$477.33	$477.33
Replace building structure ground	50	0.80 M.L.F.	$4,662.74	$5,639.58	0.7000	0	0	$0.00	$0.00
Maintenance and repair of general wiring lightning protection system	1	0.80 M.L.F.	$89.06	$109.89	35.0000	35	35	$3,846.06	$3,846.06
Replace lightning protection general wiring system	25	0.80 M.L.F.	$10,739.42	$12,716.51	1.4000	1	1	$12,716.51	$12,716.51
Maintenance and repair special ground system	4	1.00 Ea.	$23.25	$29.16	8.7500	8	8	$233.31	$233.31
Replace special ground system	50	1.12 M.L.F.	$2,977.68	$3,578.26	0.7000	0	0	$0.00	$0.00
Maintenance and inspection generator, gasoline, 175 KW	0.08	0.50 Ea.	$34.99	$43.90	437.5000	437	437	$19,183.19	$19,183.19
Replace lamp emergency lighting fixture	2	6.00 Ea.	$343.89	$415.07	17.5000	17	17	$7,056.24	$7,056.24
Replace emergency lighting fixture	20	6.00 Ea.	$3,742.69	$4,418.97	1.7500	1	1	$4,418.97	$4,418.97
Replace lamp with exit light L.E.D. retrofit kits	15	4.00 Ea.	$412.07	$474.66	2.3333	2	2	$949.32	$949.32
Maintenance and inspection UPS battery	0.17	1.00 Ea.	$69.98	$87.79	205.8824	205	205	$17,997.96	$17,997.96
Replace motor generator UPS battery	15	1.00 Ea.	$1,195.58	$1,413.61	2.3333	2	2	$2,827.23	$2,827.23
Maintenance and repair voice/data outlet	10	14.00 Ea.	$779.71	$974.61	3.5000	3	3	$2,923.82	$2,923.82
Replace voice/data outlet	20	14.00 Ea.	$396.44	$482.81	1.7500	1	1	$482.81	$482.81
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	70.0000	70	70	$8,122.94	$8,122.94
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	2.3333	2	2	$2,276.61	$2,276.61
			$202,472.54	$241,335.36				MR Subtotal:	$467,245.53
								MR Per Year:	$13,349.87
								PM Total:	$22,863.96
								Subtotal:	$36,213.83
								Total Per Unit:	$9.72

FAC 1413 Air Control Tower

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $9.72
UM: SF
Expected Service Life: 35
Model Size: 3725

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	3	0.78	$47.47	$35.20	$0.0000	82.67	97.97	115.65
Elevator, cable, electric, passenger / freight, annualized	1	47.90	$3,787.50	$4,430.40	$0.0000	8,217.90	9,925.77	11,823.02
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (vacuum breaker type), annualized	3	0.53	$27.55	$28.68	$0.0000	56.23	67.59	80.33
Lavatories, annualized	4	1.39	$30.87	$87.98	$0.0000	118.86	148.34	179.37
Valve, globe, above 4", annualized	1	0.16	$6.89	$8.54	$0.0000	15.43	18.68	22.28
Water heater, gas, to 120 gal., annually	1	1.02	$35.66	$54.99	$0.0000	90.65	110.71	132.56
Air handling unit, 3 thru 24 tons, annualized	1	2.06	$163.16	$110.83	$0.0000	273.98	323.55	381.27
Fan coil unit, annualized	2	6.68	$171.95	$358.70	$0.0000	530.66	655.46	788.87
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Switchboard, with air circuit breaker, annualized	2	26.64	$38.22	$1,902.36	$0.0000	1,940.58	2,515.11	3,091.56
Circuit breaker, high voltage air, annualized	12	5.64	$198.20	$400.39	$0.0000	598.59	738.53	888.38
Transformer, dry type 500 KVA and over, annualized	2	1.54	$33.03	$109.56	$0.0000	142.59	178.77	216.59
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Motor control center, over 400 A, annualized	1	0.39	$25.95	$27.89	$0.0000	53.84	64.80	77.06
Emergency diesel or gas generator, up to 15 KVA, annualized	0.5	6.58	$54.89	$415.83	$0.0000	470.72	600.96	733.94
Uninterrupted power system, up to 200 KVA, annualized	1	22.92	$253.49	$1,444.20	$0.0000	1,697.69	2,156.30	2,627.58
Light, emergency, hardwired system, annualized	6	1.50	$54.49	$94.72	$0.0000	149.21	183.08	219.66
						$15,397.74	$19,004.24	$22,863.96

FAC 1421 Helium Production/Storage Building

FY25 SUC:	$2.98 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1422 Helium Storage Facility

FY25 SUC:	$1,386.30 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1431 Ship Operations Building

FY25 SUC:	$5.16 / SF
Source:	FY25 Navy Study

FAC 1431

Expected Service Life 50 Years
Model Size 15,339 SF

UNIFORMAT Lvl 2	LEVEL 2 GROUP TITLE	Average of Normalized Cost	Ave Cost per SF w/OP	Frequency (Average from RS Means Model)	Average Occurrences	Lifetime Cost /SF
AB10	Shell Structure	$1,437,596.81	$93.72	50	1.0	$46.86
B20	Exterior Enclosure	$55,849.22	$3.64	24.1	2.1	$7.56
B30	Roofing	$74,703.00	$4.87	25.0	2.0	$9.74
C10	Interior Construction	$45,556.26	$2.97	16.1	3.1	$9.22
C20	Stairs	$50,802.00	$3.31	38.8	1.3	$4.26
C30	Interior Finishes	$94,638.79	$6.17	20.7	2.4	$14.92
D10	Conveying	$74,943.72	$4.89	5.0	10.0	$48.86
D20	Plumbing	$27,083.62	$1.77	12.7	3.9	$6.94
D30	HVAC	$43,133.38	$2.81	14.4	3.5	$9.79
D40	Fire Protection	$98,226.96	$6.40	17.4	2.9	$18.40
D50	Electrical	$48,166.21	$3.14	15.9	3.1	$9.86
				$133.69	Subtotal	$186.41
					Per Year	$3.73
					PM/SC/SW/Repairs	$1.31
					FY24 SUC	$5.04
					FY25 SUC	$5.16

FAC 1441 Photo/TV Production Building

FY25 SUC:	$6.47 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1442 Operations Support Lab

FY25 SUC:	$4.96 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1443 Operations Supply Building

FY25 SUC:	$3.58 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1443 Operations Supply Building

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $3.58
UM: SF
Expected Service Life: 45
Model Size: 9221

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	436.00 S.F.	$17,738.39	$21,603.95	3.0000	3	3	$64,811.85	$64,811.85
Repair 8" concrete block wall, 1st floor	25	1,773.00 S.F.	$47,469.24	$58,071.19	1.8000	1	1	$58,071.19	$58,071.19
Waterproof concrete block wall, 1st floor	10	95.00 C.S.F.	$18,434.08	$22,213.46	4.5000	4	4	$88,853.84	$88,853.84
Waterproof concrete block wall, 2nd floor	10	21.50 C.S.F.	$17,335.54	$20,708.59	4.5000	4	4	$82,834.34	$82,834.34
Replace steel louver, 1st floor	40	2.00 Ea.	$1,288.25	$1,505.87	1.1250	1	1	$1,505.87	$1,505.87
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	1.32 S.F.	$18.02	$21.16	45.0000	45	45	$952.13	$952.13
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	12.00 Ea.	$1,937.98	$2,309.47	2.2500	2	2	$4,618.94	$4,618.94
Replace glass - 3rd floor (1% of glass) - alum. window fixed	1	36.10 S.F.	$1,002.14	$1,212.20	45.0000	45	45	$54,549.19	$54,549.19
Repair 2'-0" x 3'-0" aluminum window - 3rd floor	20	32.00 Ea.	$8,410.11	$10,191.53	2.2500	2	2	$20,383.06	$20,383.06
Replace 2'-0" x 3'-0" aluminum window - 3rd floor	50	32.00 Ea.	$29,538.61	$34,756.57	0.9000	0	0	$0.00	$0.00
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	3.2143	3	3	$11,049.22	$11,049.22
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.00 Ea.	$191.97	$235.01	11.2500	11	11	$2,585.11	$2,585.11
Replace 3'-0" x 7'-0" steel, painted, door	45	4.00 Ea.	$2,943.44	$3,426.28	1.0000	1	1	$3,426.28	$3,426.28
Replace tempered glass - (3% of glass) steel painted door	1	1.26 S.F.	$41.51	$49.01	45.0000	45	45	$2,205.28	$2,205.28
Repair 12' x 12' steel roll-up door	10	6.00 Ea.	$5,413.01	$6,378.73	4.5000	4	4	$25,514.93	$25,514.93
Replace 12' x 12' steel roll-up door	35	6.00 Ea.	$21,652.04	$25,514.93	1.2857	1	1	$25,514.93	$25,514.93
Debris removal and visual inspection of built-up roofing	0.5	9.20 M.S.F.	$374.09	$456.87	90.0000	90	90	$41,118.16	$41,118.16
Non-destructive moisture inspection of built-up roofing	5	8.40 M.S.F.	$1,061.83	$1,296.78	9.0000	9	9	$11,671.02	$11,671.02
Minor BUR membrane repairs, 2% of roof area	1	1.84 Sq.	$1,074.71	$1,270.41	45.0000	45	45	$57,168.66	$57,168.66
Total BUR roof replacement	28	92.00 Sq.	$89,455.64	$105,281.64	1.6071	1	1	$105,281.64	$105,281.64
Replace roof hatch and structure single unit	40	1.00 Ea.	$1,898.95	$2,184.17	1.1250	1	1	$2,184.17	$2,184.17
Repair steel painted interior door	14	3.00 Ea.	$890.55	$1,038.97	3.2143	3	3	$3,116.90	$3,116.90
Refinish 3'-0" x 7'-0" steel painted interior door	4	3.00 Ea.	$180.61	$222.07	11.2500	11	11	$2,442.81	$2,442.81
Safety glass replacement, (3% of glass) steel painted interior door	1	1.89 S.F.	$48.53	$57.25	45.0000	45	45	$2,576.24	$2,576.24
Repair solid core wood door, interior	11	3.00 Ea.	$890.55	$1,038.97	4.0909	4	4	$4,155.86	$4,155.86
Replace 3'-0" x 7'-0" solid core wood door, interior	40	3.00 Ea.	$1,931.33	$2,226.90	1.1250	1	1	$2,226.90	$2,226.90
Repair 5/8" drywall - (2% of walls)	20	1,918.00 S.F.	$3,582.84	$4,357.97	2.2500	2	2	$8,715.93	$8,715.93
Refinish concrete floor finished	25	67.00 C.S.F.	$30,720.34	$36,908.55	1.8000	1	1	$36,908.55	$36,908.55
Replace vinyl tile flooring	18	37.00 S.Y.	$2,092.66	$2,561.48	2.5000	2	2	$5,122.95	$5,122.95
Repair gypsum board ceiling - (2% of ceilings)	20	0.05 C.S.F.	$20.43	$25.05	2.2500	2	2	$50.11	$50.11
Refinish gypsum board ceiling, up to 12' high	20	2.31 C.S.F.	$351.44	$432.07	2.2500	2	1	$864.14	$432.07
Replace gypsum board ceiling, up to 12' high	40	2.31 C.S.F.	$967.59	$1,186.83	1.1250	1	1	$1,186.83	$1,186.83
Replace acoustic tile ceiling, fire-rated	20	8.29 C.S.F.	$5,178.70	$6,090.13	2.2500	2	2	$12,180.26	$12,180.26
Replace flush valve diaphragm tankless water closet	10	4.00 Ea.	$110.36	$137.10	4.5000	4	4	$548.42	$548.42
Rebuild flush valve tankless water closet	20	4.00 Ea.	$773.08	$931.82	2.2500	2	2	$1,863.63	$1,863.63
Replace tankless water closet	35	4.00 Ea.	$5,506.63	$6,372.78	1.2857	1	1	$6,372.78	$6,372.78
Replace tankless flush valve	25	4.00 Ea.	$1,090.62	$1,280.11	1.8000	1	1	$1,280.11	$1,280.11
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	6.4286	6	6	$411.31	$411.31
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.2500	2	2	$931.82	$931.82
Unplug line urinal	5	2.00 Ea.	$305.81	$383.01	9.0000	9	9	$3,447.05	$3,447.05
Replace wall-hung urinal	35	2.00 Ea.	$2,184.58	$2,628.78	1.2857	1	1	$2,628.78	$2,628.78
Replace washer in spud connection lavatory, vitreous china	7	6.00 Ea.	$104.36	$127.40	6.4286	6	6	$764.41	$764.41
Replace washer in faucet lavatory, vitreous china	2	6.00 Ea.	$81.59	$101.78	22.5000	22	22	$2,239.10	$2,239.10
Replace faucets lavatory, vitreous china	10	6.00 Ea.	$1,191.74	$1,432.70	4.5000	4	4	$5,730.80	$5,730.80
Replace lavatory, vitreous china	35	6.00 Ea.	$4,508.25	$5,405.31	1.2857	1	1	$5,405.31	$5,405.31
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	22.5000	22	22	$370.61	$370.61
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	15.0000	15	15	$169.41	$169.41
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	4.5000	4	4	$955.13	$955.13
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	22.5000	22	22	$1,216.57	$1,216.57
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	1.00 Ea.	$910.17	$1,070.70	4.5000	4	4	$4,282.81	$4,282.81
Inspect and clean spray heads, emergency eye wash	3	1.00 Ea.	$52.06	$65.20	15.0000	15	15	$978.01	$978.01
Replace eye wash station, emergency eye wash	25	1.00 Ea.	$790.45	$961.55	1.8000	1	1	$961.55	$961.55
Resolder joint pipe & fittings, copper	10	2.00 Ea.	$101.81	$125.57	4.5000	4	4	$502.29	$502.29
Replace pipe and fittings, copper 3/4"	20	16.00 L.F.	$385.58	$468.64	2.2500	2	2	$937.28	$937.28
Replace pipe and fittings, copper 2"	25	16.00 L.F.	$904.99	$1,084.54	1.8000	1	1	$1,084.54	$1,084.54
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	16.00 L.F.	$165.02	$201.61	3.0000	3	3	$604.82	$604.82
Remove old insulation & replace with new, pipe 1-1/2", wall 1"	15	16.00 L.F.	$184.99	$225.37	3.0000	3	3	$676.10	$676.10
Clean & service water heater, gas / oil, 70 gallon	1	1.00 Ea.	$206.74	$258.93	45.0000	45	45	$11,651.78	$11,651.78
Replace water heater, gas / oil, 70 gallon	12	1.00 Ea.	$5,470.45	$6,302.52	3.7500	3	3	$18,907.56	$18,907.56
Unclog main drain pipe & fittings, cast iron	10	1.00 Ea.	$48.83	$61.15	4.5000	4	4	$244.62	$244.62
Replace pipe & fittings, cast iron, 4"	40	16.00 L.F.	$975.43	$1,182.15	1.1250	1	1	$1,182.15	$1,182.15
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.2500	2	2	$126.21	$126.21
Repair joint pipe and fittings, PVC	10	1.00 Ea.	$157.21	$195.91	4.5000	4	4	$783.64	$783.64
Replace pipe, 4" pipe and fittings, PVC	30	16.00 L.F.	$1,499.18	$1,834.72	1.5000	1	1	$1,834.72	$1,834.72
General maintenance & repair distribution: gutters, pipe	1	0.04 M.L.F.	$13.38	$16.76	45.0000	45	45	$754.35	$754.35
General maintenance & repair drain: roof, scupper, area	1	4.00 Ea.	$156.87	$196.47	45.0000	45	45	$8,841.30	$8,841.30
Replace drain: roof, scupper, area	40	4.00 Ea.	$4,385.43	$5,060.86	1.1250	1	1	$5,060.86	$5,060.86
Repair fan coil unit, 1 ton	10	2.00 Ea.	$910.96	$1,090.77	4.5000	4	3	$4,363.09	$3,272.32
Replace fan coil unit, 1 ton	15	2.00 Ea.	$2,712.98	$3,168.31	3.0000	3	3	$9,504.94	$9,504.94
Replace fan & motor, propeller exhaust, 4700 CFM exhaust fan	15	2.00 Ea.	$4,525.85	$5,266.51	3.0000	3	3	$15,799.52	$15,799.52
Maintenance and repair standard suspended heater	2	6.00 Ea.	$713.63	$842.31	22.5000	22	22	$18,530.82	$18,530.82
Replace heater standard suspended heater	15	6.00 Ea.	$5,500.58	$6,355.81	3.0000	3	3	$19,067.43	$19,067.43
Repair single zone rooftop unit, 5 ton	10	1.00 Ea.	$2,912.53	$3,474.76	4.5000	4	4	$13,899.02	$13,899.02
Replace single zone rooftop unit, 5 ton	15	1.00 Ea.	$8,648.69	$10,289.33	3.0000	3	3	$30,867.99	$30,867.99
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	45.0000	45	45	$2,043.45	$2,043.45
Replace sprinkler head	20	45.00 Ea.	$4,126.08	$5,084.88	2.2500	2	2	$10,169.75	$10,169.75
Replace fuse	25	24.00 Ea.	$14,585.05	$16,709.54	1.8000	1	1	$16,709.54	$16,709.54
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	4.5000	4	4	$6,215.64	$6,215.64
Maintenance and repair secondary transformer, dry	10	1.00 Ea.	$295.51	$351.26	4.5000	4	4	$1,405.05	$1,405.05
Maintenance and inspection secondary transformer, dry	0.5	1.00 Ea.	$87.02	$109.17	90.0000	90	90	$9,825.40	$9,825.40
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	15.0000	15	15	$1,649.02	$1,649.02
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	2.00 Ea.	$154.57	$193.91	2.2500	2	2	$387.82	$387.82
Maintenance and repair breaker, molded case, 480 V, 3 pole	20	3.00 Ea.	$231.86	$290.87	2.2500	2	2	$581.74	$581.74
Maintenance and inspection circuit breaker, molded case, 480 V, 3 pole	0.5	3.00 Ea.	$104.06	$130.55	90.0000	90	90	$11,749.25	$11,749.25
Maintenance and repair breaker, enclosed, 240 V, 3 pole	25	4.00 Ea.	$309.15	$387.82	1.8000	1	1	$387.82	$387.82
Maintenance and inspection circuit breaker, enclosed, 240 V, 3 pole	1	4.00 Ea.	$138.75	$174.06	45.0000	45	45	$7,832.83	$7,832.83
Maintenance and repair safety switch general, 2 pole	8	6.00 Ea.	$262.90	$329.80	5.6250	5	5	$1,649.02	$1,649.02
Maintenance and inspection safety switch, 2 pole	1	6.00 Ea.	$262.90	$329.80	45.0000	45	45	$14,841.16	$14,841.16
Maintenance and repair receptacles and plugs	20	45.00 Ea.	$2,059.16	$2,572.89	2.2500	2	2	$5,145.78	$5,145.78
Replace receptacle/plug receptacles and plugs	20	45.00 Ea.	$3,633.44	$4,469.45	2.2500	2	2	$8,938.90	$8,938.90
Maintenance and repair wiring devices, switches	10	23.00 Ea.	$1,052.46	$1,315.03	4.5000	4	4	$5,260.13	$5,260.13
Replace wiring devices, switches	15	23.00 Ea.	$1,599.30	$1,991.43	3.0000	3	3	$5,974.30	$5,974.30
Replace fluorescent light fixture ballast, 80 W	10	8.00 Ea.	$871.46	$1,074.62	4.5000	4	4	$4,298.47	$4,298.47
Replace lamps (2 lamps), 4', 34 W energy saver	10	26.00 Ea.	$705.94	$885.20	4.5000	4	4	$3,540.80	$3,540.80
Replace metal halide ballast, 175 W	10	8.00 Ea.	$1,372.49	$1,643.98	4.5000	4	4	$6,575.91	$6,575.91
Replace metal halide fixture lamp, 175 W	5	8.00 Ea.	$486.71	$591.39	9.0000	9	9	$5,322.49	$5,322.49
Repair smoke detector	10	12.00 Ea.	$729.18	$902.46	4.5000	4	3	$3,609.85	$2,707.39
Replace smoke detector	15	12.00 Ea.	$4,049.06	$4,818.09	3.0000	3	3	$14,454.26	$14,454.26
Check and repair manual pull station	10	3.00 Ea.	$284.97	$350.72	4.5000	4	3	$1,402.88	$1,052.16
Replace manual pull station	15	3.00 Ea.	$690.23	$829.51	3.0000	3	3	$2,488.54	$2,488.54
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	9.0000	9	9	$1,758.83	$1,758.83
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	90.0000	90	90	$5,221.89	$5,221.89
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.0000	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.2500	2	2	$971.29	$971.29
Remove and replace hydraulic dock leveler lift cylinder	15	2.00 Ea.	$16,605.83	$18,912.06	3.0000	3	3	$56,736.19	$56,736.19
Remove and replace hydraulic dock leveler hydraulic pump	20	2.00 Ea.	$4,350.90	$4,976.29	2.2500	2	2	$9,952.59	$9,952.59
			$439,631.01	$522,752.68				MR Subtotal:	$1,182,478.69
								MR Per Year:	$26,277.30
								PM Total:	$6,763.97
								Subtotal:	$33,041.27
								Total Per Unit:	$3.58

FAC 1443 Operations Supply Building

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $3.58
UM: SF
Expected Service Life: 45
Model Size: 9221

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	3	0.78	$47.47	$35.20	$0.0000	82.67	97.97	115.65
Door, overhead, manual, up to 24' high x 25' wide, annualized	6	13.18	$91.37	$594.51	$0.0000	685.88	873.37	1,065.43
Fire doors, swinging, annualized	3	1.18	$43.47	$48.22	$0.0000	91.69	110.51	131.49
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (vacuum breaker type), annualized	4	0.71	$36.74	$38.24	$0.0000	74.97	90.12	107.10
Lavatories, annualized	6	2.09	$46.31	$131.98	$0.0000	178.29	222.51	269.05
VAV Boxes, annualized	2	1.87	$19.05	$119.29	$0.0000	138.34	176.03	214.67
Fire dampers, annualized	2	2.31	$16.80	$148.05	$0.0000	164.85	210.95	257.89
Fan, axial, up to 5,000 CFM, annualized	1	1.24	$13.78	$66.83	$0.0000	80.61	102.04	124.15
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Circuit breaker, high voltage air, annualized	12	5.64	$198.20	$400.39	$0.0000	598.59	738.53	888.38
Panelboard, 225 A and above, annualized	1	0.44	$25.95	$31.37	$0.0000	57.32	69.33	82.63
Light, emergency, dry cell, annualized	8	2.85	$303.39	$179.28	$0.0000	482.67	566.80	666.09
Hydraulic lift, loading dock, annualized	2	3.26	$93.93	$124.59	$0.0000	218.52	265.29	316.76
Hoist, pneumatic, annualized	1	1.31	$227.25	$51.21	$0.0000	278.46	316.55	366.01
Hoist / winch, chain / cable, electric, annualized	1	1.65	$226.24	$64.09	$0.0000	290.33	332.18	385.35
						$4,585.78	$5,633.93	$6,763.97

FAC 1444 Miscellaneous Operations Support Building

FY25 SUC:	$3.86 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1445 Working Animal Support Building

FY25 SUC:	$4.27 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1446 Security Force Building

FY25 SUC:	$4.48 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1451 Strategic Missile Launch Facility

FY25 SUC:	$87,533.54 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1452 Missile Guidance Facility

FY25 SUC:	$7.74 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1453 Missile Access Shaft

FY25 SUC:	\$2,333.06 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Ratio based on FAC 1452 (Cost Works Model)

FAC 1454 Missile Access Tunnel

FY25 SUC:	$19.68 / LF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Ratio based on FAC 1452 (Cost Works Model)

FAC 1456 Missile Defense Facility

FY25 SUC:	$11,136.64 / EA
Source:	Set to FAC 1403: Cost Works Model; UM conversion factor = 1400 SF

FAC 1457 Ballistic Missile Control Facility

FY25 SUC:	$35.44 / SF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2023 Study of AFIMSC/IZ data

FAC 1457 BALLISTIC MISSILE CONTROL FACILITY

Source: FY23 analysis of a seven year history of maintenance and qualifying SRM funded project data provided by AFIMSC/IZ of assets at ten locations. Study was conducted in coordination with R&K Solutions.

Source Data: Air Force NextGen
Each qualifying sustainment event was normalized for year (2023) and location (ACF= 1.00) using the Spring 2022 Area Cost Factors: USACE PAX 3.2.1. Each asset's maintenance history was averaged, and reduced to a Square Foot unit cost.

		Annual Sum of Sustainment Activities								
Asset #	**Size (SF)**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Annual Average**	**Per SF**
1	2770		$9,964.23	$4,933.75	$4,513.88	$5,169.37	$2,916.90	$7,100.32	$5,766.41	$2.08
2	1264		$5,920.83	$2,868.71	$4,503.36	$2,037.06	$373.56		$3,140.71	$2.48
3	7400						$22,146.61		$22,146.61	$2.99
4	4880							$14,803.72	$14,803.72	$3.03
5	1786			$10,348.01	$12,002.04	$573.66	$517.90		$5,860.40	$3.28
6	1264		$8,439.06	$224.12					$4,331.59	$3.43
7	34600	$1,352,795.18	$121,096.20	$42,108.01	$76,690.63	$29,382.81	$60,199.95	$32,162.24	$244,919.29	$7.08
8	9655		$49,400.97	$103,700.54	$64,842.53	$105,458.27	$69,956.98	$65,340.75	$76,450.01	$7.92
9	9655	$407.55	$117,338.68	$91,957.83	$95,518.80	$98,126.81	$90,211.86	$47,558.18	$77,302.81	$8.01
10	9655	$283.94	$222,042.93	$94,891.49	$63,500.77	$73,371.36	$46,605.62	$47,367.19	$78,294.76	$8.11
11	9655		$199,588.81	$65,673.17	$62,082.87	$61,340.29	$52,947.45	$48,360.24	$81,665.47	$8.46
12	9655	$2,273.37	$183,618.43	$149,854.99	$92,611.45	$73,691.08	$44,287.61	$41,907.94	$84,034.98	$8.70
13	9655	$407.55	$213,262.80	$75,305.86	$82,737.55	$114,272.79	$74,761.85	$43,166.05	$86,273.49	$8.94
14	9655	$1,644.92	$216,376.38	$111,433.18	$95,564.78	$96,332.61	$48,238.76	$49,516.71	$88,443.91	$9.16
15	1000							$10,606.47	$10,606.47	$10.61
16	9655	$993.79	$259,732.80	$163,175.89	$81,986.18	$97,254.40	$70,989.88	$74,705.86	$106,976.97	$11.08
17	9655		$319,300.29	$79,322.08	$56,569.34	$58,184.89	$80,159.34	$59,490.04	$108,837.66	$11.27
18	9655		$254,316.68	$153,636.93	$74,861.16	$102,981.72	$67,733.45	$55,983.93	$118,252.31	$12.25
19	9655		$461,460.98	$88,147.59	$80,393.96	$103,463.81	$80,570.59	$68,975.78	$147,168.78	$15.24
20	43760		$822,525.67						$822,525.67	$18.80
21	9655		$673,619.37	$161,383.10	$99,777.22	$64,388.60	$62,831.02	$75,841.56	$189,640.14	$19.64
22	9655		$342,826.33	$557,181.17	$93,400.52	$77,460.94	$55,889.68	$37,297.53	$194,009.36	$20.09
23	6795	$51,873.59	$476,102.92	$328,747.69	$26,660.34	$25,871.73	$19,555.89	$55,490.86	$140,614.72	$20.69
24	6667	$49,247.01	$461,131.73	$314,498.89	$47,769.58	$25,407.84	$25,899.70	$79,888.50	$143,406.18	$21.51
25	9655		$896,433.09	$71,599.50	$83,659.65	$72,242.11	$65,990.36	$76,642.34	$211,094.51	$21.86
26	7164		$470,573.77	$203,638.22	$53,109.10	$47,862.63	$81,364.32	$88,148.13	$157,449.36	$21.98
27	7164		$360,873.82	$435,502.33	$51,058.19	$44,098.56	$49,469.97	$37,052.54	$163,009.24	$22.75
28	7164		$245,966.75	$616,901.06	$51,596.54	$52,470.80	$75,949.99	$34,659.30	$179,590.74	$25.07
29	5983	$10,069.89	$586,927.75	$216,258.08	$34,177.73	$25,787.35	$35,539.97	$185,545.89	$156,329.52	$26.13
30	7164		$217,600.23	$667,658.69	$73,196.78	$28,268.14	$85,600.64	$58,792.44	$188,519.49	$26.31
31	7164		$200,921.71	$692,737.88	$61,669.42	$43,256.28	$68,186.87	$71,040.83	$189,635.50	$26.47
32	7164		$590,791.09	$387,524.67	$68,079.05	$45,025.14	$42,047.38	$26,918.30	$193,397.60	$27.00
33	6795	$134,034.46	$651,639.03	$352,971.77	$54,251.76	$49,148.42	$22,542.86	$59,657.18	$189,177.93	$27.84
34	7164		$336,693.35	$760,217.56	$21,217.28	$62,623.98	$64,773.03	$60,169.47	$217,615.78	$30.38
35	6429		$496,926.14	$494,266.48	$40,460.22	$27,397.74	$71,632.04	$49,442.11	$196,687.46	$30.59
36	7164		$345,504.49	$751,217.02	$72,907.33	$42,871.31	$75,357.91	$70,570.39	$226,404.74	$31.60
37	659		$2,911.09	$86,367.66	$5,790.90	$28,790.83	$2,326.29	$3,459.65	$21,607.74	$32.79
38	2500		$124,277.53	$273,711.74	$31,011.82	$27,875.51	$28,738.31	$9,508.50	$82,520.57	$33.01
39	6301		$403,241.49	$681,648.92	$41,102.44	$48,224.15	$60,588.93	$45,749.02	$213,425.83	$33.87
40	6667	$145,066.58	$301,598.90	$890,290.69	$29,825.51	$30,282.54	$26,986.20	$193,247.07	$231,042.50	$34.65
41	7164		$719,660.83	$670,922.52	$52,043.91	$59,481.16	$68,504.04	$42,159.14	$268,795.27	$37.52
42	5983	$84,702.20	$1,006,788.59	$321,535.78	$55,734.53	$48,133.67	$56,981.18	$48,063.07	$231,705.57	$38.73
43	7164		$835,686.88	$677,337.28	$66,119.35	$52,918.27	$84,915.07	$48,222.43	$294,199.88	$41.07
44	6667	$123,280.01	$776,301.22	$1,056,090.42	$51,102.55	$23,413.88	$35,593.03	$77,761.66	$306,220.40	$45.93
45	9655		$640,848.04	$1,025,133.65	$79,530.73	$884,221.47	$65,613.29	$51,006.57	$457,725.63	$47.41
46	7164		$704,969.01	$489,943.94	$37,369.96	$30,464.59	$44,558.03	$892,709.38	$366,669.15	$51.18
47	7164		$289,153.08	$610,300.37	$52,368.31	$37,958.33	$53,924.65	$1,197,925.71	$373,605.08	$52.15
48	6795	$46,696.48	$1,519,316.09	$790,501.62	$49,564.81	$27,626.61	$25,209.40	$48,773.19	$358,241.17	$52.72
49	5983	$50,270.36	$1,659,724.05	$280,957.79	$35,017.58	$31,091.88	$31,886.70	$193,887.41	$326,119.40	$54.51
50	7164		$455,997.58	$403,497.39	$52,865.12	$48,098.88	$46,622.28	$1,389,555.80	$399,439.51	$55.76
51	5983	$17,198.63	$1,912,623.39	$118,013.77	$53,142.51	$29,710.22	$24,620.11	$193,035.22	$335,477.69	$56.07
52	5983	$2,694.43	$609,581.42	$1,767,963.38	$26,520.83	$31,937.29	$39,703.66	$47,917.76	$360,902.68	$60.32
53	6795	$63,901.66	$635,825.46	$2,739,358.63	$54,131.06	$23,429.73	$29,887.66	$50,341.35	$513,839.36	$75.62
54	6111	$6,692.82	$645,246.86	$2,671,888.21	$88,425.12	$36,191.89	$43,103.04	$89,521.85	$511,581.40	$83.71
55	5983	$24,076.49	$2,227,917.57	$1,239,817.14	$23,566.41	$25,875.66	$24,755.07	$29,938.90	$513,706.75	$85.86
56	5395							$535,259.87	$535,259.87	$99.21
57	5983	$66,342.35	$392,205.74	$2,606,301.63	$404,586.29	$293,174.73	$210,644.36	$291,422.23	$609,239.62	$101.83
58	1264	$13.17		$1,043,742.82	$83.94	$1,480.89			$261,330.21	$206.75
									Average	**$33.51**

FAC 1458 Mechanical Security Barricade

FY25 SUC:	$9,319.88 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1459 Overhead Cover

FY25 SUC:	$0.69 / SF
Source:	Set to FAC 7384: Cost Works Model

FAC 1461 Aircraft Arresting System

FY25 SUC:	$106,830.96 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	AFCEC Study, FY2021

FAC 1461 - AIRCRAFT ARRESTING SYSTEM			UM: EA ESL: 10			Mx (in hrs)									LABOR					
BARRIER	INSP TYPE	DESCRIPTION	COMPONENT	(MATERIAL) COST TO MX (in dollars per yr)	COST TO REPLACE	Daily	Wkly	Mo	Qrtly	Yrly	2 Yr	3 Yr	4 Yr	10 Yr	TOTAL HRS	LABOR RATE	LABOR COST	Freq (in days)	Replacement Frequency (Years)	Annual Cost
BAK-12	LUBRICATION SCHEDULE	FAIRLEAD AND RUNWAY COMPONENT INSPECTION	Pendant (Arresting Cable)	$75.00	$0.00	361.77	63.35	30.94	8.73	7.97	2.00	0.66	1.00	3.60	480.013	$33.86	$16,252.34	365	1	$75.00
			Sheave, Deflector (3.5 yr bearing repack)	$150.00	$0.00													1277.5	3.5	$42.86
			Sheave, Fairlead	$0.00	$0.00													365	1	$0.00
			Sheave, Fairlead Lead-On	$0.00	$0.00													365	1	$0.00
			Sheave, Runway Edge (3.5 yr bearing repack)	$225.00	$0.00													1277.5	3.5	$64.29
		ENERGY ABSORBER INSPECTION	Cam Gear Reducer (all gear boxes/fluid couplings, semi-annual)	$117.26	$0.00													182.5	0.5	$234.52
			Carrier Assembly	$0.00	$0.00													365	1	$0.00
			Control Valve Linkage	$0.00	$0.00													365	1	$0.00
			Drive Chains (10w oil, all components)	$16.50	$0.00													182.5	0.5	$33.00
			Fluid Coupling	$0.00	$0.00													365	1	$0.00
			Phenolic Pads	$0.00	$0.00													365	1	$0.00
			Rewind Gear Reducer	$0.00	$0.00													365	1	$0.00
			Sheave, Engine Base (3.5 yr bearing repack)	$75.00	$0.00													1277.5	3.5	$21.43
			Sprockets	$0.00	$0.00													365	1	$0.00
			Swivel Joint	$0.00	$0.00													365	1	$0.00
			Tachometer Drive Unit	$0.00	$0.00													365	1	$0.00
			Tachometer Drive Pillow Block	$0.00	$0.00													365	1	$0.00
			Tensioner, Synch Chain	$0.00	$0.00													365	1	$0.00
			Tensioner, Rewind	$0.00	$0.00													365	1	$0.00
			Synch, Right Angle Drive	$0.00	$0.00													365	1	$0.00
			Synchronizer Sprockets, Chain and Idler Sprocket	$0.00	$0.00													365	1	$0.00
			Pillow Block Bearings	$0.00	$0.00													365	1	$0.00
		REWIND ENGINE INSPECTION	Wisconsin Engine (Semi-annual)	$45.30	$0.00													182.5	0.5	$90.60
			Deutz Engine (Annual)	$115.25	$0.00													365	1	$115.25
			Overcenter Clutch	$0.00	$0.00													365	1	$0.00
	MX	PREVENTIVE MX SCHED	Pendant (Arresting Cable) 303 FT	$0.00	$11,951.89	-	-	-	-	-		-		-	0	-	-	1095	3	$3,983.96
			Crop End of Tape	$0.00	$20.00	-	-	-	-	-		-		-	0	-	-	182.5	0.5	$40.00
			Turn Tape End-for-End	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Synchronize Units and Proof Test Hydraulic Sys	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Perform Functional Check Out	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Clean Entire Equipment	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Replace Tape	$0.00	$20,512.94	-	-	-	-	-		-		-	0	-	-	1460	4	$5,128.24
			Change Rewind Engine Oil Filter	$0.00	$5.73	-	-	-	-	-		-		-	0	-	-	182.5	0.5	$11.46
			Clean Rewind Engine Air Filter	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Bleed Brakes	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Bleed Clutch	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Bleed Max Brake Pressure Guage	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Drain Rewind Engine Exhaust Moisture Trap	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Anchor Inspection	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
			Mx Records	$0.00	$0.00	-	-	-	-	-		-		-	0	-	-	365	1	$0.00
	OTHER (Minor Mx)	MX Purchases (PER YEAR)	Support Disks (200)	$0.00	$3,064.00	-	-	-	-	-		-		-	0	-	-	365	1	$3,064.00
			Pendant tie-downs (3/8 IN rope)	$0.00	$260.87	-	-	-	-	-		-		-	0	-	-	365	1	$260.87
			tape connector (1 ea)	$0.00	$1,427.14	-	-	-	-	-		-		-	0	-	-	182.5	0.5	$2,854.28
			spray paint (12 cans)	$0.00	$86.39	-	-	-	-	-		-		-	0	-	-	365	1	$86.39
			4 tubes of grease	$0.00	$148.60	-	-	-	-	-		-		-	0	-	-	365	1	$148.60
			Pendant Cable (303')	$0.00	$11,951.89	-	-	-	-	-		-		-	0	-	-	365	1	$11,951.89
			Purchase Tape	$0.00	$20,512.94	-	-	-	-	-		-		-	0	-	-	365	1	$20,512.94
			tape brush (2 each)	$0.00	$245.70	-	-	-	-	-		-		-	0	-	-	365	1	$245.70
		DEPOT LEVEL OVERHAUL	2 BAK-12 Absorbers	$316,575.10	$0.00	-	-	-	-	-		-		-	0	-	-	3650	10	$31,657.51
		DEPOT LEVEL OVERHAUL	2 Fairlead Beams	$41,579.58	$0.00	-	-	-	-	-		-		-	0	-	-	3,650	10	$4,157.96

* Labor determined as hourly rate for a Wage Grade 10 + Fringe as defined by OMB Circular A-25 at 36.25%.

Annual Labor Cost	**$16,252.34**
Annual Consumables Cost	**$84,780.74**
SUC	**$101,033.08**

FAC 1463 Aircraft Firing-In Butt

FY25 SUC:	$53,284.84 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Air Force (Edwards AFB) data provided in FY-99

FAC 1464 Aircraft Blast Deflector

FY25 SUC:	$15.63 / LF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1464 Aircraft Blast Deflector

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $15.63
UM: LF
Expected Service Life: 29
Model Size: 110

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	22.00 S.F.	$895.06	$1,090.11	1.9333	1	1	$1,090.11	$1,090.11
Metal floor grating repairs - (2% of grating)	10	44.00 S.F.	$1,521.29	$1,832.01	2.9000	2	2	$3,664.03	$3,664.03
Refinish steel louver, 1st floor	5	38.00 Ea.	$4,198.44	$5,195.22	5.8000	5	5	$25,976.12	$25,976.12
Refinish aluminum shutter - 1st floor	5	28.00 Ea.	$3,093.59	$3,828.06	5.8000	5	5	$19,140.30	$19,140.30
			$9,708.38	$11,945.40				MR Subtotal:	$49,870.56
								MR Per Year:	$1,719.67
								PM Total:	$0.00
								Subtotal:	$1,719.67
								Total Per Unit:	$15.63

FAC 1464 Aircraft Blast Deflector

Release:	2024 Qtr 3	FY25 SUC:	$15.63
Zip Code Prefix:	222	UM:	LF
Type:	PM	Expected Service Life:	29
		Model Size:	110

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
						$0.00	$0.00	$0.00

FAC 1465 Aircraft Shelter, Hardened

FY25 SUC:	$1.46 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1466 Aircraft Shelter

FY25 SUC:	$1.18 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1467 Aircraft Support Facility

FY25 SUC:	$13,311.11 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1481 Propulsion Support Facility

FY25 SUC:	$2,581.06 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Composite of multiple FACs

FAC 1491 Weapons Support Facility

FY25 SUC:	$2,658.73 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Composite of multiple FACs

FAC 1493 Explosives Railway Holding Yard

FY25 SUC:	$9,063.62 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Composite of multiple FACs

FAC 1493 SUC FY16v18 - Explosives Railway Holding Yard
UM: EA
Design Size:1
ESL: 60

Composite of FACs 1492, 8601, 8712, 1495

Model Component	Reference FAC	Modeled Units	Modeled Quantity	Unit Cost (FY16)	FAC Units	Conversion	Component Total
Rail Road Track	8601	LF	400	7677.73	MI	0.0001894	$ 581.67
Retaining Wall	8712	LF	5280	0.61	LF	1	$ 3,220.80
Explosives Holding Transfer Area (Assume 30 yd x 40 yd)	1492	SY	1200	1.54	SY	1	$ 1,848.00
Berm (Assume 2 Berms @ 40 yds each + 4 wings @ 20 yds)	1495	LF	480	133.05	EA	0.01	$ 638.64
						Grand Total	$ 6,289.11

FAC 1494 Explosives Holding/Transfer Facility

FY25 SUC:	$154.08 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Ratio based on FAC 1493 (Composite of multiple FACs)

FAC 1495 Revetment

FY25 SUC:	$193.67 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Calculation based on R.S. Means Facilities Maintenance and Repair Data, Facilities Construction Cost Data, 2015Q3

FAC 1495 SUC FY16v18

Assumed Length	100	LF
UM: EA	1	
ESL	36	

Maintenance Type	Maintenance Activity	Frequecy	Duration (Hours) or total Qty (MFS)	Crew	Labor Rate (+ Fringe and Overhead)	Equipment	Equipment rate	Material	Material Quantity	Material Cost / Unit	Cost / Occurance	Occurances in ESL	Cost Over Lifetime
Preventative Maintenance	Maintenance Inspection, Debris Removal, and Animal Burrow Control	1	1	1 x WG9(5) 1 x WG7(5)	$ 66.64	1 x Pickup Truck	$ 13.65	0	0	0	$ 80.29	36	$ 2,890.46
Maintenance / Repair	Repair Embankment and side slopes	5	1.5	1 x WG9(5) 2 x WG7(5)	$ 96.61	1 x Truck, Dump 1 x Flatbed, 2 Axil, 25T 1 x Backhoe/loader	$ 54.75	Engineered Soil	1.5	$ 24.50	$ 263.79	7.2	$ 1,899.30
										Sum of Costs over Lifetime			$ 4,789.75
										Cost per Year			$ 133.05
										Cost per UM			$ 133.05

References

Equipment Costs:	RS Means Facilities Construction Cost Data, 30th Ed
Labor Costs	2015 Salary Tables from OPM.gov with Circular No. A-76 Revised
Material Costs	RS Meams "Costworks" with Facility Maintenance and Repair Costbook, 2015Q3

FAC 1496 Tactical Vehicle Wash Facility

FY25 SUC:	$2.96 / SF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Calculation based on R.S. Means data

2 December 2019

FAC 1496: Tactical Vehicle Wash Facility

SUC Modeling Notes
UMA – SF
RPA Type Code – S
ESL – 35 Years

FAC Definition:
A facility for pre-wash mud removal and washing of tactical vehicles. Included are water recirculation, high- and low- pressure cleaning, water containment and drains, and sediment and sludge removal.

References:
UFC 4-214-03, 17 March 2018
Army Public Works Tech Bulletin 200-1-87, 3 March 2011
2018 RPAD
USACE HII Project data for Central Vehicle Wash Facility 2006 - 2015
USMC Record Cards for 29 Palms
FAC 1496 SUC 2010
2019 RPCS

Background:
The 2019 RPCS changed the unit of measure of FAC 1496 from EA to SF. This inspired a remodeling of the SUC to comply with this change. The Navy/Marine Corps real property communities hope to re-categorized these assets once the Navy establishes a CatCode under FAC 1496.

Components / Stages included in TVWF.
These facilities are sub-components of the TVWF, are required to make the facility complete and usable, and should not be inventories separately

- Preparation Area (Concrete Pavement)
- Wash Stations Area (Concrete Pavement)
- Pre-wash / Soak Station Area (Concrete Pavement)
- Assembly Area (Concrete Pavement)
- Primary Water Treatment – Basin with sediment and petroleum product separation
- Secondary Water Treatment - sand filter or lagoon type
- Equalization or water supply basin (Optional depending on design)
- Utilities/ancillary equipment
  - Fences
  - Gates
  - Lighting

Accountability Note: The control building is not included as a component of the Tactical Vehicle Wash Facility. The control building should be accounted for as a separate asset under FAC 1444/Miscellaneous Operational Support Building (RPA Type Code B). The components inside the control building that support the TVWF are to be considered components of the TVWF. The components that are integral to the building itself (door, window, lighting, switches, outlets, flooring, roofing) are components of the building asset.

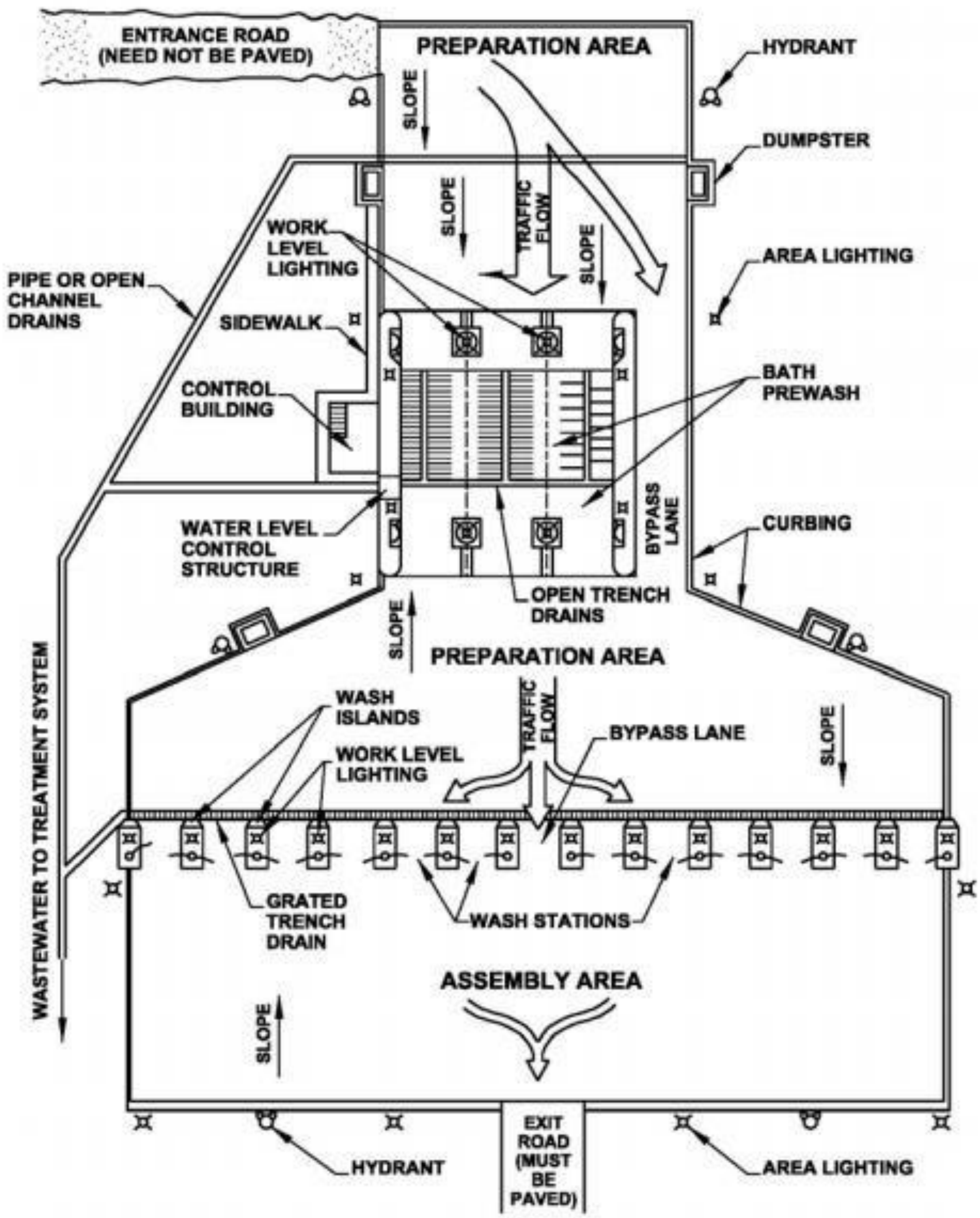
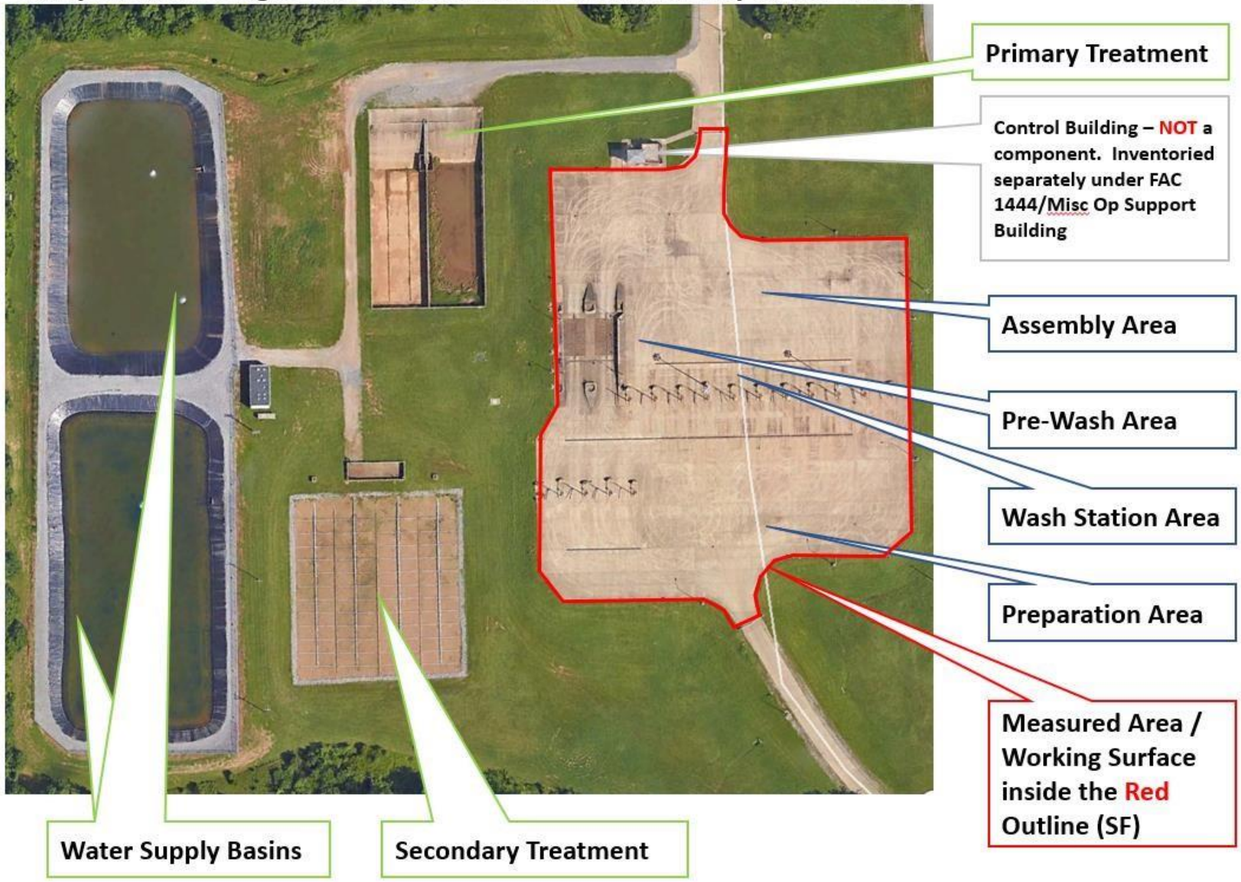


Figure 1: Working Surface of a TVWF UFC 4-214-03

Wash Rack Measurements

As the FAC unit of measure changed from “Each” to “Square Feet”, the facility size will be determined by measuring the working paved surface of the TVWF.

Components / Stages of a Tactical Vehicle Wash Facility // FAC 1496



FAC 1498 Security Support Building

FY25 SUC:	$5.05 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1499 Miscellaneous Operations Support Facility

FY25 SUC:	$239.72 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1511 Pier

FY25 SUC:	$31.98 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	NAVFAC/EXWC Data, 2020

FAC 1511	ESL	50 Years
FY21 SUC Remodel	2019 Median Size	5,261 SY

Pivot Capture from CALC Table

Pier Section	Average of ADJ Net Cost w/OP	Average of ADJ Net Cost w/OP per SY
H1010 - Pile	$280,187.34	$129.23
H1020 Superstructure	$102,023.21	$49.45
H1030 Deck	$153,105.24	$27.74
H1040 Mooring	$102,754.37	$35.96
H1050 - Other Pier Component	$5,880.16	$4.23
H5 - Other Anciliary Components	$20,165.42	$5.20
Grand Total	**$129,218.82**	**$48.82**

Pier Section	Sum of ADJ Net Cost w/OP	Average of ADJ Net Cost w/OP	Average of ADJ Net Cost w/OP per SY	Frequency (Years, based on UFC)	# Of Events in 50 Years	Lifetime Cost /SY
Inspection			$18.13	6	8	$145.06
H1010 Pile	$111,976,347.67	$414,727.21	$129.23	10	5	$646.17
H1020 Superstructure	$31,954,843.61	$177,526.91	$49.45	25	2	$98.90
H1030 Deck	$47,608,124.03	$207,895.74	$27.74	10	5	$138.68
H1040 Mooring	$50,592,942.61	$139,374.50	$35.96	10	5	$179.82
H1050 Other	$779,252.48	$10,253.32	$4.23	10	5	$21.15
H5 - Anciliary Components	$6,001,256.98	$29,274.42	$5.20	10	5	$25.99
	$248,912,767.39	$188,142.68			Subtotal	$1,255.78
					Per Year	$25.12

Notes:

Data Provided by EXWC October, 2020

Inspection Costs Inflated form FY14 Study (Original Life Cost per asset = $652,491.25)

Each Maintenance Event cost normalized for size of individual pier worked on

O/P Set to 20% if not presented in EXWC data

FAC 1512 Wharf

FY25 SUC:	$22.81 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	NAVFAC EXWC Data FY21

FAC 1512	Expected Service Life (ESL)	50	Years
FY22 SUC Remodel	2020 Average Size	4820	SY

Pivot Capture from CALC Table

Row Labels	Sum of ADJ Net Cost w/OP	Average of ADJ Net Cost w/OP	Average of ADJ Net Cost w/OP per SY	Frequency (Years, based on UFC)	# Of Events in 50 Years	Lifetime Cost /SY
Inspection			$19.78	6	8	$ 158.21
H1010 - Pile	$101,529,463.70	$214,197.18	$59.90	10	5	$299.50
H1020 Superstructure	$22,801,807.44	$175,398.52	$62.76	25	2	$125.52
H1030 Deck	$41,670,735.26	$110,532.45	$50.68	10	5	$253.40
H1040 Mooring	$20,847,922.05	$47,167.24	$16.00	10	5	$80.00
H1050 - Other Pier Component	$651,668.47	$7,947.18	$6.18	10	5	$30.90
H5 - Other Anciliary Components	$2,652,039.38	$7,091.01	$5.91	10	5	$29.55
Grand Total	$190,153,636.30	$101,199.38	$34.83		Subtotal	$977.08
					Per Year	$19.54
					FY22 FSMv24 SUC	$19.54

Notes:
Data Provided by EXWC October, 2020
Inspection Costs are same as Pier (FAC 1511) Inspection Costs inflated to FY21
Each Maintenance Event cost normalized for size of individual pier worked on
O/P Set to 20%
Inspection frequency based on UFC 4-150-07, *Maintenance of Waterfront Facilities*

FAC 1513 Pier/Wharf Access Trestle

FY25 SUC:	$37.45 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	NAVFAC EXWC Data FY21

FAC 1513 Pier-Wharf Access Trestle ESL 50 Years
FY22 SUC Remodel 2020 Average Size 4,819 SY

Pivot Capture from CALC Table

Row Labels	Sum of ADJ Net Cost w/OP	Average of ADJ Net Cost w/OP	Average of ADJ Net Cost w/OP per SY	Frequency (Years, based on UFC)	# Of Events in 50 Years	Lifetime Cost /SY
Inspection			$19.78	6	8	$ 158.24
H1010 - Pile	$19,710,201.93	$657,006.73	$179.67	10	5	$898.37
H1020 Superstructure	$4,099,022.89	$409,902.29	$102.47	25	2	$204.95
H1030 Deck	$1,038,674.99	$37,095.54	$42.25	10	5	$211.27
H1040 Mooring	$757,430.45	$84,158.94	$22.62	10	5	$113.11
H1050 - Other Pier Component	$36,271.04	$18,135.52	$3.13	10	5	$15.66
H5 - Other Ancillary Components	$33,407.77	$11,135.92	$0.35	10	5	$1.75
Grand Total	**$25,675,009.06**	**$313,109.87**	**$95.23**		Subtotal	$1,603.35
					Per Year	$32.07
					FY22 FSMv24 SUC	$32.07

Notes:
Data Provided by EXWC October, 2021
Inspection Costs are same as Pier (FAC 1511) Inspection Costs inflated to FY22
Each Maintenance Event cost normalized for size of individual pier-wharf access trestle in CALC tab below
O/P Set to 20%
Inspection frequency based on UFC 4-150-07, *Maintenance of Waterfront Facilities*

FAC 1541 Shore Erosion Prevention Facility

FY25 SUC:	$16.05 / LF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Calculation based on 2010 R.S. Means Maintenance & Repair Cost Data

FAC 1541 Shore Erosion Prevention Facility V13 Sustainment Unit Cost

References:
Real Property Classification System Version 2010-2
MO-104, Maintenance of Waterfront Facilities, June 1978
2010 Base General Schedule Pay Scale
2010 DoD CPMS Wage Scales
2010 R.S. Means Maintenance & Repair Cost Data
____UM= LF

SUSTAINMENT UNIT COST = $9.75

Cost factor based on the following tasks:

Details:

Annual Inspection:

3 hours per 100 LF (includes preparation, to/from site, report):
1 GS-13 (9) Hourly Rate: Basic Rate 43.65/hour x 1.325 (fringe) x 1.12 (overhead) = $64.78 1
GS-12 (9) Hourly Rate: Basic Rate 36.70/hour x 1.325 (fringe) x 1.12 (overhead) = $54.46

Total/Hour = 119.24

1 Pickup Truck/Small Boat = $1.70/Hour
Cost per 100 LF = $362.82
Per LF = $3.63

Annual Preventive Maintenance consisting of vegetation, debris, corrosion & marine organism control.

Details:

4 hours per 100 LF (includes preparation, to/from site):
1 WG9 (5) Hourly Rate: Basic Rate $28.02/hour x 1.325 (fringe) x 1.12 (overhead) = $41.58
3 WG7 (5) Hourly Rate: Basic Rate $24.67/hour x 1.325 (fringe) x 1.12 (overhead) = $109.83
Total/Hour = $151.41
1 Pickup Truck/Small Boat = $1.70/Hour
Cost per 100 LF = $612.44
Per LF = $6.12

Total Annual M&R = $3.63 + $6.12 = $9.75

FAC 1551 Small Craft Berthing

FY25 SUC:	$23.60 / FB
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Calculation based on 2010 R.S. Means Maintenance & Repair Cost Data

FAC 1551 Small Craft Berthing V13 Sustainment Unit Cost

References:
Real Property Classification System Version 2010-2
MO-104, Maintenance of Waterfront Facilities, June 1978
2010 Base General Schedule Pay Scale
2010 DoD CPMS Wage Scales
2010 R.S. Means Maintenance & Repair Cost Data
UM= FB

SUSTAINMENT UNIT COST = $14.35

Cost factor based on the following tasks:

Details:

Annual Inspection (includes divers).

4 hours per 100 LF (includes preparation, to/from site, report):
1 GS-13 (9) Hourly Rate: Basic Rate 43.65/hour x 1.325 (fringe) x 1.12 (overhead) = $64.78 1
GS-12 (9) Hourly Rate: Basic Rate 36.70/hour x 1.325 (fringe) x 1.12 (overhead) = $54.46 2
WG9 (5) Hourly Rate: Basic Rate $28.02/hour x 1.325 (fringe) x 1.12 (overhead) = $83.16

Total/Hour =$202.40

2 Pickup Trucks/Small Boats = $3.40/Hour
Cost per 100 LF = $823.20
Per LF = $8.23

Annual Preventive Maintenance consisting of checking/tightening fasteners, vegetation, debris, corrosion & marine organism control.

Details:

4 hours per 100 LF (includes preparation, to/from site):
1 WG9 (5) Hourly Rate: Basic Rate $28.02/hour x 1.325 (fringe) x 1.12 (overhead) = $41.58
3 WG7 (5) Hourly Rate: Basic Rate $24.67/hour x 1.325 (fringe) x 1.12 (overhead) = 109.83
Total/Hour = $151.41

1 Pickup Truck/Small Boat = $1.70/Hour
Cost per 100 LF = $612.44
Per LF = $6.12

Total Annual M&R = $8.23 + $6.12 = $14.35

FAC 1552 Small Craft Building

FY25 SUC:	$2.08 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1592 Magnetic Silencing Range

FY25 SUC:	$42,678.37 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	NAVFAC/EXWC Data, 2023

FAC 1592 MAGNETIC SILENCING RANGE

Source: FY23 analysis based on data provided by NAVFAC and EXWC modeled to a typical Magnetic Silencing Range with Data Concentrator Shed (DCS), in coordination with R&K Solutions.

Model Data:

FAC 1592 - MAGNETIC SILENCING RANGE	UM: EA		ESL	30			Mx (in hrs)					LABOR				
DESCRIPTION		COMPONENT / ACTIVITY	QUANTITY	Unit of Measure	Unit Cost to Maintain/Repair /Replace (Burdened)	Replacement Frequency (Years)	Daily	Wkly	Mo	Qrtly	Yrly	TOTAL HRS	LABOR RATE	LABOR COST	Total Number of Occurances	Lifetime Cost
PREVENTIVE MAINTENANCE AND INSPECTION SCHEDULE	Surface Inspection of Sensor Array															
	Dive Survey / Inspection of Sensor Array															
	Component / Conectivity testing						365.00	208.00	48.00	32.00	16.00	669	$33.86	$22,651.09		$22,651.09
COMPONENT REPLACEMENT (Cost Includes Labor and Materials)	Sensor Array	Refresh Gravel Base (10% per 5 years)		SY	$51,789.24	5									6	$310,735.44
	Sensor Array	Replace 3 x 10' sensor tubes/ PVC piping	30	LF	$151.74	2									15	$68,283.00
	Sensor Array	Replace damaged section of 18" Concrete pipe/conduit	20	LF	$2,820.00	5									6	$338,400.00
	Sensor Array	Replace 2 x Cable runs due to wear / damage		LF	$13,335.43	5									6	$80,012.55
	Sensor Array	Reset Sensor	1	EA	$16,482.56	4									7	$115,377.92
	DCS	Refinish fire escape stair and platform	2	Flight	$598.59	7									4	$4,788.72
	DCS	Refinish fire escape ladder	12	V.L.F.	$54.00	7									4	$2,592.00
	DCS	Replace steel decking	16	S.F.	$170.72	30									1	$2,731.52
	DCS	Metal floor grating repairs - (2% of grating)	16	S.F.	$626.56	10									3	$30,074.88
	DCS	Refinish steel louver, 1st floor	1	Ea.	$107.11	5									6	$642.66
	DCS	Replace glass - 1st floor (1% of glass) - steel frame window fixed	4	S.F.	$49.16	1									30	$5,899.20
	DCS	Repair 2'-0" x 3'-0" steel frame window - 1st floor.	1	Ea.	$156.97	20									1	$156.97
	DCS	Refinish 2'-0" x 3'-0" steel frame window - 1st floor.	1	Ea.	$87.72	5									6	$526.32
	DCS	Refinish 3'-0" x 7'-0" steel, painted, door	1	Ea.	$44.67	4									7	$312.69
	DCS	Maintenance and repair secondary transformer, dry	1	Ea.	$183.56	10									3	$550.68
	DCS	Maintenance and inspection secondary transformer, dry	1	Ea.	$85.94	0.5									60	$5,156.40
	DCS	Maintenance and inspection lighting panel, indoor	1	Ea.	$42.97	3									10	$429.70
	DCS	Maintenance and repair breaker, molded case, 480 V, 1 pole	6	Ea.	$457.98	20									1	$2,747.88
	DCS	Maintenance and repair receptacles and plugs	2	Ea.	$92.82	20									1	$185.64
	DCS	Replace receptacle/plug receptacles and plugs	2	Ea.	$148.88	20									1	$297.76
	DCS	Maintenance and repair wiring devices, switches	1	Ea.	$46.41	10									3	$139.23
	DCS	Replace wiring devices, switches	1	Ea.	$68.19	15									2	$136.38
	DCS	Replace fluorescent light fixture ballast, 80 W	2	Ea.	$280.98	10									3	$1,685.88
	DCS	Replace lamps (2 lamps), 4', 34 W energy saver	2	Ea.	$80.20	10									3	$481.20
	DCS	Replace metal halide ballast, 175 W	1	Ea.	$189.44	10									3	$568.32
	DCS	Replace metal halide fixture lamp, 175 W	1	Ea.	$74.03	5									6	$444.18
	DCS	Repair heat detector	1	Ea.	$64.54	10									3	$193.62
	DCS	Check operation heat detector	1	Ea.	$17.24	1									30	$517.20
	DCS	Minor repairs to annunciation panel	1	Ea.	$170.42	5									6	$1,022.52
	DCS	Maintenance and repair building structure ground	260	L.F	$1.94	7									4	$2,012.82
	DCS	Maintenance and repair of general wiring lightning protection system	260	L.F	$2.14	1									30	$16,685.76
	DCS	Maintenance and repair lightning ground rod	2	Ea.	$193.54	1									30	$11,612.40
	DCS	Maintenance and repair voice/data outlet	28	Ea.	$1,826.24	10									3	$153,404.16
	DCS	Maintenance and inspection patch panel	2	Ea.	$184.00	0.5									60	$22,080.00
	DCS	Replace patch panel	2	Ea.	$1,831.94	15									2	$7,327.76

*DCS: Data Concentrator Shed

** Labor determined as hourly rate for a Wage Grade 10 + Fringe as defined by OMB Circular A-25 at 36.25%.

Total Maintenance Cost	**$1,210,864.45**
Annual Cost	**$40,362.15**
SUC	**$40,362.15**

FAC 1593 Water Launch Ramp

FY25 SUC:	$1.99 / SY
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1611 Harbor Control Facility

FY25 SUC:	$1,520.16 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Composite of multiple FACS

FAC 1611 Harbor Control Facility V13 Sustainment Unit Cost

References:
FSM FMM FOM Version 12, Common References Tables, 4-09-10
Real Property Classification System Version 2010-2
UFC 2-000-05N Facilities Planning Criteria for Navy/Marine Corps Shore Installations

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UM= Each

SUSTAINMENT UNIT COST = $923.74

Cost Methodology

This SUC was determined using a combination of two other FACs (FAC 2134 Marine Maintenance Facility and FAC 8526 Misc. Paved Area) and preventive maintenance and inspection tasks for Navy CATCODE 16120, Fixed Net Anchorage. A weighted average of the annual maintenance and repair of the three categories of facilities in this FAC based on FAD inventories determined the SUC. The attached embedded spreadsheet shows each cost element.

Fixed Net Anchorage (Navy CATCODE 16120):

Annual Inspection (includes divers):

4 hours per facility:
1 GS-13 (9) Hourly Rate: Basic Rate 43.65/hour x 1.325 (fringe) x 1.12 (overhead) = $64.78
1 GS-12 (9) Hourly Rate: Basic Rate 36.70/hour x 1.325 (fringe) x 1.12 (overhead) = $54.46
3 WG9 (5) Hourly Rate: Basic Rate $28.02/hour x 1.325 (fringe) x 1.12 (overhead) = $124.74
1 WG7 (5) Hourly Rate: Basic Rate $24.07/hour x 1.325 (fringe) x 1.12 (overhead) = $36.61
Total/Hour = $280.59
1 Pickup Truck/Motor launch = $1.70/Hour

Total Cost per hour = $282.29
Total Cost per inspection = $1129.16

Annual Preventive Maintenance consisting of servicing fastening devices, corrosion control, debris control.

Details:
4 hours per PM Service:
1 WG9 (5) Hourly Rate: Basic Rate $28.02/hour x 1.325 (fringe) x 1.12 (overhead) = $41.58
3 WG7 (5) Hourly Rate: Basic Rate $24.07/hour x 1.325 (fringe) x 1.12 (overhead) = $109.83
Total/Hour = $151.41
1 Pickup Truck/Small Boat = $1.70/Hour
Total Cost per hour = $153.11

Cost per PM Service = $612.44

Total Annual Maintenance and Repair for Fixed Net Anchorage = $1129.16+$612.44 = $1741.60

Winch House: Use FAC 2134, Marine Maintenance Support Facility @ 400 SF

Harbor Entrance Control Facility: Use FAC 8526 Misc. Paved Area @ 560 SY

FAC 1611 Harbor Control Facility

FAC composition	Quantity	Assumed Size	UM	Surrogate FAC	Surrogate FAC Description	Surrogate FAC SUC	Unit Annual Sustainment	Total Annual Sustainment Contribution
Harbor Entrance Control Facility	7	560	SY	8526	Misc. Paved Area	$1.49	$834.40	104.30
Winch House	46	400	SF	2134	Marine Maintenance Support Facility	$2.21	$884.00	726.14
Fixed Net Anchorage	3	N/A	N/A	N/A	N/A	N/A	$1,741.60	93.30
Total	56						$3,460.00	$923.74
						SUC=	**$923.74**	

FAC 1631 Offshore Mooring Facility

FY25 SUC:	$1,174.10 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Calculation based on service data, UFC and Means labor rates

FAC 1631 Offshore Mooring Facility

UM = EA Design Qty 1 ESL = 36

Requirements		Unit	Qty	Unit Cost	Frequency (years)	Occurances over Lifetime	Extended Cost
	Inspection -						
	1 x GS-13 (9) ($55.92) + fringe (1.325) + OH (1.12)	HR	2.0	$82.98	1	36	$ 5,974.56
	1 x GS-12 (9) ($47.03) + fringe (1.325) + OH (1.12)	HR	2.0	$69.79	1	36	$ 5,024.88
	3 x WG-9 (5) + fringe (1.325) + OH (1.12)	HR	2.0	$129.21	1	36	$ 9,303.12
	1 x WG-7 (5) + fringe (1.325) + OH (1.12)	HR	2.0	$35.20	1	36	$ 2,534.40
	1 Pickup Truck/Motor launch	HR	2.0	$10.05	1	36	$ 723.60
	Annual PM consisting of servicing fastening devices,						
	corrosion control, debris control						
	1 x WG-9 (5) + fringe (1.325) + OH (1.12)	HR	2	$43.07	1	36	$ 3,101.04
	3 x WG-7 (5) + fringe (1.325) + OH (1.12)	HR	2	$105.60	1	36	$ 7,603.20
	1 Pickup Truck/Motor launch	HR	2	$10.05	1	36	$ 723.60
	Fasteners/cable/shop stock	EA	4.0	$43.50	5	7	$ 1,218.00
TOTAL							$ 36,206.40
PER UNIT (EA)							$ 1,005.73

Reference: 2021

RPCS

2020 RPAD

UFC 2-000-05N Facilities Planning Criteria for Navy/Marine Corps Shore Installations

RS Means Costworks 2021Q3

FAC 1641 Harbor Marine Improvements

FY25 SUC:	$16.05 / LF
Source:	Set to FAC 1541: Calculation based on Means

FAC 1711 General Purpose Instruction Building

FY25 SUC:	$6.15 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1712 Applied Instruction Building

FY25 SUC:	$4.46 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1713 Band Training Facility

FY25 SUC:	$6.90 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1714 Reserve Training Facility

FY25 SUC:	$7.44 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1715 Physical Education Building

FY25 SUC:	$3.03 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1717 Organizational Classroom

FY25 SUC:	$4.82 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1717 Organizational Classroom

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.82
UM: SF
Expected Service Life: 50
Model Size: 5115

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair clay brick wall, 1st floor	25	2,363.00 S.F.	$112,551.30	$138,087.90	2.0000	2	2	$276,175.80	$276,175.80
Waterproof clay brick wall, 1st floor	10	19.60 C.S.F.	$3,803.24	$4,582.99	5.0000	5	5	$22,914.94	$22,914.94
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	6.00 S.F.	$81.91	$96.18	50.0000	50	50	$4,808.75	$4,808.75
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	18.00 Ea.	$2,906.96	$3,464.21	2.5000	2	2	$6,928.41	$6,928.41
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	18.00 Ea.	$14,791.75	$17,282.04	1.0000	1	1	$17,282.04	$17,282.04
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	3.5714	3	3	$8,286.91	$8,286.91
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	12.5000	12	12	$2,115.09	$2,115.09
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	1.1111	1	1	$2,569.71	$2,569.71
Replace tempered glass - (3% of glass) steel painted door	1	0.09 S.F.	$2.97	$3.50	50.0000	50	50	$175.02	$175.02
Non-destructive moisture inspection, modified bituminous/thermoplastic	5	3.83 M.S.F.	$484.52	$591.73	10.0000	10	10	$5,917.33	$5,917.33
Minor thermoplastic membrane repairs, 2% of roof area	1	1.50 Sq.	$520.96	$620.79	50.0000	50	50	$31,039.40	$31,039.40
Flashing repairs, 2 S.F. per sq. repaired, modified bitumen/thermoplastic	1	1.50 S.F.	$6.21	$7.45	50.0000	50	50	$372.43	$372.43
Membrane replacement-(25% of roof area),modified bitum/thermoplastic	20	10.00 Sq.	$9,054.69	$10,787.85	2.5000	2	2	$21,575.69	$21,575.69
Total roof replacement, modified bituminous / thermoplastic	25	54.50 Sq.	$40,523.07	$47,969.42	2.0000	2	2	$95,938.85	$95,938.85
Repair 8" concrete block wall - (2% of walls) painted	25	0.30 C.S.F.	$364.78	$438.16	2.0000	2	2	$876.31	$876.31
Repair steel painted interior door	14	2.00 Ea.	$593.70	$692.64	3.5714	3	3	$2,077.93	$2,077.93
Refinish 3'-0" x 7'-0" steel painted interior door	4	2.00 Ea.	$120.41	$148.05	12.5000	12	12	$1,776.59	$1,776.59
Replace 3'-0" x 7'-0" steel painted interior door	60	2.00 Ea.	$2,819.04	$3,265.60	0.8333	0	0	$0.00	$0.00
Repair solid core wood door, interior	11	8.00 Ea.	$2,374.80	$2,770.57	4.5455	4	4	$11,082.30	$11,082.30
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	8.00 Ea.	$437.45	$532.18	12.5000	12	11	$6,386.12	$5,853.94
Replace 3'-0" x 7'-0" solid core wood door, interior	40	8.00 Ea.	$5,150.22	$5,938.40	1.2500	1	1	$5,938.40	$5,938.40
Repair 5/8" drywall - (2% of walls)	20	154.00 S.F.	$287.67	$349.91	2.5000	2	2	$699.82	$699.82
Replace 5/8" drywall	75	7,700.00 S.F.	$19,858.42	$24,305.58	0.6667	0	0	$0.00	$0.00
Refinish concrete floor finished	25	4.30 C.S.F.	$1,971.60	$2,368.76	2.0000	2	2	$4,737.52	$4,737.52
Replace vinyl tile flooring	18	27.00 S.Y.	$1,527.07	$1,869.18	2.7778	2	2	$3,738.37	$3,738.37
Ceramic tile floor repairs - (2% of floors)	15	0.10 C.S.F.	$69.66	$86.85	3.3333	3	3	$260.56	$260.56
Replace 2" x 2" thin set ceramic tile floor	50	6.40 C.S.F.	$10,458.49	$12,492.52	1.0000	1	1	$12,492.52	$12,492.52
Acoustic tile repairs - (2% of ceilings)	9	0.80 C.S.F.	$920.57	$1,066.95	5.5556	5	5	$5,334.74	$5,334.74
Replace acoustic tile ceiling, fire-rated	20	15.50 C.S.F.	$9,682.74	$11,386.85	2.5000	2	2	$22,773.71	$22,773.71
Replace flush valve diaphragm tankless water closet	10	6.00 Ea.	$165.54	$205.66	5.0000	5	5	$1,028.29	$1,028.29
Rebuild flush valve tankless water closet	20	6.00 Ea.	$1,159.63	$1,397.72	2.5000	2	2	$2,795.45	$2,795.45
Unplug clogged line tankless water closet	5	6.00 Ea.	$1,378.69	$1,726.73	10.0000	10	10	$17,267.27	$17,267.27
Replace tankless water closet	35	6.00 Ea.	$8,259.94	$9,559.17	1.4286	1	1	$9,559.17	$9,559.17
Replace tankless flush valve	25	6.00 Ea.	$1,635.93	$1,920.17	2.0000	2	2	$3,840.34	$3,840.34
Replace wax ring gasket for tankless water closet	5	6.00 Ea.	$898.53	$1,124.29	10.0000	10	10	$11,242.92	$11,242.92
Replace flush valve diaphragm for a urinal	7	3.00 Ea.	$82.77	$102.83	7.1429	7	7	$719.80	$719.80
Rebuild flush valve for a urinal	20	3.00 Ea.	$579.81	$698.86	2.5000	2	2	$1,397.72	$1,397.72
Unplug line urinal	5	3.00 Ea.	$458.71	$574.51	10.0000	10	10	$5,745.09	$5,745.09
Replace wall-hung urinal	35	3.00 Ea.	$3,276.87	$3,943.16	1.4286	1	1	$3,943.16	$3,943.16
Replace faucets lavatory, vitreous china	10	10.00 Ea.	$1,986.23	$2,387.83	5.0000	5	5	$11,939.17	$11,939.17
Clean out strainer and P trap lavatory, vitreous china	2	10.00 Ea.	$370.88	$464.51	25.0000	25	25	$11,612.75	$11,612.75
Replace lavatory, vitreous china	35	10.00 Ea.	$7,513.76	$9,008.85	1.4286	1	1	$9,008.85	$9,008.85
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	25.0000	25	25	$421.14	$421.14
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	16.6667	16	16	$180.70	$180.70
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	5.0000	5	5	$1,193.92	$1,193.92
Check / minor repairs drinking fountain	1	1.00 Ea.	$51.94	$65.06	50.0000	50	50	$3,252.87	$3,252.87
Repair internal leaks drinking fountain	4	1.00 Ea.	$47.79	$59.85	12.5000	12	12	$718.23	$718.23
Replace refrigerant drinking fountain	2	1.00 Ea.	$36.77	$43.00	25.0000	25	25	$1,074.93	$1,074.93
Repair drain leak drinking fountain	4	1.00 Ea.	$30.51	$36.81	12.5000	12	10	$441.70	$368.08
Replace fountain drinking fountain	10	1.00 Ea.	$1,523.39	$1,794.44	5.0000	5	5	$8,972.20	$8,972.20
Drain and flush water heater, electric, 120 gallon	7	1.00 Ea.	$310.63	$389.04	7.1429	7	7	$2,723.30	$2,723.30
Check operation water heater, electric, 120 gallon	3	1.00 Ea.	$2.72	$3.41	16.6667	16	16	$54.54	$54.54
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.5000	2	2	$126.21	$126.21
Repair boiler, gas, 250 MBH	7	1.00 Ea.	$2,552.63	$2,989.56	7.1429	7	6	$20,926.92	$17,937.36
Replace boiler, gas, 250 MBH	30	1.00 Ea.	$1,636.25	$2,049.31	1.6667	1	1	$2,049.31	$2,049.31
Repair fan coil unit, 5 ton	10	1.00 Ea.	$642.62	$761.18	5.0000	5	4	$3,805.91	$3,044.73
Replace fan coil unit, 5 ton	15	1.00 Ea.	$2,936.77	$3,403.68	3.3333	3	3	$10,211.05	$10,211.05
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	1.00 Ea.	$4,344.36	$5,039.65	2.5000	2	2	$10,079.30	$10,079.30
Repair circulator pump, 1/12 - 3/4 H.P.	5	1.00 Ea.	$104.83	$123.65	10.0000	10	10	$1,236.47	$1,236.47
Repair single zone rooftop unit, 5 ton	10	1.00 Ea.	$2,912.53	$3,474.76	5.0000	5	5	$17,373.78	$17,373.78
Replace single zone rooftop unit, 5 ton	15	1.00 Ea.	$8,648.69	$10,289.33	3.3333	3	3	$30,867.99	$30,867.99
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	50.0000	50	50	$2,270.50	$2,270.50
Replace sprinkler head	20	24.00 Ea.	$2,200.58	$2,711.93	2.5000	2	2	$5,423.87	$5,423.87
Maintenance and repair motor starter, up to 600 V	5	3.00 Ea.	$1,048.66	$1,256.79	10.0000	10	10	$12,567.89	$12,567.89
Replace starter motor starter, up to 600 V	18	3.00 Ea.	$2,456.87	$2,932.35	2.7778	2	2	$5,864.71	$5,864.71
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	16.6667	16	16	$1,758.95	$1,758.95
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	21.00 Ea.	$1,623.02	$2,036.08	2.5000	2	2	$4,072.16	$4,072.16
Maintenance and repair receptacles and plugs	20	44.00 Ea.	$2,013.40	$2,515.71	2.5000	2	2	$5,031.43	$5,031.43
Maintenance and repair wiring devices, switches	10	14.00 Ea.	$640.63	$800.45	5.0000	5	5	$4,002.27	$4,002.27
Maintenance and repair incandescent lighting fixtures	10	8.00 Ea.	$594.65	$708.12	5.0000	5	3	$3,540.60	$2,124.36
Replace incandescent lighting fixture lamp	5	8.00 Ea.	$109.06	$131.11	10.0000	10	10	$1,311.11	$1,311.11
Replace incandescent lighting fixture	20	8.00 Ea.	$1,183.10	$1,433.36	2.5000	2	2	$2,866.71	$2,866.71
Replace fluorescent light fixture ballast, 80 W	10	32.00 Ea.	$3,485.82	$4,298.47	5.0000	5	5	$21,492.37	$21,492.37
Replace lamps (2 lamps), 4', 34 W energy saver	10	32.00 Ea.	$868.85	$1,089.48	5.0000	5	5	$5,447.39	$5,447.39
Repair smoke detector	10	10.00 Ea.	$607.65	$752.05	5.0000	5	4	$3,760.26	$3,008.21
Check operation smoke detector	1	10.00 Ea.	$174.66	$219.11	50.0000	50	50	$10,955.28	$10,955.28
Replace smoke detector	15	10.00 Ea.	$3,374.21	$4,015.07	3.3333	3	3	$12,045.22	$12,045.22
Repair heat detector	10	6.00 Ea.	$397.52	$488.66	5.0000	5	5	$2,443.28	$2,443.28
Check operation heat detector	1	6.00 Ea.	$104.79	$131.46	50.0000	50	50	$6,573.17	$6,573.17
Replace heat detector	15	6.00 Ea.	$1,138.82	$1,390.91	3.3333	3	3	$4,172.73	$4,172.73
Check and repair manual pull station	10	3.00 Ea.	$284.97	$350.72	5.0000	5	4	$1,753.60	$1,402.88
Replace manual pull station	15	3.00 Ea.	$690.23	$829.51	3.3333	3	3	$2,488.54	$2,488.54
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	10.0000	10	10	$1,954.25	$1,954.25
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	100.0000	100	100	$5,802.10	$5,802.10
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.3333	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.5000	2	2	$971.29	$971.29
Replace EMS, Three Phase, 5 Meters	15	1.00 Ea.	$15,259.67	$17,770.50	3.3333	3	3	$53,311.51	$53,311.51
Replace EMS, Mech, BTU, 3 Meters, 3 Duct Sensors, 3 Space Sensors	20	1.00 Ea.	$16,542.70	$19,338.83	2.5000	2	2	$38,677.66	$38,677.66
Maintenance and repair building structure ground	7	0.25 M.L.F.	$23.86	$29.83	7.1429	7	7	$208.83	$208.83
Replace lamp emergency lighting fixture	2	2.00 Ea.	$114.63	$138.36	25.0000	25	25	$3,458.94	$3,458.94
Replace emergency lighting fixture	20	2.00 Ea.	$1,247.56	$1,472.99	2.5000	2	2	$2,945.98	$2,945.98
Maintenance and repair exit light	20	4.00 Ea.	$159.66	$197.62	2.5000	2	2	$395.25	$395.25
Replace lamp exit light	5	4.00 Ea.	$73.19	$86.76	10.0000	10	10	$867.63	$867.63
			$359,355.00	$431,543.64				MR Subtotal:	$1,010,169.83
								MR Per Year:	$20,203.40
								PM Total:	$4,462.45
								Subtotal:	$24,665.85
								Total Per Unit:	$4.82

FAC 1717 Organizational Classroom

Release:	2024 Qtr 3	FY25 SUC:	$4.82
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	50
		Model Size:	5115

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Fire doors, swinging, annualized	4	1.57	$57.96	$64.30	$0.0000	122.26	147.34	175.32
Urinals, annualized	3	0.68	$20.52	$36.80	$0.0000	57.32	70.41	84.53
Toilet (vacuum breaker type), annualized	6	1.06	$55.10	$57.36	$0.0000	112.46	135.18	160.65
Lavatories, annualized	10	3.48	$77.18	$219.96	$0.0000	297.14	370.85	448.41
Drink fountain, annualized	1	0.62	$36.15	$33.42	$0.0000	69.57	83.21	98.65
Boiler, hot water, oil, gas, or comb. fired, up to 120 MBH, annualized	1	12.53	$90.37	$799.47	$0.0000	889.84	1,138.72	1,392.12
Fan coil unit, annualized	2	6.68	$171.95	$358.70	$0.0000	530.66	655.46	788.87
VAV Boxes, annualized	3	2.80	$28.58	$178.93	$0.0000	207.51	264.04	322.01
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Light, emergency, hardwired system, annualized	6	1.50	$54.49	$94.72	$0.0000	149.21	183.08	219.66
						$2,979.92	$3,699.37	$4,462.45

FAC 1718 Indoor Firing Range and Supporting Facility

FY25 SUC:	$5.76 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1721 Flight Simulator Facility

FY25 SUC:	$7.37 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1722 Physiological Training Facility

FY25 SUC:	$4.94 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1723 Gas Training Facility

FY25 SUC:	$3.43 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1724 General Purpose Simulator Facility

FY25 SUC:	$5.54 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1725 Training Pool and Tank

FY25 SUC:	$21,438.28 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1726 Enclosed Fire Fighter Trainer Facility

FY25 SUC:	$14.63 / SF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	NAVFAC/EXWC Data, 2020

FAC 1726 ENCLOSED FIRE FIGHTER TRAINER FACILITY

San Diego FFTs	Structure Name	Facility NBR	RPA Name	Year Built	NBR Stories	Floor Area	UM	Immediate Repairs	Supplemental Repairs	Total	SF Cost
	Structure B1 (19F3-B1)	3415A	FIRE TRAINER ALPHA	1989	2	4,298	SF	$159,857	$233,412	$393,269	$91.50
	Structure B2 (19F3-B2)	3415B	FIRE TRAINER BRAVO	1989	1	6,568	SF	$26,379	$226,235	$252,614	$38.46
	Structure B3 (19F3-B3)	3415C	FIRE TRAINER CHARLIE	1989	1	2,776	SF	$122,070	$119,872	$241,942	$87.15
	Structure B4 (19F3-B4)	3415D	FIRE TRAINER DELTA	1989	1	2,776	SF	$124,473	$132,413	$256,886	$92.54
	Structure F1 (19F1A)	3415	FIRE TRAINER FOXTROT	1989	3	15,994	SF	$189,768	$235,579	$425,347	$26.59
	Structure F4 (19F4)	3415E	FIRE TRAINER ECHO	1989	1	7,392	SF	$219,265	$326,729	$545,994	$73.86
				Totals	9	39,804	SF	$841,812	$1,274,240	$2,116,052	$53.16
				Average	1.5	4,423	SF	$140,302.00	$212,373.33	$352,675.33	$68.35
				Median	1	5,433	SF	$142,165.00	$229,823.50	$325,077.50	$80.51

	Cycle	Years	SF Cost	Yearly SF Cost	City of San Diego SUST ACF	Yearly SF Cost with ACF = 1.0	Inflation Factor FY17 Thru FY21	ACF = 1.0 Cost
San Diego M&R Costs	5 Year Cycle	5	$53.16	$10.63	1.06	$10.03	1.082	$10.86

Norfolk FFTs	Structure Name	Facility NBR	RPA Name	Year Built	NBR Stories	Floor Area	UM	Immediate Repairs	Supplemental Repairs	Total	SF Cost
	Structure B1 (19F3-B1)			1990	2	5,100	SF				
	Structure B2 (19F3-B2)			1990	1	5,300	SF				
	Structure B3 (19F3-B3)			1990	1	3,800	SF				
	Structure B4 (19F3-B4)			1990	1	3,800	SF				
	Structure F1 (19F1A)			1990	3	16,000	SF				
	Structure F4 (19F4)			1990	1	7,350	SF				
				1990	9	41,350	SF			$1,001,182	$24.21

	Cycle	Years	SF Cost	Yearly SF Cost	City of San Diego SUST ACF	Yearly SF Cost with ACF = 1.0	Inflation Factor FY17 Thru FY21	ACF = 1.0 Cost
Norfolk M&R Costs	5 Year Cycle	5	$24.21	$4.84	0.97	$4.99	1.082	$5.40

San Diego & Norfolk FFTs Combined	Cycle	Years	SF Cost	Yearly SF Cost	NAVBASE San Diego SUST ACF	Yearly SF Cost with ACF = 1.0	Inflation Factor FY17 Thru FY21	ACF = 1.0 Cost
Average of San Diego & Norfolk M&R	5 Year Cycle	5	$38.69	$7.74	1.02	$7.51	$1.08	$8.13
							PM Inspection Annual Cost	$3.36
							SUC	**$11.49**

FAC 1731 Range Support Building

FY25 SUC:	$2.89 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1732 Training Aids Support Building

FY25 SUC:	$2.93 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1732 Training Aids Support Building

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $2.93
UM: SF
Expected Service Life: 40
Model Size: 8369

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	220.00 S.F.	$8,950.56	$10,901.08	2.6667	2	2	$21,802.15	$21,802.15
Repair concrete stairs	30	84.00 S.F.	$2,677.69	$3,099.10	1.3333	1	1	$3,099.10	$3,099.10
Refinish concrete steps	3	84.00 S.F.	$146.84	$180.62	13.3333	13	13	$2,348.11	$2,348.11
Replace metal hand rail	30	22.00 L.F.	$1,355.95	$1,576.59	1.3333	1	1	$1,576.59	$1,576.59
Repair 8" concrete block wall, 1st floor	25	926.00 S.F.	$24,792.17	$30,329.34	1.6000	1	1	$30,329.34	$30,329.34
Point and refinish painted concrete block wall, 1st floor	25	24.00 C.S.F.	$13,157.39	$16,170.45	1.6000	1	1	$16,170.45	$16,170.45
Repair 3'-9" x 5'-5" steel frame window - 1st floor.	20	24.00 Ea.	$8,233.82	$9,657.84	2.0000	2	2	$19,315.69	$19,315.69
Replace 3'-9" x 5'-5" steel frame window - 1st floor.	45	24.00 Ea.	$45,783.93	$52,688.67	0.8889	0	0	$0.00	$0.00
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	0.60 S.F.	$8.19	$9.62	40.0000	40	40	$384.70	$384.70
Repair 2'-0" x 3'-0" aluminum window - 2nd floor	20	6.00 Ea.	$1,275.78	$1,536.36	2.0000	2	2	$3,072.71	$3,072.71
Replace 2'-0" x 3'-0" aluminum window - 2nd floor	50	6.00 Ea.	$5,237.38	$6,142.30	0.8000	0	0	$0.00	$0.00
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	2.8571	2	2	$5,524.61	$5,524.61
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	10.0000	10	10	$1,762.58	$1,762.58
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	0.8889	0	0	$0.00	$0.00
Repair 12' x 12' steel roll-up door	10	2.00 Ea.	$1,804.34	$2,126.24	4.0000	4	4	$8,504.98	$8,504.98
Replace 12' x 12' steel roll-up door	35	2.00 Ea.	$7,217.35	$8,504.98	1.1429	1	1	$8,504.98	$8,504.98
Non-destructive moisture inspection of built-up roofing	5	8.40 M.S.F.	$1,061.83	$1,296.78	8.0000	8	8	$10,374.24	$10,374.24
Minor BUR membrane repairs, 2% of roof area	1	1.68 Sq.	$981.25	$1,159.94	40.0000	40	40	$46,397.75	$46,397.75
BUR flashing repairs, 2 S.F. per sq. repaired	1	2.10 S.F.	$8.06	$9.79	40.0000	40	40	$391.67	$391.67
Total BUR roof replacement	28	84.00 Sq.	$81,676.89	$96,126.71	1.4286	1	1	$96,126.71	$96,126.71
Repair 8" concrete block wall - (2% of walls) painted	25	11.60 C.S.F.	$14,104.89	$16,942.07	1.6000	1	1	$16,942.07	$16,942.07
Refinish concrete block wall painted	4	11.60 C.S.F.	$1,590.97	$1,912.69	10.0000	10	10	$19,126.88	$19,126.88
Repair steel painted interior door	14	2.00 Ea.	$593.70	$692.64	2.8571	2	2	$1,385.29	$1,385.29
Replace 3'-0" x 7'-0" steel painted interior door	60	2.00 Ea.	$2,819.04	$3,265.60	0.6667	0	0	$0.00	$0.00
Repair solid core wood door, interior	11	5.00 Ea.	$1,484.25	$1,731.61	3.6364	3	3	$5,194.83	$5,194.83
Replace 3'-0" x 7'-0" solid core wood door, interior	40	5.00 Ea.	$3,218.89	$3,711.50	1.0000	1	1	$3,711.50	$3,711.50
Repair 5/8" drywall - (2% of walls)	20	28.00 S.F.	$52.30	$63.62	2.0000	2	2	$127.24	$127.24
Replace 5/8" drywall	75	1,404.00 S.F.	$3,620.94	$4,431.82	0.5333	0	0	$0.00	$0.00
Refinish concrete floor finished	25	147.00 C.S.F.	$67,401.35	$80,978.46	1.6000	1	1	$80,978.46	$80,978.46
Replace vinyl tile flooring	18	23.10 S.Y.	$1,306.50	$1,599.19	2.2222	2	2	$3,198.38	$3,198.38
Repair gypsum board ceiling - (2% of ceilings)	20	2.55 C.S.F.	$1,042.06	$1,277.73	2.0000	2	2	$2,555.46	$2,555.46
Refinish gypsum board ceiling, up to 12' high	20	2.80 C.S.F.	$425.98	$523.72	2.0000	2	2	$1,047.45	$1,047.45
Acoustic tile repairs - (2% of ceilings)	9	14.60 C.S.F.	$16,800.40	$19,471.81	4.4444	4	4	$77,887.24	$77,887.24
Replace acoustic tile ceiling, fire-rated	20	5.60 C.S.F.	$3,498.28	$4,113.96	2.0000	2	2	$8,227.92	$8,227.92
Replace flush valve diaphragm tankless water closet	10	3.00 Ea.	$82.77	$102.83	4.0000	4	4	$411.31	$411.31
Rebuild flush valve tankless water closet	20	3.00 Ea.	$579.81	$698.86	2.0000	2	2	$1,397.72	$1,397.72
Replace tankless water closet	35	3.00 Ea.	$4,129.97	$4,779.59	1.1429	1	1	$4,779.59	$4,779.59
Replace wax ring gasket for tankless water closet	5	3.00 Ea.	$449.26	$562.15	8.0000	8	8	$4,497.17	$4,497.17
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	5.7143	5	5	$342.76	$342.76
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.0000	2	2	$931.82	$931.82
Replace wall-hung urinal	35	2.00 Ea.	$2,184.58	$2,628.78	1.1429	1	1	$2,628.78	$2,628.78
Replace washer in spud connection lavatory, vitreous china	7	4.00 Ea.	$69.57	$84.93	5.7143	5	5	$424.67	$424.67
Replace washer in faucet lavatory, vitreous china	2	4.00 Ea.	$54.39	$67.85	20.0000	20	20	$1,357.03	$1,357.03
Replace faucets lavatory, vitreous china	10	4.00 Ea.	$794.49	$955.13	4.0000	4	4	$3,820.54	$3,820.54
Clean out strainer and P trap lavatory, vitreous china	2	4.00 Ea.	$148.35	$185.80	20.0000	20	20	$3,716.08	$3,716.08
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	20.0000	20	20	$336.92	$336.92
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	13.3333	13	13	$146.82	$146.82
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	4.0000	4	4	$955.13	$955.13
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	20.0000	20	20	$1,105.98	$1,105.98
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	1.00 Ea.	$910.17	$1,070.70	4.0000	4	4	$4,282.81	$4,282.81
Inspect and clean spray heads, emergency eye wash	3	1.00 Ea.	$52.06	$65.20	13.3333	13	13	$847.61	$847.61
Replace eye wash station, emergency eye wash	25	1.00 Ea.	$790.45	$961.55	1.6000	1	1	$961.55	$961.55
Drain and flush water heater, electric, 120 gallon	7	1.00 Ea.	$310.63	$389.04	5.7143	5	5	$1,945.22	$1,945.22
Check operation water heater, electric, 120 gallon	3	1.00 Ea.	$2.72	$3.41	13.3333	13	13	$44.32	$44.32
Replace water heater, electric, 120 gallon	15	1.00 Ea.	$15,946.05	$18,237.49	2.6667	2	2	$36,474.98	$36,474.98
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.0000	2	2	$126.21	$126.21
Repair joint pipe and fittings, PVC	10	2.00 Ea.	$314.41	$391.82	4.0000	4	4	$1,567.29	$1,567.29
Replace pipe, 4" pipe and fittings, PVC	30	300.00 L.F.	$28,109.55	$34,400.96	1.3333	1	1	$34,400.96	$34,400.96
General maintenance & repair drain: roof, scupper, area	1	8.00 Ea.	$313.74	$392.95	40.0000	40	40	$15,717.87	$15,717.87
Replace drain: roof, scupper, area	40	8.00 Ea.	$8,770.86	$10,121.72	1.0000	1	1	$10,121.72	$10,121.72
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	1.00 Ea.	$4,344.36	$5,039.65	2.0000	2	2	$10,079.30	$10,079.30
Repair damaged pipe insulation, fiberglass 3/4"	5	4.00 Ea.	$91.82	$111.96	8.0000	8	8	$895.65	$895.65
Repair damaged pipe insulation, fiberglass 2"	5	2.00 Ea.	$54.99	$66.89	8.0000	8	8	$535.12	$535.12
Replace pipe insulation, fiberglass 3/4"	5	0.03 M.L.F.	$284.00	$344.73	8.0000	8	8	$2,757.86	$2,757.86
Replace pipe insulation, fiberglass 2"	5	0.01 M.L.F.	$114.07	$138.06	8.0000	8	8	$1,104.51	$1,104.51
Maintenance and repair infrared heater suspended, commercial	1	4.00 Ea.	$181.95	$228.26	40.0000	40	40	$9,130.30	$9,130.30
Maintenance and inspection infrared heater suspended, commercial	0.5	4.00 Ea.	$339.09	$425.39	80.0000	80	80	$34,031.13	$34,031.13
Repair single zone rooftop unit, 5 ton	10	1.00 Ea.	$2,912.53	$3,474.76	4.0000	4	4	$13,899.02	$13,899.02
Replace single zone rooftop unit, 5 ton	15	1.00 Ea.	$8,648.69	$10,289.33	2.6667	2	2	$20,578.66	$20,578.66
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	40.0000	40	40	$1,816.40	$1,816.40
Replace sprinkler head	20	45.00 Ea.	$4,126.08	$5,084.88	2.0000	2	2	$10,169.75	$10,169.75
Replace fuse	25	14.00 Ea.	$8,507.95	$9,747.23	1.6000	1	1	$9,747.23	$9,747.23
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	4.0000	4	4	$6,215.64	$6,215.64
Maintenance and repair secondary transformer, dry	10	1.00 Ea.	$295.51	$351.26	4.0000	4	4	$1,405.05	$1,405.05
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	13.3333	13	13	$1,429.15	$1,429.15
Maintenance and repair breaker, enclosed, 240 V, 3 pole	25	6.00 Ea.	$463.72	$581.74	1.6000	1	1	$581.74	$581.74
Maintenance and inspection circuit breaker, enclosed, 240 V, 3 pole	1	6.00 Ea.	$208.13	$261.09	40.0000	40	40	$10,443.78	$10,443.78
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	1.00 Ea.	$43.82	$54.97	5.0000	5	5	$274.84	$274.84
Maintenance and inspection safety switch, 3 pole, heavy duty	1	1.00 Ea.	$43.82	$54.97	40.0000	40	40	$2,198.69	$2,198.69
Replace safety switch, heavy duty 30 A	25	1.00 Ea.	$767.57	$911.04	1.6000	1	1	$911.04	$911.04
Maintenance and repair receptacles and plugs	20	74.00 Ea.	$3,386.18	$4,230.97	2.0000	2	2	$8,461.95	$8,461.95
Replace receptacle/plug receptacles and plugs	20	74.00 Ea.	$5,974.99	$7,349.76	2.0000	2	2	$14,699.52	$14,699.52
Maintenance and repair wiring devices, switches	10	19.00 Ea.	$869.42	$1,086.33	4.0000	4	4	$4,345.32	$4,345.32
Replace wiring devices, switches	15	19.00 Ea.	$1,321.16	$1,645.10	2.6667	2	2	$3,290.20	$3,290.20
Replace fluorescent light fixture ballast, 80 W	10	64.00 Ea.	$6,971.65	$8,596.95	4.0000	4	4	$34,387.79	$34,387.79
Replace lamps (2 lamps), 4', 34 W energy saver	10	64.00 Ea.	$1,737.70	$2,178.95	4.0000	4	4	$8,715.82	$8,715.82
Replace metal halide ballast, 175 W	10	6.00 Ea.	$1,029.37	$1,232.98	4.0000	4	4	$4,931.93	$4,931.93
Replace metal halide fixture lamp, 175 W	5	6.00 Ea.	$365.03	$443.54	8.0000	8	8	$3,548.33	$3,548.33
Repair smoke detector	10	15.00 Ea.	$911.48	$1,128.08	4.0000	4	3	$4,512.31	$3,384.23
Check operation smoke detector	1	15.00 Ea.	$261.98	$328.66	40.0000	40	40	$13,146.33	$13,146.33
Replace smoke detector	15	15.00 Ea.	$5,061.32	$6,022.61	2.6667	2	2	$12,045.22	$12,045.22
Check and repair manual pull station	10	3.00 Ea.	$284.97	$350.72	4.0000	4	3	$1,402.88	$1,052.16
Replace manual pull station	15	3.00 Ea.	$690.23	$829.51	2.6667	2	2	$1,659.03	$1,659.03
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.0000	2	2	$971.29	$971.29
Maintenance and repair of general wiring lightning protection system	1	1.20 M.L.F.	$133.59	$164.83	40.0000	40	40	$6,593.25	$6,593.25
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	40.0000	40	40	$9,546.63	$9,546.63
Maintenance and repair exit light	20	5.00 Ea.	$199.58	$247.03	2.0000	2	2	$494.06	$494.06
Replace lamp exit light	5	5.00 Ea.	$91.49	$108.45	8.0000	8	8	$867.63	$867.63
Maintenance and repair voice/data outlet	10	7.00 Ea.	$389.86	$487.30	4.0000	4	4	$1,949.21	$1,949.21
Replace voice/data outlet	20	7.00 Ea.	$198.22	$241.40	2.0000	2	2	$482.81	$482.81
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	2.6667	2	2	$2,276.61	$2,276.61
			$456,075.51	$542,172.90				MR Subtotal:	$904,466.12
								MR Per Year:	$22,611.65
								PM Total:	$1,947.90
								Subtotal:	$24,559.55
								Total Per Unit:	$2.93

FAC 1732 Training Aids Support Building

Release:	2024 Qtr 3	FY25 SUC:	$2.93
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	40
		Model Size:	8369

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	2	0.52	$31.64	$23.47	$0.0000	55.11	65.32	77.10
Door, overhead, manual, up to 24' high x 25' wide, annualized	3	6.59	$45.68	$297.26	$0.0000	342.94	436.68	532.71
Fire doors, swinging, annualized	3	1.18	$43.47	$48.22	$0.0000	91.69	110.51	131.49
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (vacuum breaker type), annualized	3	0.53	$27.55	$28.68	$0.0000	56.23	67.59	80.33
Lavatories, annualized	4	1.39	$30.87	$87.98	$0.0000	118.86	148.34	179.37
Unit heater, gas radiant, annually	4	4.04	$6.92	$216.58	$0.0000	223.49	289.16	355.17
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Panelboard, 225 A and above, annualized	1	0.44	$25.95	$31.37	$0.0000	57.32	69.33	82.63
						$1,302.94	$1,615.66	$1,947.90

FAC 1733 Training Support Structure

FY25 SUC:	$0.49 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1734 Observation & Training Tower

FY25 SUC:	$67.31 / LF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1734 Observation & Training Tower

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $67.31
UM: LF
Expected Service Life: 36
Model Size: 32

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair concrete stairs	30	16.00 S.F.	$510.04	$590.31	1.2000	1	1	$590.31	$590.31
Repair metal stairs	15	45.00 S.F.	$3,752.80	$4,330.93	2.4000	2	2	$8,661.85	$8,661.85
Refinish fire escape balcony, 2' wide	7	2.00 L.F.	$47.90	$57.87	5.1429	5	5	$289.35	$289.35
Replace steel decking	30	40.00 S.F.	$240.15	$279.08	1.2000	1	1	$279.08	$279.08
Repair 8" concrete block wall, 1st floor	25	65.00 S.F.	$1,740.27	$2,128.95	1.4400	1	1	$2,128.95	$2,128.95
Maintenance and repair motor starter, 600 V	3	1.00 Ea.	$744.73	$915.59	12.0000	12	12	$10,987.08	$10,987.08
Maintenance and repair breaker, enclosed, 240 V, 2 pole	25	4.00 Ea.	$309.15	$387.82	1.4400	1	1	$387.82	$387.82
Maintenance and repair receptacles and plugs	20	4.00 Ea.	$183.04	$228.70	1.8000	1	1	$228.70	$228.70
Replace receptacle/plug receptacles and plugs	20	4.00 Ea.	$322.97	$397.28	1.8000	1	1	$397.28	$397.28
Maintenance and repair wiring devices, switches	10	2.00 Ea.	$91.52	$114.35	3.6000	3	3	$343.05	$343.05
Replace wiring devices, switches	15	2.00 Ea.	$139.07	$173.17	2.4000	2	2	$346.34	$346.34
Replace fluorescent light fixture ballast, 80 W	10	4.00 Ea.	$435.73	$537.31	3.6000	3	3	$1,611.93	$1,611.93
Replace lamps (2 lamps) fluorescent lighting fixture, 8', 60 W energy saver	10	8.00 Ea.	$296.52	$359.84	3.6000	3	3	$1,079.53	$1,079.53
Replace fluorescent lighting fixture, strip, surface mtd, 8', two 75 W	20	2.00 Ea.	$565.59	$677.89	1.8000	1	1	$677.89	$677.89
Maintenance and repair of general wiring lightning protection system	1	0.75 M.L.F.	$83.49	$103.02	36.0000	36	36	$3,708.70	$3,708.70
Replace lightning protection general wiring system	25	0.25 M.L.F.	$3,356.07	$3,973.91	1.4400	1	1	$3,973.91	$3,973.91
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	36.0000	36	36	$8,591.97	$8,591.97
Repair cable splice overhead service	12	1.60 M.L.F.	$946.90	$1,183.53	3.0000	3	3	$3,550.59	$3,550.59
Replace service cable overhead service, splice	30	1.60 M.L.F.	$14,425.51	$16,736.64	1.2000	1	1	$16,736.64	$16,736.64
			$28,382.37	$33,414.86				MR Subtotal:	$64,570.97
								MR Per Year:	$1,793.64
								PM Total:	$360.25
								Subtotal:	$2,153.89
								Total Per Unit:	$67.31

FAC 1734 Observation & Training Tower

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $67.31
UM: LF
Expected Service Life: 36
Model Size: 32

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	1	0.26	$15.82	$11.73	$0.0000	27.56	32.66	38.55
Unit heater, gas radiant, annualized	1	1.01	$1.73	$54.14	$0.0000	55.87	72.29	88.79
Panelboard, 225 A and above, annualized	1	0.44	$25.95	$31.37	$0.0000	57.32	69.33	82.63
Motor control center, over 400 A, annually	1	0.39	$25.95	$27.89	$0.0000	53.84	64.80	77.06
Light, emergency, hardwired system, annualized	2	0.50	$18.16	$31.57	$0.0000	49.74	61.03	73.22
						$244.33	$300.11	$360.25

FAC 1735 Missile Proof Shelter (MPS) and Observation Bunker (OB)

FY25 SUC:	$8.08 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 1735 Missile Proof Shelter (MPS) and Observation Bunker (OB)

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $8.08
UM: SF
Expected Service Life: 30
Model Size: 200

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	200.00 S.F.	$8,136.87	$9,910.07	2.0000	2	2	$19,820.14	$19,820.14
Repair 8" concrete block wall, 1st floor	25	400.00 S.F.	$10,709.36	$13,101.23	1.2000	1	1	$13,101.23	$13,101.23
Repair window - 1st floor (2% of glass) - fixed glass block	8	18.00 S.F.	$1,477.16	$1,759.98	3.7500	3	3	$5,279.94	$5,279.94
Maintenance and repair wiring devices, switches	10	1.00 Ea.	$45.76	$57.18	3.0000	3	3	$171.53	$171.53
Replace wiring devices, switches	15	1.00 Ea.	$69.53	$86.58	2.0000	2	2	$173.17	$173.17
Replace incandescent lighting fixture lamp for explosion proof fixture	5	2.00 Ea.	$52.38	$63.12	6.0000	6	6	$378.73	$378.73
Replace lightning protection general wiring system	25	0.15 M.L.F.	$2,013.64	$2,384.35	1.2000	1	1	$2,384.35	$2,384.35
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	30.0000	30	30	$7,159.97	$7,159.97
			$22,695.62	$27,601.18				MR Subtotal:	$48,469.06
								MR Per Year:	$1,615.64
								PM Total:	$0.00
								Subtotal:	$1,615.64
								Total Per Unit:	$8.08

FAC 1735 Missile Proof Shelter (MPS) and Observation Bunker (OB)

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $8.08
UM: SF
Expected Service Life: 30
Model Size: 200

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
						$0.00	$0.00	$0.00

FAC 1736 Ground Combat Training Structure

FY25 SUC:	$5,646.82 / EA
Source:	R.S. Means Cost Data

FAC	1736	Ground Combat Training Structures	UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
Various structure(s) designed to support troop training such as hand-to-hand courses and mock-ups of vehicles, ships, or platforms.										
A10331100010	Concrete Pad, 400 SF, 2 EA per Range		$50.54	SF	800	SF per Rng	15	1	$ 40,432.00	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	1	EA per Rng	3	8	$ 438.24	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	6	EA per Rng	4	6	$ 1,577.52	EA
D50231500010	Maintenance of receptacles, 12 EA per Range		$56.78	EA	12	EA per Rng	20	1	$ 681.36	EA
D50231280010	Replace branch wiring 600 V, 1,320 FT to Distribution Main		$1,603.15	MLF	1.32	MLF per Rng	20	1	$ 2,116.16	EA
312216100200	Trail Grading, Fine Grading for Roadways, 11,733 SY of trail/track		$0.80	SY	11733	SY per Rng	5	5	$ 46,770.08	EA
311413230400	Berm, 400 M x 2 M x 1 M = 1,046 CY / Backfill & compaction		$1.19	CY	1046	CY per Rng	5	5	$ 6,199.49	EA
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	1063	SY per Rng	10	2	$ 9,500.54	EA
B20131451010	Repair Wooden Training Structures; Silouettes, Mout Buildings		$1,161.64	CSF	5	CSF per Rng	4	6	$ 33,455.23	EA
							Total Thru ESL		$ 141,170.62	EA
							Annualized		$ 5,646.82	EA

FAC 1741 Maneuver/Training Land, Light Forces

FY25 SUC:	$2.29 / AC
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Army Training Area Carrying Capacity model (ATACC) adapted for FSM

Sustainment Unit Cost Calculations for FACs 1741 and 1742

			Acres per Training Event	TD Cost	Total Cost per Acre
Training-Independent costs per acre (same for light and heavy forces)	$1.42	Per Acre			
Training-dependent costs per Infantry BCT (FAC 1741)**	$23,298.00	Per Year	118,611	$ 0.196	$1.62
Training-dependent costs per Heavy BCT (FAC 1742)**	$269,337.00	Per Year	306,410	$ 0.879	$2.30

Sources:

TC 25-1, Training Land, Appendix A

Army Training Area Carrying Capacity model (ATACC) adapted for FSM

**annual mileage for maneuver training for all events in a year

Maneuver Training Land Sustainment

Maneuver Training Land Sustainment is modeled as the sum of:

(1) The cost of land sustainment activities that do not depend on the training load of the installation.(Independent Costs – IC)

(2) The cost of land sustainment activities that depend on the training load of the installation (Training Load-dependent Costs – TC). These activities seek to restore the condition of the training land back to its original state before the training activities. The variable cost also depends on the type of training land at the installation, which affects its carrying capacity to support maneuver training.

Sustainment Cost (FAC 1741 or 1742) = IC +TC.

The training-dependent and training-independent costs are calculated as shown below.

Independent Costs (IC)

Costs that do not depend on the training load, and only depend on the acreage of maneuver training land. Examples include but are not limited to Erosion Control Management Plans, Studies and necessary equipment. These costs are calculated based on a study of actual maintenance costs between 1998 and 2004.

Total IC per Installation = IC per Acre * Acreage of Maneuver Land.

The cost factor for IC is the same for both light and heavy maneuver land, since the program costs for the land maintenance program remains the same for both light & heavy maneuver units.

Training Load Dependent Cost of Sustainment (TC)

To calculate the cost of restoring land to its pre-training condition, erosion status (ES) is used as the measure of land condition. ES is chosen as the best measure of land condition for military installations because soil erosion is a quantifiable variable that is easily understood by both military trainers and natural resources managers. Although other measures of land condition including vegetation composition exist, soil erosion is a good general indicator.

Military training activities directly and indirectly affect erosion rates and installations often have land management plans with goals to maintain erosion rates at levels that ensure the training lands will continue to support the training mission. The Erosion Rate of 16 different soil types at various military installations was studied by CERL and AEC in 2002, and this algorithm uses an average of these erosion rates to quantify the amount of erosion to be expected for a given training load. Further, the results of an analysis of land maintenance costs to restore land condition at Army installations, for tasks such as seeding and the construction of sediment traps, are used to model an average cost for a given training load.

To calculate the training-dependent costs, the following formula is used:

TC = Training Load * Land Cost Factor where

Training Load = the number of multiples of a notional Heavy Brigade Combat Team (for FAC 1742) or a notional light Brigade Combat Team (for FAC 1741) supported by an installation.

Land Cost Factor = Land Maintenance cost to support one notional Heavy Brigade Combat Team (for FAC 1742) or one notional light Brigade Combat Team (for FAC 1741).

FAC 1742 Maneuver/Training Land, Heavy Forces

FY25 SUC:	$3.27 / AC
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Army Training Area Carrying Capacity model (ATACC) adapted for FSM

Sustainment Unit Cost Calculations for FACs 1741 and 1742

			Acres per Training Event	TD Cost	Total Cost per Acre
Training-Independent costs per acre (same for light and heavy forces)	$1.42	Per Acre			
Training-dependent costs per Infantry BCT (FAC 1741)**	$23,298.00	Per Year	118,611	$ 0.196	$1.62
Training-dependent costs per Heavy BCT (FAC 1742)**	$269,337.00	Per Year	306,410	$ 0.879	$2.30

Sources:
TC 25-1, Training Land, Appendix A
Army Training Area Carrying Capacity model (ATACC) adapted for FSM
**annual mileage for maneuver training for all events in a year

Maneuver Training Land Sustainment

Maneuver Training Land Sustainment is modeled as the sum of:

(1) The cost of land sustainment activities that do not depend on the training load of the installation.(Independent Costs – IC)
(2) The cost of land sustainment activities that depend on the training load of the installation (Training Load-dependent Costs – TC). These activities seek to restore the condition of the training land back to its original state before the training activities. The variable cost also depends on the type of training land at the installation, which affects its carrying capacity to support maneuver training.

Sustainment Cost (FAC 1741 or 1742) = IC +TC.

The training-dependent and training-independent costs are calculated as shown below.

Independent Costs (IC)

Costs that do not depend on the training load, and only depend on the acreage of maneuver training land. Examples include but are not limited to Erosion Control Management Plans, Studies and necessary equipment. These costs are calculated based on a study of actual maintenance costs between 1998 and 2004.

Total IC per Installation = IC per Acre * Acreage of Maneuver Land.

The cost factor for IC is the same for both light and heavy maneuver land, since the program costs for the land maintenance program remains the same for both light & heavy maneuver units.

Training Load Dependent Cost of Sustainment (TC)

To calculate the cost of restoring land to its pre-training condition, erosion status (ES) is used as the measure of land condition. ES is chosen as the best measure of land condition for military installations because soil erosion is a quantifiable variable that is easily understood by both military trainers and natural resources managers. Although other measures of land condition including vegetation composition exist, soil erosion is a good general indicator.

Military training activities directly and indirectly affect erosion rates and installations often have land management plans with goals to maintain erosion rates at levels that ensure the training lands will continue to support the training mission. The Erosion Rate of 16 different soil types at various military installations was studied by CERL and AEC in 2002, and this algorithm uses an average of these erosion rates to quantify the amount of erosion to be expected for a given training load. Further, the results of an analysis of land maintenance costs to restore land condition at Army installations, for tasks such as seeding and the construction of sediment traps, are used to model an average cost for a given training load.

To calculate the training-dependent costs, the following formula is used:

TC = Training Load * Land Cost Factor where

Training Load = the number of multiples of a notional Heavy Brigade Combat Team (for FAC 1742) or a notional light Brigade Combat Team (for FAC 1741) supported by an installation.

Land Cost Factor = Land Maintenance cost to support one notional Heavy Brigade Combat Team (for FAC 1742) or one notional light Brigade Combat Team (for FAC 1741).

FAC 1743 Weapons Impact Area

FY25 SUC:	$0.00 / AC
Source:	

FAC 1744 Parachute Drop Zone

FY25 SUC:	$2.29 / AC
Source:	Set to FAC 1741

FAC 1745 Parade and Drill Field

FY25 SUC:	$86.00 / AC
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1750 General Purpose Small Arms Range

FY25 SUC:	$438.60 / FP
Source:	R.S. Means Cost Data

FAC	1750 General Purpose Small Arms Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**	**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	SIT Emplacement (4 SF concrete repair) 7 per FP	$50.54	SF	28	SF per FP	15	1	$ 1,415.12	FP
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	7	EA per FP	3	8	$ 3,067.68	FP
D50231301020	Breaker, 2 pole, 480 v, Maint/Inspect	$43.82	EA	7	EA per FP	4	6	$ 1,840.44	FP
D50231500010	Maintenance and repair receptacles and plugs	$56.78	EA	7	EA per FP	20	1	$ 397.46	FP
D50231280010	Replace branch wiring 600 V	$1,603.15	MLF	1.3265	MLF per FP	20	1	$ 2,126.58	FP
D50333100010	Communication & Data Cable	$75.53	MLF	1.3265	MLF per FP	8	3	$ 300.57	FP
D50132800020	Panelboard, Maint/Inspect	$54.78	EA	1	SF per FP	3	8	$ 438.24	FP
311413230400	Berm, 522 M x 2 M x 5 M = 6,828 CY / Backfill & compaction	$1.19	CY	213.4	CY per FP	5	5	$ 1,264.64	FP
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	12.8	SY per FP	10	2	$ 114.23	FP
						Total Thru ESL		$ 10,964.96	FP
						Annualized		$ 438.60	FP

FAC 1751 Zero Range

FY25 SUC:	$68.77 / FP
Source:	R.S. Means Cost Data

FAC	1751	Zero Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	Foxhole w/Drain (36 IN reinforced Concrete Culvert, 4 FT deep)		$50.54	SF	4	SF to FP	15	1	$ 202.16	FP
D20331100030	Target Boots / 4 per FP		$73.88	LF	8	LF tp FP	15	1	$ 591.04	FP
D50231280010	Replace branch wiring 600 V		$1,603.15	MLF	0.224	MLF per FP	20	1	$ 359.11	FP
311413230400	Berm, 148 M x 2 M x 5 M = 1,936 CY / Backfill & compaction		$1.19	CY	77.4	CY per FP	5	5	$ 458.98	FP
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	12.1	CY per FP	10	2	$ 108.09	FP
							Total Thru ESL		$ 1,719.37	FP
							Annualized		$ 68.77	FP

FAC 1752 Field Fire Range

FY25 SUC:	$295.73 / FP
Source:	R.S. Means Cost Data

FAC	**1752** **Field Fire Range**	UM =	FP	ESL =	25	Source	**RS Means Costworks 2024 Q3 Update**			
Reference	**Component**	**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**		
A10331100010	SIT Emplacement (4 SF concrete repair) 3 per FP	$50.54	SF	12	SF per FP	15	1	$	606.48	FP
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	3	EA per FP	3	8	$	1,314.72	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	3	EA per FP	4	6	$	788.76	FP
D50231500010	Maintenance and repair receptacles and plugs	$56.78	EA	12	EA per FP	20	1	$	681.36	FP
D50231280010	Replace branch wiring 600 V	$1,603.15	MLF	1.3265	MLF per FP	20	1	$	2,126.58	FP
D50333100010	Communication & Data Cable	$75.53	MLF	1.3265	MLF per FP	8	3	$	300.57	FP
A10331100010	Foxhole w/Drain (36 IN reinforced Concrete Culvert, 4 FT deep)	$50.54	SF	4	SF per FP	15	1	$	202.16	FP
311413230400	Berm, 522 M x 2 M x 5 M = 6,827 CY / Backfill & compaction	$1.19	CY	213.3	CY per FP	5	5	$	1,264.46	FP
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	12.1	SY per FP	10	2	$	108.14	FP
						Total Thru ESL		$	7,393.23	FP
						Annualized		$	295.73	FP

FAC 1753 Record Fire Range

FY25 SUC:	$466.82 / FP
Source:	R.S. Means Cost Data

FAC	1753 Record Fire Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	Component	Unit Price	Units	Conversion		Frequency	Occurrences in ESL	Extended Price	
A10331100010	SIT Emplacement (4 SF concrete repair) 7 per FP	$50.54	SF	28	SF per FP	15	1	$ 1,415.12	FP
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	7	EA per FP	3	8	$ 3,067.68	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	7	EA per FP	4	6	$ 1,840.44	FP
D50231500010	Maintenance and repair receptacles and plugs	$56.78	EA	7	EA per FP	20	1	$ 397.46	FP
D50231280010	Replace branch wiring 600 V	$1,603.15	MLF	2.009	MLF per FP	20	1	$ 3,220.73	FP
D50333100010	Communication & Data Cable	$75.53	MLF	2.009	MLF per FP	8	3	$ 455.22	FP
A10331100010	Foxhole w/Drain (36 IN reinforced Concrete Culvert, 4 FT deep)	$50.54	SF	4	SF per FP	15	1	$ 202.16	FP
311413230400	Berm, 340 M x 2 M x 5 M = 4,447 CY / Backfill & compaction	$1.19	CY	138.9	CY per FP	5	5	$ 823.24	FP
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	27.8	SY per FP	10	2	$ 248.57	FP
						Total Thru ESL		$ 11,670.62	FP
						Annualized		$ 466.82	FP

FAC 1754 Night Fire Range

FY25 SUC:	$99.92 / FP
Source:	R.S. Means Cost Data

FAC	1754	Night Fire Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	SIT Emplacement (4 SF concrete repair) 2 per FP		$50.54	SF	8	SF per FP	15	1	$ 404.32	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	2	EA per FP	4	6	$ 525.84	FP
D50231500010	Maintenance and repair receptacles and plugs		$56.78	EA	4	EA per FP	20	1	$ 227.12	FP
D50231280010	Replace branch wiring 600 V		$1,603.15	MLF	0.082	MLF per FP	20	1	$ 131.46	FP
A10331100010	Foxhole w/Drain (36 IN reinforced Concrete Culvert, 4 FT deep)		$50.54	SF	4	SF per FP	15	1	$ 202.16	FP
311413230400	Berm, 522 M x 2 M x 3 M = 4,096 CY / Backfill & compaction		$1.19	CY	128.0	CY per FP	5	5	$ 758.64	FP
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	27.8	SY per FP	10	2	$ 248.57	FP
							Total Thru ESL		$ 2,498.11	FP
							Annualized		$ 99.92	FP

FAC 1755 Known Distance Range

FY25 SUC:	$221.96 / FP
Source:	R.S. Means Cost Data

FAC	1755	Known Distance Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**	**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**		
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	2	EA per FP	4	6	$	525.84	FP
D50231500010	Maintenance and repair receptacles and plugs	$56.78	EA	4	EA per FP	20	1	$	227.12	FP
D50231280010	Replace branch wiring 600 V	$1,603.15	MLF	1.284	MLF per FP	20	1	$	2,058.44	FP
D50333100010	Communication & Data Cable	$75.53	MLF	1.284	MLF per FP	8	3	$	290.94	FP
311413230400	Berm, 340 M x 4 M x 5 M = 8,894 CY / Backfill & compaction	$1.19	CY	355.8	CY per FP	5	5	$	2,108.77	FP
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	37.8	SY per FP	10	2	$	337.84	FP
						Total Thru ESL		$	5,548.96	FP
						Annualized		$	221.96	FP

FAC 1756 Sniper Range

FY25 SUC:	$946.27 / FP
Source:	R.S. Means Cost Data

FAC	1756	Sniper Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	Sniper range = 4 SITs/6MITs/8 Iron Maiden Pads per FP									
A10331100010	SIT Emplacement (4 SF concrete repair) 4 per FP		$50.54	SF	16	SF per FP	15	1	$ 808.64	FP
A10331100010	MIT Emplacement 15M (12.5 SF Concrete repair) 12 IN		$50.54	SF	69	SF per FP	15	1	$ 3,487.26	FP
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	1	EA per FP	3	8	$ 438.24	FP
340123510400	Maintenance of Trolleyway, 1 Ton, 50 FT / MIT		$22.03	LF	300	LF per FP	15	1	$ 6,608.70	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	10	EA per FP	4	6	$ 2,629.20	FP
D50231500010	Maintenance and repair receptacles and plugs		$56.78	EA	40	EA per FP	20	1	$ 2,271.20	FP
D50231280010	Replace branch wiring 600 V		$1,603.15	MLF	1.64	MLF per FP	20	1	$ 2,629.17	FP
A10331100010	Concrete Pad 4 FT x 8 FT (1 per Firing Pad / 1 per Iron Maiden		$50.54	SF	64	SF per FP	15	1	$ 3,234.56	FP
311413230400	Berm, 80 M x 2 M x 5 M = 1,046 CY / Backfill & compaction		$1.19	CY	261.5	CY per FP	5	5	$ 1,549.87	FP
							Total Thru ESL		$ 23,656.84	FP
							Annualized		$ 946.27	FP

FAC 1757 Pistol Range

FY25 SUC:	$207.63 / FP
Source:	R.S. Means Cost Data

FAC	1757	Pistol Range		UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**			**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	SIT Emplacement (1 SF concrete repair) 8 per FP			$50.54	SF	8	SF per FP	15	1	$ 404.32	FP
D50132200020	Maintenance and inspection switchgear, less than 600 V			$54.78	EA	1	EA per FP	3	8	$ 438.24	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect			$43.82	EA	8	EA per FP	4	6	$ 2,103.36	FP
D50231500010	Maintenance and repair receptacles and plugs, 2 per SIT			$56.78	EA	16	EA per FP	20	1	$ 908.48	FP
D50231280010	Replace branch wiring, 600 V			$1,603.15	MLF	0.808	MLF per FP	20	1	$ 1,295.35	FP
321123230370	Bank run gravel, Spread, 6 IN deep			$4.47	SY	4.5	SY per FP	10	2	$ 39.77	FP
311413230400	Berm, 8 EA per FP, 1 M x 1 M x 2 M = 20.9 CY / Backfill &			$1.19	CY	0.2	CY per FP	5	5	$ 1.24	FP
								Total Thru ESL		$ 5,190.76	FP
								Annualized		$ 207.63	FP

FAC 1758 Machinegun Range

FY25 SUC:	$693.96 / FP
Source:	R.S. Means Cost Data

FAC	1758	Machinegun Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update			
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**		
	MPMG = 3 SITs/5 WSITs/2MITs/2 SATs/8 Iron Maiden Pads										
A10331100010	SIT Emplacement (4 SF concrete repair) 3 per FP		$50.54	SF	12	SF per FP	15	1	$	606.48	FP
A10331100010	WSIT Emplacement (7 SF concrete repair) 5 per FP		$50.54	SF	35	SF per FP	15	1	$	1,768.90	FP
A10331100010	SAT Emplacement (27.5 SF of concrete repair) 2 per FP		$50.54	SF	55	SF per FP	15	1	$	2,779.70	FP
A10331100010	MIT Emplacement 15 M x 0.5 M x 12 IN concrete wall (12.5 SF		$50.54	SF	25	SF per FP	15	1	$	1,263.50	FP
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	4	EA per FP	3	8	$	1,752.96	FP
340123510400	Maintenance of Trolleyway, 1 Ton, 50 FT / MIT		$22.03	LF	100	LF per FP	15	1	$	2,202.90	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	6	EA per FP	4	6	$	1,577.52	FP
D50231500010	Maintenance of receptacles, 2 per SIT/2 per MIT/3 per WSIT /		$56.78	EA	12	EA per FP	20	1	$	681.36	FP
D50231280010	Replace branch wiring 600 V, 1,640 FT Avg. Distance		$1,603.15	MLF	1.64	MLF per FP	20	1	$	2,629.17	FP
A10331100010	Concrete Pad (1 per Firing Pad / 1 per Iron Maiden) (4 SF		$50.54	SF	36	SF per FP	15	1	$	1,819.44	FP
311413230400	Berm, 30 M x 2 M x 5 M = 392 CY / Backfill & compaction		$1.19	CY	39.2	CY per FP	5	5	$	232.33	FP
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	3.9	SY per FP	10	2	$	34.86	FP
							Total Thru ESL		$	17,349.11	FP
							Annualized		$	693.96	FP

FAC 1760 General Purpose Direct Fire Range

FY25 SUC:	$947.66 / FP
Source:	R.S. Means Cost Data

FAC	1760	General Purpose Direct Fire Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	Vehicle Battle Position - Defilade (380 SF concrete repair)		$50.54	SF	380	SF per FP	15	1	$ 19,205.20	FP
311413230400	Berm, 148 M x 2 M x 5 M = 1,936 CY / Backfill & compaction		$1.19	CY	484.0	CY per FP	5	5	$ 2,868.60	FP
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	181.0	SY per FP	10	2	$ 1,617.68	FP
							Total Thru ESL		$ 23,691.48	FP
							Annualized		$ 947.66	FP

FAC 1761 Grenade Launcher Range

FY25 SUC:	$137.51 / FP
Source:	R.S. Means Cost Data

FAC	1761	Grenade Launcher Range		UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**			**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
333413130015	Target Bunker (Precast Septic Tank, 1,000 GA)			$1,494.83	EA	1	EA per FP	10	2	$ 2,989.65	FP
311413230400	Target Berm, 1 M x 1 M x 2 M x 4 Targets/LN = 2.6 CY /			$1.19	CY	10.4	CY per FP	5	5	$ 61.64	FP
311413230400	Berm, 40 M x 1 M x 2 M = 104 CY / Backfill & compaction			$1.19	CY	26.0	CY per FP	5	5	$ 154.10	FP
321123230370	Bank run gravel, Spread, 6 IN deep			$4.47	SY	26.0	SY per FP	10	2	$ 232.37	FP
								Total Thru ESL		$ 3,437.76	FP
								Annualized		$ 137.51	FP

FAC 1762 Grenade Machinegun Range

FY25 SUC:	$997.71 / LN
Source:	R.S. Means Cost Data

FAC	1762	Grenade Machinegun Range		UM =	LN	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**			**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	Vehicle Firing Point (480 SF concrete repair)			$50.54	SF	480	SF per LN	15	1	$ 24,259.20	LN
311413230400	Berm, 20 M x 2 M x 1 M = 52 CY / Backfill & compaction			$1.19	CY	52.0	CY per LN	5	5	$ 308.20	LN
321123230370	Bank run gravel, Spread, 6 IN deep			$4.47	SY	42.0	SY per LN	10	2	$ 375.37	LN
								Total Thru ESL		$ 24,942.77	LN
								Annualized		$ 997.71	LN

FAC 1763 Light Antiarmor Weapon Range

FY25 SUC:	$1,014.40 / FP
Source:	R.S. Means Cost Data

FAC	1763 Light Antiarmor Weapon Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update			
Reference	**Component**	**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**		
	LAW/AT-4 = 2 MG Bunkers/ 9 SATs / 2 MATs per FP									
A10331100010	SAT Emplacement (7 SF concrete repair) 9 per FP	$50.54	SF	63	SF per FP	15	1	$	3,184.02	FP
A10331100010	MAT Emplacement 200 M (25.5 SF of Concrete repair) 2 per FP	$50.54	SF	51	SF per FP	15	1	$	2,577.54	FP
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	5	EA per FP	3	8	$	2,191.20	FP
340123510400	Maintenance of Trolleyway, 1 Ton, 156 FT / MAT	$22.03	LF	156	LF per FP	15	1	$	3,436.52	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	8	EA per FP	4	6	$	2,103.36	FP
D50231500010	Maintenance of receptacles, 3 per SAT / 4 per MAT	$56.78	EA	35	EA per FP	20	1	$	1,987.30	FP
D50231280010	Replace branch wiring 600 V, 984 FT Avg. Distance	$1,603.15	MLF	0.984	MLF per FP	20	1	$	1,577.50	FP
333413130015	Target Bunker (Precast Septic Tank, 1,000 GA)	$1,494.83	EA	2	EA per FP	10	2	$	5,979.30	FP
311413230400	Berm, 400 M x 1 M x 1 M = 392 CY / Backfill & compaction	$1.19	CY	392.0	CY per FP	5	5	$	2,323.33	FP
						Total Thru ESL		$	25,360.07	FP
						Annualized		$	1,014.40	FP

FAC 1764 Heavy Antiarmor Weapon Range

FY25 SUC:	$12,130.30 / LN
Source:	R.S. Means Cost Data

FAC	1764 Heavy Antiarmor Weapon Range	UM =	LN	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**	**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	HAWR = 12 SATs / 5 MATs / 1 Course Road per LN								
A10331100010	SAT Emplacement (7 SF concrete repair) 12 per LN	$50.54	SF	84	SF per LN	15	1	$ 4,245.36	LN
A10331100010	MAT Emplacement 350 M (32.7 SF of Concrete repair) 2 per FP	$50.54	SF	186	SF per LN	15	1	$ 9,400.44	LN
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	17	EA per LN	3	8	$ 7,450.08	LN
340123510400	Maintenance of Trolleyway, 1 Ton, 1,148 FT / MAT	$22.03	LF	5740	LF per LN	15	1	$ 126,446.46	LN
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	34	EA per LN	4	6	$ 8,939.28	LN
D50231500010	Maintenance of receptacles, 5 per SAT / 4 per MAT	$56.78	EA	80	EA per LN	20	1	$ 4,542.40	LN
D50231280010	Replace branch wiring 600 V, 6,761 FT Avg. Distance	$1,603.15	MLF	20.283	MLF per LN	20	1	$ 32,516.69	LN
312216100200	Trail Grading, Fine Grading for Roadways, Base Course 11,525	$0.80	SY	11525	SY per LN	5	5	$ 45,940.96	LN
A10331100010	Vehicle Battle Position 6 EA - Defilade (28 SF concrete repair)	$50.54	SF	168	SF per LN	15	1	$ 8,490.72	LN
311413230400	Berm, 1,800 M x 2 M x 1 M = 4,709 CY / Backfill & compaction	$1.19	CY	4709.0	CY per LN	5	5	$ 27,909.54	LN
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	3063.0	SY per LN	10	2	$ 27,375.50	LN
						Total Thru ESL		$ 303,257.42	LN
						Annualized		$ 12,130.30	LN

FAC 1765 Artillery Direct Fire Range

FY25 SUC:	$2,805.76 / EA
Source:	R.S. Means Cost Data

FAC	**1765**	**Artillery Direct Fire Range**	UM =	EA	ESL =	25	Source	**RS Means Costworks 2024 Q3 Update**	
Reference	**Component**	**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	ADFR = 18 SATs / 6 Firing Positions per Range								
A10331100010	SAT Emplacement (7 SF concrete repair), 6 per range	$50.54	SF	42	SF per Range	15	1	$ 2,122.68	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	6	EA per Range	3	8	$ 2,629.44	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	6	EA per Range	4	6	$ 1,577.52	EA
D50231500010	Maintenance of receptacles, 5 per SAT	$56.78	EA	30	EA per Range	20	1	$ 1,703.40	EA
D50231280010	Replace branch wiring 600 V, 2,560 FT Avg. Distance	$1,603.15	MLF	2.56	Rnge	20	1	$ 4,104.06	EA
312216100200	Trail Grading, Fine Grading for Roadways, Base Course 11,525	$0.80	SY	11525	SY per Rnge	5	5	$ 45,940.96	EA
A10331100010	Vehicle Battle Position 6 EA - Defilade (28 SF concrete repair)	$50.54	SF	168	SF per Rnge	15	1	$ 8,490.72	EA
311413230400	Berm, 117 M x 2 M x 1 M = 279 CY / Backfill & compaction	$1.19	CY	279.0	CY per Rnge	5	5	$ 1,653.59	EA
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	215.0	SY per Rnge	10	2	$ 1,921.56	EA
						Total Thru ESL		$ 70,143.93	EA
						Annualized		$ 2,805.76	EA

FAC 1766 Tank Stationary Gunnery Range

FY25 SUC:	$34,195.12 / EA
Source:	R.S. Means Cost Data

FAC	1766	Tank Stationary Gunnery Range	UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	TSGR = 25 SATs / 4 MATs / 42 SITS / 7 MITS per Range									
A10331100010	SIT Emplacement (4 SF concrete repair) 42 per Range		$50.54	SF	168	SF per Rng	15	1	$ 8,490.72	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	42	EA per Rng	3	8	$ 18,406.08	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	42	EA per Rng	4	6	$ 11,042.64	EA
A10331100010	SAT Emplacement (7 SF concrete repair) 25 per range		$50.54	SF	175	SF per Rng	15	1	$ 8,844.50	EA
A10331100010	MAT Emplacement 200 M (25.5 SF of Concrete repair) 4 per		$50.54	SF	102	SF per Rng	15	1	$ 5,155.08	EA
A10331100010	MIT Emplacement 15 M (12.5 SF Concrete repair)		$50.54	SF	87.5	SF per Rng	15	1	$ 4,422.25	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	36	EA per Rng	3	8	$ 15,776.64	EA
340123510400	Maintenance of Trolleyway, 1 Ton, 656 FT / MAT 49 FT /MIT		$22.03	LF	2967	LF per Rng	15	1	$ 65,360.04	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	36	EA per Rng	4	6	$ 9,465.12	EA
D50231500010	Maintenance of receptacles, 5 per SAT / 4 per MAT, MIT, SIT		$56.78	EA	337	EA per Rng	20	1	$ 19,134.86	EA
D50231280010	Replace branch wiring 600 V, 5,105 FT Avg. Distance		$1,603.15	MLF	398.19	MLF per Rng	20	1	$ 638,358.30	EA
312216100200	Trail Grading, Fine Grading for Roadways, Base Course, 2,488		$0.80	SY	2488	SY per Rng	5	5	$ 9,917.67	EA
A10331100010	Vehicle Battle Position 2 EA - Defilade (28 SF concrete repair)		$50.54	SF	56	SF per Rng	15	1	$ 2,830.24	EA
A10331100010	Vehicle Firing Point x 10 (12.8 SF concrete repair)		$50.54	SF	128	SF per Rng	15	1	$ 6,469.12	EA
311413230400	Berm, 1,400 M x 2 M x 1 M = 3,662 CY / Backfill & compaction		$1.19	CY	3662	CY per Rng	5	5	$ 21,704.12	EA
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	1063	SY per Rng	10	2	$ 9,500.54	EA
							Total Thru ESL		$ 854,877.92	EA
							Annualized		$ 34,195.12	EA

FAC 1767 Indirect Fire Range

FY25 SUC:	$0.00 / EA
Source:	

FAC 1768 Scaled Indirect Fire Range

FY25 SUC:	$178.76 / EA
Source:	R.S. Means Cost Data

FAC	1768	Scaled Indirect Fire Range		UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	Component			Unit Price	Units	Conversion		Frequency	Occurrences in ESL	Extended Price	
	ADFR = 6 Hasty Firing Positions per Range										
311413230400	Berm, 117 M x 2 M x 1 M = 279 CY / Backfill & compaction			$1.19	CY	279.0	CY per Rng	5	5	$ 1,653.59	EA
321123230370	Bank run gravel, Spread, 6 IN deep			$4.47	SY	315.0	SY per Rng	10	2	$ 2,815.31	EA
								Total Thru ESL		$ 4,468.90	EA
								Annualized		$ 178.76	EA

FAC 1769 Scaled Gunnery Range

FY25 SUC:	$2,135.08 / EA
Source:	R.S. Means Cost Data

FAC	**1769** **Scaled Gunnery Range**	UM =	EA	ESL =	25	Source	**RS Means Costworks 2024 Q3 Update**			
Reference	**Component**	**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**		
	Scaled Range = 16 SITS / 8 MITS per Range									
A10331100010	SIT Emplacement (4 SF concrete repair) 16 per range	$50.54	SF	64	SF per Rng	15	1	$	3,234.56	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	16	EA per Rng	3	8	$	7,011.84	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	16	EA per Rng	4	6	$	4,206.72	EA
A10331100010	MIT Emplacement 15M (12.5 SF Concrete repair)	$50.54	SF	100	SF per Rng	15	1	$	5,054.00	EA
340123510400	Maintenance of Trolleyway, 1 Ton, 49 FT /MIT	$22.03	LF	392	LF per Rng	15	1	$	8,635.37	EA
D50231301020	Breaker, 2 pole, 480 v, Maint/Inspect	$43.82	EA	8	EA per Rng	4	6	$	2,103.36	EA
D50231500010	Maintenance of receptacles, 4 per MIT, SIT	$56.78	EA	96	EA per Rng	20	1	$	5,450.88	EA
D50231280010	Replace branch wiring 600 V, 356 FT Avg. Distance	$1,603.15	MLF	4.272	LF per Rng	20	1	$	6,848.66	EA
312216100200	Trail Grading, Fine Grading for Roadways, Base Course 478 SY	$0.80	SY	478	SY per Rng	5	5	$	1,905.40	EA
A10331100010	Vehicle Battle Position 2 EA - Defilade (28 SF concrete repair)	$50.54	SF	56	SF per Rng	15	1	$	2,830.24	EA
A10331100010	Vehicle Firing Point x 2 (12.8 SF concrete repair)	$50.54	SF	25.6	SF per Rng	15	1	$	1,293.82	EA
311413230400	Berm, 220 M x 2 M x 1 M = 575 CY / Backfill & compaction	$1.19	CY	575.0	CY per Rng	5	5	$	3,407.94	EA
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	156.0	SY per Rng	10	2	$	1,394.25	EA
						Total Thru ESL		$	53,377.04	EA
						Annualized		$	2,135.08	EA

FAC 1771 Armor Vehicle Crew Training Range

FY25 SUC:	$57,979.33 / LN
Source:	R.S. Means Cost Data

FAC	1771	Armor Vehicle Crew Training Range	UM =	LN	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	DMPTR= 30 SATs / 6 MATs / 146 SITS / 4 MITS									
A10331100010	SIT Emplacement (4 SF concrete repair) 146 per LN		$50.54	SF	584	SF per LN	15	1	$ 29,515.36	LN
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	146	EA per LN	3	8	$ 63,983.04	LN
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	146	EA per LN	4	6	$ 38,386.32	LN
A10331100010	SAT Emplacement (7 SF concrete repair) 30 per LN		$50.54	SF	210	SF per LN	15	1	$ 10,613.40	LN
A10331100010	MAT Emplacement 200M (25.5 SF of Concrete repair)		$50.54	SF	153	SF per LN	15	1	$ 7,732.62	LN
A10331100010	MIT Emplacement 15M (12.5 SF Concrete repair)		$50.54	SF	322.8	SF per LN	15	1	$ 16,314.31	LN
340123510400	Maintenance of Trolleyway, 1 Ton, 656 FT / MAT, 49 FT /MIT		$22.03	LF	4132	LF per LN	15	1	$ 91,023.83	LN
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	40	EA per LN	4	6	$ 10,516.80	LN
D50231500010	Maintenance of receptacles, 5 per SAT / 4 per MAT, MIT, SIT		$56.78	EA	1208	EA per LN	20	1	$ 68,590.24	LN
D50231280010	Replace branch wiring 600 V, 5,105 FT Avg. Distance		$1,603.15	MLF	165.233	MLF per LN	20	1	$ 264,893.28	LN
312216100200	Trail Grading, Fine Grading for Roadways, Base Course 2,488 SY		$0.80	SY	2488	SY per LN	5	5	$ 9,917.67	LN
A10331100010	Vehicle Battle Position 8 EA - Defilade (28 SF concrete repair)		$50.54	SF	224	SF per LN	15	1	$ 11,320.96	LN
311413230400	Total Berm, 2,184 M x 2 M x 1 M = 5,713 CY / Backfill &		$1.19	CY	5713.0	CY per LN	5	5	$ 33,860.09	LN
333413130015	Target Bunker (Precast Septic Tank, 1,000 GA)		$1,494.83	EA	2	EA per LN	10	2	$ 5,979.30	LN
321123230370	Bank run gravel, Spread, 6 FT deep		$4.47	SY	7850.0	SY per LN	10	2	$ 70,159.22	LN
015213201000	Urban Cluster / Bank Barn, 2 Story (20 FT x 20 FT), D Low		$127.98	SF	2800.0	SF per LN	10	2	$ 716,676.80	LN
							Total Thru ESL		$1,449,483.24	LN
							Annualized		$ 57,979.33	LN

FAC 1772 Armor Vehicle Unit Training Range

FY25 SUC:	$98,298.86 / EA
Source:	R.S. Means Cost Data

FAC	1772	Armor Vehicle Unit Training Range	UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	Component		Unit Price	Units	Conversion		Frequency	Occurrences in ESL	Extended Price	
	DMPRC= 80 SATs / 12 MATs / 306 SITS / 45 MITS									
A10331100010	SIT Emplacement (4 SF concrete repair), 306 per range		$50.54	SF	1224	SF per Rng	15	1	$ 61,860.96	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	306	EA per Rng	3	8	$ 134,101.44	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	306	EA per Rng	4	6	$ 80,453.52	EA
A10331100010	SAT Emplacement (7 SF concrete repair), 80 per LN		$50.54	SF	560	SF per Rng	15	1	$ 28,302.40	EA
A10331100010	MAT Emplacement 200 M (25.5 SF of Concrete repair)		$50.54	SF	306	SF per Rng	15	1	$ 15,465.24	EA
A10331100010	MIT Emplacement 15 M (12.5 SF Concrete repair)		$50.54	SF	562.5	SF per Rng	15	1	$ 28,428.75	EA
340123510400	Maintenance of Trolleyway, 1 Ton, 656 FT / MAT, 49 FT /MIT		$22.03	LF	4132	LF per Rng	15	1	$ 91,023.83	EA
D50231500010	Maintenance of receptacles, 5 per SAT / 4 per MAT, MIT, SIT		$56.78	EA	1852	EA per Rng	20	1	$ 105,156.56	EA
D50231280010	Replace branch wiring 600 V, 6.5 lanes of targetry		$1,603.15	MLF	176.2	MLF per Rng	20	1	$ 282,475.03	EA
312216100200	Trail Grading, Fine Grading for Roadways, Base Course 7,464 SY		$0.80	SY	7464	SY per Rng	5	5	$ 29,753.00	EA
A10331100010	Vehicle Battle Position, 30 EA - Defilade (28 SF concrete repair)		$50.54	SF	840	SF per Rng	15	1	$ 42,453.60	EA
311413230400	Total Berm, 6,552 M x 2 M x 1 M = 17,139 CY / Backfill &		$1.19	CY	17139.0	CY per Rng	5	5	$ 101,580.28	EA
334211602060	Maching Gun Bunker (Precast Septic Tank, 1,000 GA), 4 per		$939.90	EA	4	EA per Rng	10	2	$ 7,519.23	EA
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	CY	24650.0	CY per Rng	10	2	$ 220,308.88	EA
015213201000	Urban Cluster / Bank Barn, 2 Story (20 FT x 20 FT), D Low		$127.98	SF	4800.0	SF per Rng	10	2	$1,228,588.80	EA
							Total Thru ESL		$2,457,471.52	EA
							Annualized		$ 98,298.86	EA

FAC 1773 Fire and Movement Range

FY25 SUC:	$1,229.49 / LN
Source:	R.S. Means Cost Data

FAC	1773	Fire and Movement Range	UM =	LN	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	DMPRC= 6 SITS / LN									
A10331100010	SIT Emplacement (4 SF concrete repair), 6 per LN		$50.54	SF	24	SF per LN	15	1	$ 1,212.96	LN
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	2	EA per LN	3	8	$ 876.48	LN
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	6	EA per LN	4	6	$ 1,577.52	LN
D50231500010	Maintenance of receptacles, 4 per SIT		$56.78	EA	24	EA per LN	20	1	$ 1,362.72	LN
D50231280010	Replace branch wiring 600 V, 346 FT Avg. Distance		$1,603.15	MLF	2.076	MLF per LN	20	1	$ 3,328.14	LN
311413230400	Berm, 150 M x 3 M x 4 M = 2,354 CY / Backfill & compaction		$1.19	CY	2354.0	CY per LN	5	5	$ 13,951.80	LN
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	290.0	SY per LN	10	2	$ 2,591.87	LN
312216100200	Trail Grading, Fine Grading for Roadways, Base Course 1,464 SY		$0.80	SY	1464	SY per Rng	5	5	$ 5,835.80	LN
							Total Thru ESL		$ 30,737.29	LN
							Annualized		$ 1,229.49	LN

FAC 1774 Squad Defense Range

FY25 SUC:	$2,906.31 / EA
Source:	R.S. Means Cost Data

FAC	1774 Squad Defense Range	UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**	**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	SDR= 31 SITS / EA								
A10331100010	SIT Emplacement (4 SF concrete repair), 31 per range	$50.54	SF	124	SF per Rng	15	1	$ 6,266.96	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	31	EA per Rng	3	8	$ 13,585.44	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	31	EA per Rng	4	6	$ 8,150.52	EA
D50231500010	Maintenance of receptacles, 4 per SIT	$56.78	EA	124	EA per Rng	20	1	$ 7,040.72	EA
D50231280010	Replace branch wiring 600 V, 574 FT Avg. Distance	$1,603.15	MLF	8.152	MLF per Rng	20	1	$ 13,068.88	EA
334211602080	2-person fighting position, concrete, 5 per range	$351.42	EA	20	EA per Rng	10	2	$ 14,056.60	EA
311413230400	Berm, 300 M x 2 M x 1 M = 785 CY / Backfill & compaction	$1.19	CY	785.0	CY per FP	5	5	$ 4,652.58	EA
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	653.0	SY per FP	10	2	$ 5,836.17	EA
						Total Thru ESL		$ 72,657.87	EA
						Annualized		$ 2,906.31	EA

FAC 1775 Infantry Battle Course

FY25 SUC:	$9,722.20 / EA
Source:	R.S. Means Cost Data

FAC	1775	Infantry Battle Course	UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	ISBC= 6 SATs / 1 MATs / 20 SITS / 6 MITS									
A10331100010	SIT Emplacement (4 SF concrete repair) 20 per Range		$50.54	SF	80	SF per Rng	15	1	$ 4,043.20	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	20	EA per Rng	3	8	$ 8,764.80	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	42	EA per Rng	4	6	$ 11,042.64	EA
A10331100010	SAT Emplacement (7 SF concrete repair), 6 per Range		$50.54	SF	42	SF per Rng	15	1	$ 2,122.68	EA
A10331100010	MAT Emplacement 200 M (25.5 SF of Concrete repair)		$50.54	SF	25.5	SF per Rng	15	1	$ 1,288.77	EA
A10331100010	MIT Emplacement 15 M (12.5 SF Concrete repair)		$50.54	SF	75	SF per Rng	15	1	$ 3,790.50	EA
340123510400	Maintenance of Trolleyway, 1 Ton, 656 FT / MAT, 49 FT /MIT		$22.03	LF	950	LF per Rng	15	1	$ 20,927.55	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	13	EA per Rng	4	6	$ 3,417.96	EA
D50231500010	Maintenance of receptacles, 5 per SAT / 4 per MAT, MIT, SIT		$56.78	EA	138	EA per Rng	20	1	$ 7,835.64	EA
D50231280010	Replace branch wiring 600 V, 5,105 FT Avg. Distance		$1,603.15	MLF	35.105	MLF per Rng	20	1	$ 56,278.58	EA
312216100200	Trail Grading, Fine Grading for Roadways, Base Course, 5,392		$0.80	SY	5392	SY per Rng	5	5	$ 21,493.59	EA
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	9225.0	SY per Rng	10	2	$ 82,448.25	EA
333413130015	Machine gun bunker (48 IN x 48 IN reinforced Concrete. 4 FT		$1,494.83	EA	5	EA per Rng	10	2	$ 14,948.25	EA
311413230400	Berm, 300 M x 2 M x 1 M = 785 CY / Backfill & compaction		$1.19	CY	785.0	CY per Rng	5	5	$ 4,652.58	EA
							Total Thru ESL		$ 243,054.99	EA
							Annualized		$ 9,722.20	EA

FAC 1776 Urban Combat Training Range

FY25 SUC:	$16,784.65 / EA
Source:	R.S. Means Cost Data

FAC	1776	Urban Combat Training Range	UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	Component		Unit Price	Units	Conversion		Frequency	Occurrences in ESL	Extended Price	
A10331100010	SIT Emplacement (4 SF concrete repair), 26 per range		$50.54	SF	104	SF per Rng	15	1	$ 5,256.16	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	26	EA per Rng	3	8	$ 11,394.24	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	26	EA per Rng	4	6	$ 6,835.92	EA
D50231500010	Maintenance of receptacles, 5 per SAT / 4 per MAT, MIT, SIT		$56.78	EA	104	EA per Rng	20	1	$ 5,905.12	EA
D50231280010	Replace branch wiring 600 V, plastic duct		$1,603.15	MLF	8.105	MLF per Rng	20	1	$ 12,993.53	EA
321216130160	Road, Asphalt, 3 IN thick		$17.57	SY	835	SY per Rng	15	1	$ 14,671.58	EA
A10331100010	Shoothouse, Reinforced concrete (32 SF of concrete repair), 12		$50.54	SF	384	SF per Rng	15	1	$ 19,407.36	EA
311413230400	Total Berm, 500 M x 2 M x 3 M = 3923 CY / Backfill &		$1.19	CY	3923.0	CY per Rng	5	5	$ 23,251.03	EA
333413130015	Target Bunker (Precast Septic Tank, 1,000 GA)		$1,494.83	EA	4	EA per Rng	10	2	$ 11,958.60	EA
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	89.0	SY per Rng	10	2	$ 795.44	EA
015213201000	Urban Cluster / Bank Barn, 2 Story (20 FT x 20 FT), D Low		$127.98	SF	1200.0	SF per Rng	10	2	$ 307,147.20	EA
							Total Thru ESL		$ 419,616.18	EA
							Annualized		$ 16,784.65	EA

FAC 1777 Convoy Live Fire Range

FY25 SUC:	$15,345.84 / FP
Source:	R.S. Means Cost Data

FAC	1777 Convoy Live Fire Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update			
Reference	Component	Unit Price	Units	Conversion		Frequency	Occurrences in ESL	Extended Price		
	FP for CLFR= 2 SATs / 2 MATs / 9 SITS / 1 MITS									
A10331100010	SIT Emplacement (4 SF concrete repair) 9 per FP	$50.54	SF	36	SF per FP	15	1	$	1,819.44	FP
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	9	EA per FP	3	8	$	3,944.16	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	9	EA per FP	4	6	$	2,366.28	FP
A10331100010	SAT Emplacement (7 SF concrete repair), 2 per FP	$50.54	SF	14	SF per FP	15	1	$	707.56	FP
A10331100010	MAT Emplacement 200 M (25.5 SF concrete repair)	$50.54	SF	51	SF per FP	15	1	$	2,577.54	FP
A10331100010	MIT Emplacement 15 M (12.5 SF concrete repair)	$50.54	SF	12.5	SF per FP	15	1	$	631.75	FP
340123510400	Maintenance of Trolleyway, 1 Ton, 656 FT / MAT, 49 FT /MIT	$22.03	LF	1361	LF per FP	15	1	$	29,981.47	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	5	EA per FP	4	6	$	1,314.60	FP
D50231500010	Maintenance of receptacles, 5 per SAT / 4 per MAT, MIT, SIT	$56.78	EA	46	EA per FP	20	1	$	2,611.88	FP
D50231280010	Replace branch wiring 600 V	$1,603.15	MLF	13.582	MLF per FP	20	1	$	21,773.98	FP
312216100200	Trail Grading, Fine Grading for Roadways, Base Course, 1,435	$0.80	SY	1435	SY per FP	5	5	$	5,720.20	FP
311413230400	Total Berm, 6,552 M x 2 M x 1 M = 17,139 CY / Backfill &	$1.19	CY	17139.0	CY per FP	5	5	$	101,580.28	FP
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	431.0	SY per FP	10	2	$	3,852.05	FP
015213201000	Urban Cluster / Bank Barn, 2 Story (20 FT x 20 FT) x 2	$127.98	SF	800.0	SF per FP	10	2	$	204,764.80	FP
						Total Thru ESL		$	383,646.00	FP
						Annualized		$	15,345.84	FP

FAC 1781 Live Hand Grenade Range

FY25 SUC:	$187.25 / FP
Source:	R.S. Means Cost Data

FAC	1781	Live Hand Grenade Range		UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**			**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
321123230370	Bank run gravel, Spread, 6 IN deep			$4.47	SY	105.0	SY per FP	10	2	$ 938.44	FP
A10331100010	Throwing Bay (4.5 SF of concrete repair)			$50.54	SF	4.5	SF per FP	15	1	$ 227.43	FP
A10331100010	Blast Wall 50M (42 SF of concrete repair)			$50.54	SF	42	SF per FP	15	1	$ 2,122.68	FP
311413230400	Total Berm, 60 M x 3 M x 1 M = 235 CY / Backfill &			$1.19	CY	235.0	CY per FP	5	5	$ 1,392.81	FP
								Total Thru ESL		$ 4,681.36	FP
								Annualized		$ 187.25	FP

FAC 1782 Engineer Qualification Range

FY25 SUC:	$1,709.13 / FP
Source:	R.S. Means Cost Data

FAC	1782	Engineer Qualification Range		UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**			**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price in ESL**	
	FP for EQR= 2 SATs / 9 SITS										
A10331100010	SIT Emplacement (4 SF concrete repair), 9 per FP			$50.54	SF	36	SF per FP	15	1	$ 1,819.44	FP
D50132200020	Maintenance and inspection switchgear, less than 600 V			$54.78	EA	9	EA per FP	3	8	$ 3,944.16	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect			$43.82	EA	9	EA per FP	4	6	$ 2,366.28	FP
A10331100010	SAT Emplacement (7 SF concrete repair), 2 per FP			$50.54	SF	14	SF per FP	15	1	$ 707.56	FP
A10331100010	MIT Emplacement 15 M (12.5 SF Concrete repair)			$50.54	SF	80.7	SF per FP	15	1	$ 4,078.58	FP
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect			$43.82	EA	2	EA per FP	4	6	$ 525.84	FP
D50231500010	Maintenance of receptacles, 5 per SAT / 4 per MAT, MIT, SIT			$56.78	EA	55	EA per FP	20	1	$ 3,122.90	FP
D50231280010	Replace branch wiring, 600 V			$1,603.15	MLF	1.753	MLF per FP	20	1	$ 2,810.32	FP
312216100200	Trail Grading, Fine Grading for Roadways, Base Course, 1,435			$0.80	SY	1435	SY per FP	5	5	$ 5,720.20	FP
311413230400	Total Berm, 6,552 M x 2 M x 1 M = 17,139 CY / Backfill &			$1.19	CY	1214.0	CY per FP	5	5	$ 7,195.20	FP
321123230370	Bank run gravel, Spread, 6 IN deep			$4.47	SY	431.0	SY per FP	10	2	$ 3,852.05	FP
333413130015	Target Bunker (Precast Septic Tank, 1,000 GA)			$1,494.83	EA	2	EA per FP	10	2	$ 5,979.30	FP
A10331100010	Blast Wall 100 M (12 SF of concrete repair)			$50.54	SF	12	SF per FP	15	1	$ 606.48	FP
								Total Thru ESL		$ 42,728.31	FP
								Annualized		$ 1,709.13	FP

FAC 1783 Light & Heavy Demolition Range

FY25 SUC:	$4,931.13 / EA
Source:	R.S. Means Cost Data

FAC	1783	Light Demolition and Flame Training Range	UM = FP		ESL =	25	Source	RS Means Costworks 2017Q3 Update			
Reference	Component		Unit Price	Units	Conversion		Frequency	Occurrences in ESL	Extended Price in ESL		
A10331100010	Missile Proof Shelter (428 sf of concrete repair)		$43.30	SF	228	SF per FP	15	1	$	9,872.40	FP
A10331100010	Blast Wall 50M (12 sf of concrete repair)		$43.30	SF	12	SF per FP	15	1	$	519.60	FP
A10331100010	Steel / Timber Cutting Chamber x 2 (400 sf of concrete repair)		$43.30	SF	800	SF per FP	15	1	$	34,640.00	FP
311413230400	Repair Berm, / Backfill & compaction		$0.95	CY	9300.0	CY per FP	5	5	$	44,175.00	FP
							Total Thru ESL		$	89,207.00	FP
							Annualized		$	3,568.28	FP

FAC 1790 Miscellaneous Training Facility

FY25 SUC:	$1,091.23 / EA
Source:	R.S. Means Cost Data

FAC	1790	Miscellaneous Training Facility	UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	SIT Emplacement (4 SF concrete repair), 6 per range		$50.54	SF	24	SF per Rng	15	1	$ 1,212.96	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	3	EA per Rng	3	8	$ 1,314.72	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	6	EA per Rng	4	6	$ 1,577.52	EA
A10331100010	SAT Emplacement (7 SF concrete repair) 2 per range		$50.54	SF	14	SF per Rng	15	1	$ 707.56	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	2	EA per Rng	4	6	$ 525.84	EA
D50231500010	Maintenance of receptacles, 5 per SAT / 4 per SIT		$56.78	EA	34	EA per Rng	20	1	$ 1,930.52	EA
D50231280010	Replace branch wiring, 600 V		$1,603.15	MLF	0.905	MLF per Rng	20	1	$ 1,450.85	EA
312216100200	Trail Grading, Fine Grading for Roadways, Base Course, 1,913		$0.80	SY	1913	SY per Rng	5	5	$ 7,625.60	EA
311413230400	Total Berm, 400 M x 2 M x 1 M = 1,046 CY / Backfill &		$1.19	CY	846	CY per Rng	5	5	$ 5,014.12	EA
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	CY	328.0	CY per Rng	10	2	$ 2,931.49	EA
333413130015	Target Bunker (Precast Septic Tank, 1,000 GA)		$1,494.83	EA	1	SF per Rng	10	2	$ 2,989.65	EA
	FAC 1790 is a collection of 66 CatCodes. Components for this						Total Thru ESL		$ 27,280.83	EA
	model represent an average of these facilities.						Annualized		$ 1,091.23	EA

FAC 1791 Aircraft Weapons Calibration Range

FY25 SUC:	$480.10 / EA
Source:	R.S. Means Cost Data

FAC	1791	Aircraft Weapons Calibration Range		UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**			**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	BSHR= 8 SATs / 8 SITS										
A10331100010	SIT Emplacement (4 SF concrete repair), 8 per range			$50.54	SF	32	SF per Rng	15	1	$ 1,617.28	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V			$54.78	EA	2	EA per Rng	3	8	$ 876.48	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect			$43.82	EA	8	EA per Rng	4	6	$ 2,103.36	EA
A10331100010	SAT Emplacement (7 SF concrete repair), 8 per Range			$50.54	SF	56	SF per Rng	15	1	$ 2,830.24	EA
D50231500010	Maintenance of receptacles, 3 per SAT / 2 per SIT			$56.78	EA	40	EA per Rng	20	1	$ 2,271.20	EA
D50231280010	Replace branch wiring, 600 V			$1,603.15	MLF	1.248	MLF per Rng	20	1	$ 2,000.73	EA
A10331100010	Concrete Pad, 40 FT x 40 FT, 8 IN reinforced (6 SF of			$50.54	SY	6	SY per Rng	15	1	$ 303.24	EA
								Total Thru ESL		$ 12,002.53	EA
								Annualized		$ 480.10	EA

FAC 1792 Attack Helicopter Weapons Range

FY25 SUC:	$42,894.78 / EA
Source:	R.S. Means Cost Data

FAC	1792 Attack Helicopter Weapons Range	UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**	**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
	ARG= 50 SATs / 8 MATs / 246 SITS / 35 MITS								
A10331100010	SIT Emplacement (4 SF concrete repair) 246 per range	$50.54	SF	984	SF per Rng	15	1	$ 49,731.36	EA
D50132200020	Maintenance and inspection switchgear, less than 600 V	$54.78	EA	246	EA per Rng	3	8	$ 107,807.04	EA
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect	$43.82	EA	246	EA per Rng	4	6	$ 64,678.32	EA
A10331100010	SAT Emplacement (7 SF concrete repair) 50 per Range	$50.54	SF	350	SF per Rng	15	1	$ 17,689.00	EA
A10331100010	MAT Emplacement 200M (25.5 SF of Concrete repair)	$50.54	SF	204	SF per Rng	15	1	$ 10,310.16	EA
A10331100010	MIT Emplacement 15M (12.5 SF Concrete repair)	$50.54	SF	437.5	SF per Rng	15	1	$ 22,111.25	EA
340123510400	Maintenance of Trolleyway, 1 Ton, 356 FT / MAT 49 FT /MIT	$22.03	LF	4563	LF per Rng	15	1	$ 100,518.33	EA
D50231500010	Maintenance of receptacles, 3 per SAT / 3 per MAT, MIT, SIT	$56.78	EA	1017	EA per Rng	20	1	$ 57,745.26	EA
D50231280010	Replace branch wiring, 600 V	$1,603.15	MLF	21.527	MLF per Rng	20	1	$ 34,511.01	EA
312216100200	Trail Grading, Fine Grading for Roadways, Base Course, 10,525	$0.80	SY	10525	SY per Rng	5	5	$ 41,954.76	EA
311413230400	Total Berm, 2,540 M x 2 M x 1 M = 6,644 CY / Backfill &	$1.19	CY	6644.0	CY per Rng	5	5	$ 39,377.99	EA
321123230370	Bank run gravel, Spread, 6 IN deep	$4.47	SY	1569.0	SY per Rng	10	2	$ 14,022.91	EA
015213201000	Urban Cluster / Bank Barn, 2 Story (20 FT x 20 FT) x 5 Buildings	$127.98	SF	2000.0	SF per Rng	10	2	$ 511,912.00	EA
						Total Thru ESL		$1,072,369.38	EA
						Annualized		$ 42,894.78	EA

FAC 1793 Aircraft Weapons Range

FY25 SUC: $0.00 / EA

Source:

FAC 1794 Air Defense Range

FY25 SUC:	$1,114.44 / FP
Source:	R.S. Means Cost Data

FAC	1794	Air Defense Range	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	Vehicle Battle Position - Defilade (28 SF concrete repair)		$50.54	SF	481	SF per FP	15	1	$ 24,309.74	FP
311413230400	Berm, 90 M x 2 M x 3 M = 506 CY / Backfill & compaction		$1.19	CY	506.0	CY per FP	5	5	$ 2,998.99	FP
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	61.8	SY per FP	10	2	$ 552.34	FP
							Total Thru ESL		$ 27,861.06	FP
							Annualized		$ 1,114.44	FP

FAC 1795 Unenclosed Fire Fighter Trainer Facility

FY25 SUC:	$0.31 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 1796 Urban Combat Training Area, Non-Fire

FY25 SUC:	$0.82 / SF
Source:	R.S. Means Cost Data

FAC	1796	Urban Combat Training Area, Non-Fire	UM =	SF	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
015213201000	Urban Cluster / Bank Barn, 2 Story (30 FT x 30 FT) x 4		$127.98	SF	0.02	SF to SF	10	2	$ 5.12	SF
A10331100010	Structure, Reinforced concrete (Armory, CDS) 12 EA, 12 SF		$50.54	SF	0.02	SF to SF	15	1	$ 1.01	SF
D50132200020	Maintenance and inspection switchgear, less than 600 V		$54.78	EA	0.015	EA per SF	3	8	$ 6.57	SF
D50231301020	Breaker, 2 pole, 480 V, Maint/Inspect		$43.82	EA	0.0028	EA per SF	4	6	$ 0.74	SF
D50231280010	Replace branch wiring 600 V		$1,603.15	MLF	0.0024	LF per SF	20	1	$ 3.93	SF
321216130160	Road, Asphalt, 3 IN thick		$17.57	SY	0.0138	SY per SF	15	1	$ 0.24	SF
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	0.32	SY per SF	10	2	$ 2.87	SF
311413230400	Backfill & compaction, 2,020 CY		$1.19	CY	0.0031	CY per SF	5	5	$ 0.02	SF
							Total Thru ESL		$ 20.50	SF
							Annualized		$ 0.82	SF

FAC 1797 Hand Grenade Range, Non-Firing

FY25 SUC:	$165.62 / FP
Source:	R.S. Means Cost Data

FAC	1797	Hand Grenade Range, Non-Firing	UM =	FP	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**		**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
334211602080	2-person fighting position, concrete		$351.42	EA	1	EA per FP	10	2	$ 702.83	FP
333413130015	Target Bunker (Precast Septic Tank, 1,000 GA)		$1,494.83	EA	1	EA per FP	10	2	$ 2,989.65	FP
311413230400	Target Berm, 1 M x 1 M x 2 M x 4 targets/lane = 2.6 CY /		$1.19	CY	10.4	CY per FP	5	5	$ 61.64	FP
311413230400	Berm, 40 M x 1 M x 2 M = 104 CY / Backfill & compaction		$1.19	CY	26.0	CY per FP	5	5	$ 154.10	FP
321123230370	Bank run gravel, Spread, 6 IN deep		$4.47	SY	26.0	SY per FP	10	2	$ 232.37	FP
							Total Thru ESL		$ 4,140.59	FP
							Annualized		$ 165.62	FP

FAC 1798 Infiltration Course, Live Fire

FY25 SUC:	$548.32 / EA
Source:	R.S. Means Cost Data

FAC	1798	Infiltration Course, Live Fire		UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**			**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	Blast Wall 360M (32 SF of concrete repair)			$50.54	SF	32	SF per Rng	15	1	$ 1,617.28	EA
333413130015	Target Bunker (Precast Septic Tank, 1,000 GA)			$1,494.83	EA	2	EA per Rng	10	2	$ 5,979.30	EA
311413230400	Total Berm, 160 M x 2 M x 2 M = 722 CY / Backfill &			$1.19	CY	722	CY per Rng	5	5	$ 4,279.19	EA
321123230370	Bank run gravel, Spread, 6 IN deep			$4.47	SY	205.0	SY per Rng	10	2	$ 1,832.18	EA
								Total Thru ESL		$ 13,707.95	EA
								Annualized		$ 548.32	EA

FAC	1798	Infiltration Course, Live Fire		UM =	EA	ESL =	25	Source	RS Means Costworks 2024 Q3 Update		
Reference	**Component**			**Unit Price**	**Units**	**Conversion**		**Frequency**	**Occurrences in ESL**	**Extended Price**	
A10331100010	Blast Wall 360M (32 SF of concrete repair)			$50.54	SF	32	SF per Rng	15	1	$ 1,617.28	EA
333413130015	Target Bunker (Precast Septic Tank, 1,000 GA)			$1,494.83	EA	2	EA per Rng	10	2	$ 5,979.30	EA
311413230400	Total Berm, 160 M x 2 M x 2 M = 722 CY / Backfill &			$1.19	CY	722	CY per Rng	5	5	$ 4,279.19	EA
321123230370	Bank run gravel, Spread, 6 IN deep			$4.47	SY	205.0	SY per Rng	10	2	$ 1,832.18	EA
								Total Thru ESL		$ 13,707.95	EA
								Annualized		$ 548.32	EA

FAC 1799 Confidence/Obstacle Course

FY25 SUC:	$2,601.52 / EA
Source:	R.S. Means Cost Data

FAC	1799	Confidence/Obstacle Course	UM =	EA	ESL =	25	Source:	RS Means Costworks 2024 Q3 Update		
Reference	Component		Unit Price	Units	Conversion		Frequency	Occurrences in ESL	Extended Price	
312216100200	Fine grading running track		$0.80	SY	460	SY to EA	5	5	$ 1,833.65	EA
313219161500	Stabilize running track geotextile fabric		$1.80	SY	460	SY to EA	5	5	$ 4,149.84	EA
329113160100	Mulch running track		$11.96	SY	460	SY to EA	5	5	$ 27,504.78	EA
337116336200	18 stations, wood pole frames, replace		$1,127.68	EA	8	EA to SF	10	2	$ 18,042.80	EA
061110140100	18 stations, wood beams and columns, 4 IN x 4 IN, average of		$6.77	LF	112	LF to EA	5	5	$ 3,788.99	EA
051516500020	Steel Wire Rope, Replace		$1.30	LF	2520	LF to EA	10	2	$ 6,555.83	EA
051516051620	Wire rope clip, 1/2 IN diameter		$16.47	EA	96	EA to SF	10	2	$ 3,162.11	EA
							Total Thru ESL		$ 65,038.00	EA
	Note: Layout of obstacle course from FM 7-22, AFI36-2202						Annualized		$ 2,601.52	EA

FAC 2111 Aircraft Maintenance Hangar

FY25 SUC:	$4.64 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 2111 Aircraft Maintenance Hangar

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.64
UM: SF
Expected Service Life: 40
Model Size: 29046

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurences	Life Cost	Adjusted Cost
Refinish fire escape stair and platform	7	3.00 Flight	$1,724.19	$2,083.02	5.7143	5	5	$10,415.08	$10,415.08
Replace fire escape stair and platform	25	3.00 Flight	$19,874.11	$24,220.60	1.6000	1	1	$24,220.60	$24,220.60
Replace aluminum siding, 1st floor	35	23.30 C.S.F.	$14,832.87	$17,867.21	1.1429	1	1	$17,867.21	$17,867.21
Replace aluminum siding, 2nd floor	35	23.30 C.S.F.	$18,155.51	$22,000.25	1.1429	1	1	$22,000.25	$22,000.25
Replace aluminum siding, 3rd floor	35	23.30 C.S.F.	$20,163.21	$24,497.63	1.1429	1	1	$24,497.63	$24,497.63
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	15.60 S.F.	$212.96	$250.06	40.0000	40	40	$10,002.20	$10,002.20
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	84.00 Ea.	$13,565.84	$16,166.30	2.0000	2	2	$32,332.59	$32,332.59
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	84.00 Ea.	$69,028.15	$80,649.52	0.8000	0	0	$0.00	$0.00
Repair steel, painted, door	14	6.00 Ea.	$4,665.35	$5,524.61	2.8571	2	2	$11,049.22	$11,049.22
Refinish 3'-0" x 7'-0" steel, painted, door	4	6.00 Ea.	$287.95	$352.52	10.0000	10	10	$3,525.15	$3,525.15
Replace 3'-0" x 7'-0" steel, painted, door	45	6.00 Ea.	$4,415.15	$5,139.41	0.8889	0	0	$0.00	$0.00
Replace 12' x 24' steel double roll-up door	35	2.00 Ea.	$14,434.69	$17,009.96	1.1429	1	1	$17,009.96	$17,009.96
Remove and replace electric bi-folding hangar door motor	15	6.00 Ea.	$4,926.62	$5,723.08	2.6667	2	2	$11,446.16	$11,446.16
Remove and replace electric bi-folding hangar door cables	15	6.00 Ea.	$4,112.12	$4,986.01	2.6667	2	2	$9,972.01	$9,972.01
Remove and replace electric bi-folding hangar door	20	6.00 Ea.	$370,137.33	$428,597.72	2.0000	2	2	$857,195.44	$857,195.44
Debris removal, by hand and visual inspection, metal panel roofing	1	30.00 M.S.F.	$737.27	$900.40	40.0000	40	40	$36,016.00	$36,016.00
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	423.00 S.F.	$2,050.81	$2,433.76	8.0000	8	8	$19,470.11	$19,470.11
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	21.00 S.F.	$593.43	$706.19	40.0000	40	40	$28,247.79	$28,247.79
Minor metal roof panel replacement, 2.5% of roof area	20	423.00 S.F.	$5,850.41	$6,920.31	2.0000	2	2	$13,840.62	$13,840.62
Total metal roof panel replacement	30	290.00 Sq.	$278,752.39	$329,632.31	1.3333	1	1	$329,632.31	$329,632.31
Repair steel painted interior door	14	10.00 Ea.	$2,968.50	$3,463.22	2.8571	2	2	$6,926.44	$6,926.44
Refinish 3'-0" x 7'-0" steel painted interior door	4	10.00 Ea.	$602.03	$740.24	10.0000	10	10	$7,402.45	$7,402.45
Replace 3'-0" x 7'-0" steel painted interior door	60	10.00 Ea.	$14,095.18	$16,328.01	0.6667	0	0	$0.00	$0.00
Repair solid core wood door, interior	11	8.00 Ea.	$2,374.80	$2,770.57	3.6364	3	3	$8,311.72	$8,311.72
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	8.00 Ea.	$437.45	$532.18	10.0000	10	9	$5,321.76	$4,789.59
Replace 3'-0" x 7'-0" solid core wood door, interior	40	8.00 Ea.	$5,150.22	$5,938.40	1.0000	1	1	$5,938.40	$5,938.40
Repair medium weight vinyl wall covering - (2% of walls)	1	0.11 C.S.F.	$55.56	$64.84	40.0000	40	40	$2,593.79	$2,593.79
Replace medium weight vinyl wall covering	15	5.24 C.S.F.	$3,161.10	$3,718.97	2.6667	2	2	$7,437.94	$7,437.94
Repair 5/8" drywall - (2% of walls)	20	104.00 S.F.	$194.27	$236.30	2.0000	2	2	$472.61	$472.61
Replace 5/8" drywall	75	5,199.00 S.F.	$13,408.31	$16,411.00	0.5333	0	0	$0.00	$0.00
Refinish concrete floor finished	25	146.00 C.S.F.	$66,942.84	$80,427.59	1.6000	1	1	$80,427.59	$80,427.59
Replace vinyl sheet flooring	18	143.77 S.Y.	$11,468.99	$13,907.81	2.2222	2	2	$27,815.62	$27,815.62
Replace carpet	8	192.00 S.Y.	$10,694.11	$12,366.88	5.0000	5	5	$61,834.38	$61,834.38
Repair gypsum board ceiling - (2% of ceilings)	20	0.97 C.S.F.	$396.39	$486.04	2.0000	2	2	$972.08	$972.08
Refinish gypsum board ceiling, up to 12' high	20	48.53 C.S.F.	$7,383.22	$9,077.24	2.0000	2	1	$18,154.47	$9,077.24
Replace gypsum board ceiling, up to 12' high	40	48.53 C.S.F.	$20,327.69	$24,933.66	1.0000	1	1	$24,933.66	$24,933.66
Replace flush valve diaphragm tankless water closet	10	12.00 Ea.	$331.08	$411.31	4.0000	4	4	$1,645.26	$1,645.26
Rebuild flush valve tankless water closet	20	12.00 Ea.	$2,319.25	$2,795.45	2.0000	2	2	$5,590.90	$5,590.90
Unplug clogged line tankless water closet	5	12.00 Ea.	$2,757.37	$3,453.45	8.0000	8	8	$27,627.64	$27,627.64
Replace tankless water closet	35	12.00 Ea.	$16,519.88	$19,118.35	1.1429	1	1	$19,118.35	$19,118.35
Replace tankless flush valve	25	12.00 Ea.	$3,271.86	$3,840.34	1.6000	1	1	$3,840.34	$3,840.34
Replace wax ring gasket for tankless water closet	5	12.00 Ea.	$1,797.06	$2,248.58	8.0000	8	8	$17,988.67	$17,988.67
Replace flush valve diaphragm for a urinal	7	8.00 Ea.	$220.72	$274.21	5.7143	5	5	$1,371.05	$1,371.05
Rebuild flush valve for a urinal	20	8.00 Ea.	$1,546.17	$1,863.63	2.0000	2	2	$3,727.27	$3,727.27
Unplug line urinal	5	8.00 Ea.	$1,223.23	$1,532.02	8.0000	8	8	$12,256.19	$12,256.19
Replace wall-hung urinal	35	8.00 Ea.	$8,738.32	$10,515.10	1.1429	1	1	$10,515.10	$10,515.10
Replace washer in spud connection lavatory, vitreous china	7	14.00 Ea.	$243.50	$297.27	5.7143	5	5	$1,486.36	$1,486.36
Replace washer in faucet lavatory, vitreous china	2	14.00 Ea.	$190.37	$237.48	20.0000	20	20	$4,749.60	$4,749.60
Replace faucets lavatory, vitreous china	10	13.00 Ea.	$2,582.09	$3,104.19	4.0000	4	4	$12,416.74	$12,416.74
Clean out strainer and P trap lavatory, vitreous china	2	13.00 Ea.	$482.15	$603.86	20.0000	20	20	$12,077.26	$12,077.26
Replace lavatory, vitreous china	35	14.00 Ea.	$10,519.26	$12,612.40	1.1429	1	1	$12,612.40	$12,612.40
Replace faucet washer sink, service/utility	2	1.00 Ea.	$13.50	$16.85	20.0000	20	20	$336.92	$336.92
Clean trap	3	1.00 Ea.	$9.02	$11.29	13.3333	13	13	$146.82	$146.82
Replace faucets sink, service/utility	10	1.00 Ea.	$198.62	$238.78	4.0000	4	4	$955.13	$955.13
Unstop sink	2	1.00 Ea.	$44.15	$55.30	20.0000	20	20	$1,105.98	$1,105.98
Replace sink, P.E.C.I. service/utility	35	1.00 Ea.	$1,659.02	$1,940.60	1.1429	1	1	$1,940.60	$1,940.60
Inspect / clean shower head shower, terrazzo	3	8.00 Ea.	$416.47	$521.60	13.3333	13	13	$6,780.85	$6,780.85
Replace shower and fittings, aluminum	25	8.00 Ea.	$9,508.13	$11,299.61	1.6000	1	1	$11,299.61	$11,299.61
Replace shower, glazed C.M.U.	25	8.00 Ea.	$16,245.07	$19,269.08	1.6000	1	1	$19,269.08	$19,269.08
Check / minor repairs drinking fountain	1	3.00 Ea.	$155.83	$195.17	40.0000	40	40	$7,806.89	$7,806.89
Repair internal leaks drinking fountain	4	3.00 Ea.	$143.37	$179.56	10.0000	10	10	$1,795.58	$1,795.58
Correct water pressure drinking fountain	2	3.00 Ea.	$132.46	$165.90	20.0000	20	20	$3,317.93	$3,317.93
Replace refrigerant drinking fountain	2	3.00 Ea.	$110.31	$128.99	20.0000	20	20	$2,579.83	$2,579.83
Repair drain leak drinking fountain	4	3.00 Ea.	$91.53	$110.43	10.0000	10	8	$1,104.25	$883.40
Replace fountain drinking fountain	10	3.00 Ea.	$4,570.18	$5,383.32	4.0000	4	4	$21,533.28	$21,533.28
Inspect and clean spray heads, emergency eye wash	3	4.00 Ea.	$208.23	$260.80	13.3333	13	13	$3,390.43	$3,390.43
Replace eye wash station, emergency eye wash	25	4.00 Ea.	$3,161.79	$3,846.19	1.6000	1	1	$3,846.19	$3,846.19
Replace pipe and fittings, copper 3/4"	20	32.00 L.F.	$771.15	$937.28	2.0000	2	2	$1,874.56	$1,874.56
Replace pipe and fittings, copper 2"	25	16.00 L.F.	$904.99	$1,084.54	1.6000	1	1	$1,084.54	$1,084.54
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	32.00 L.F.	$330.04	$403.21	2.6667	2	2	$806.42	$806.42
Overhaul water heater, gas / oil, 70 gallon	5	1.00 Ea.	$173.21	$216.94	8.0000	8	8	$1,735.52	$1,735.52
Clean & service water heater, gas / oil, 70 gallon	1	1.00 Ea.	$206.74	$258.93	40.0000	40	40	$10,357.14	$10,357.14
Replace water heater, gas / oil, 70 gallon	12	1.00 Ea.	$5,470.45	$6,302.52	3.3333	3	3	$18,907.56	$18,907.56
Replace storage tank, glass lined, P.E., 80 gal.	50	1.00 Ea.	$5,024.42	$5,725.19	0.8000	0	0	$0.00	$0.00
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	1.00 Ea.	$8.47	$10.60	80.0000	80	80	$848.35	$848.35
Replace pump / motor assembly circulation pump, 1/12 HP	10	1.00 Ea.	$1,265.32	$1,479.95	4.0000	4	4	$5,919.80	$5,919.80
Unclog main drain pipe & fittings, cast iron	10	1.00 Ea.	$48.83	$61.15	4.0000	4	4	$244.62	$244.62
Replace pipe & fittings, cast iron, 4"	40	10.00 L.F.	$609.65	$738.85	1.0000	1	1	$738.85	$738.85
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.0000	2	2	$126.21	$126.21
Unclog 4" - 12" diameter PVC main drain per L.F.	10	1.00 L.F.	$4.00	$5.01	4.0000	4	4	$20.04	$20.04
Replace pipe, 4" pipe and fittings, PVC	30	8.00 L.F.	$749.59	$917.36	1.3333	1	1	$917.36	$917.36
General maintenance & repair drain: roof, scupper, area	1	8.00 Ea.	$313.74	$392.95	40.0000	40	40	$15,717.87	$15,717.87
Replace drain: roof, scupper, area	40	8.00 Ea.	$8,770.86	$10,121.72	1.0000	1	1	$10,121.72	$10,121.72
Replace 10' of buried 4" diam steel pipe/M.L.F. natural gas	12	1.00 Ea.	$914.79	$1,117.74	3.3333	3	3	$3,353.21	$3,353.21
Repair boiler, gas, 2000 MBH	7	1.00 Ea.	$5,513.06	$6,436.35	5.7143	5	4	$32,181.76	$25,745.41
Replace boiler, gas, 2000 MBH	30	1.00 Ea.	$47,742.79	$55,703.30	1.3333	1	1	$55,703.30	$55,703.30
Replace metal flue, all fuel SS, 6" diameter metal flue / chimney	15	1.00 L.F.	$185.43	$213.70	2.6667	2	2	$427.40	$427.40
Repair cooling tower, 100 ton	10	1.00 Ea.	$5,760.28	$6,798.36	4.0000	4	3	$27,193.45	$20,395.09
Replace cooling tower, 100 ton	15	1.00 Ea.	$24,400.92	$28,090.70	2.6667	2	2	$56,181.40	$56,181.40
Repair water cooled chiller, 100 ton, reciprocating	10	1.00 Ea.	$71,510.26	$83,428.54	4.0000	4	2	$333,714.16	$166,857.08
Replace chiller, water cooled, 100 ton, reciprocating	20	1.00 Ea.	$92,417.28	$107,576.21	2.0000	2	2	$215,152.43	$215,152.43
Repair fan coil unit, 3 ton	10	8.00 Ea.	$4,623.95	$5,476.87	4.0000	4	3	$21,907.47	$16,430.60
Replace fan coil unit, 3 ton	15	8.00 Ea.	$27,029.47	$31,183.20	2.6667	2	2	$62,366.41	$62,366.41
Replace fan coil, DX 10 ton, with heat	10	3.00 Ea.	$17,189.24	$20,179.37	4.0000	4	4	$80,717.48	$80,717.48
Repair circulator pump, 1 H.P.	5	1.00 Ea.	$105.05	$123.93	8.0000	8	6	$991.46	$743.60
Replace circulator. pump, 1 H.P.	15	1.00 Ea.	$5,461.13	$6,269.02	2.6667	2	2	$12,538.04	$12,538.04
Replace expansion tank, 60 gal capacity	50	1.00 Ea.	$2,962.57	$3,398.58	0.8000	0	0	$0.00	$0.00
Maintenance and repair explosionproof industrial heater	2	4.00 Ea.	$881.81	$1,030.57	20.0000	20	19	$20,611.31	$19,580.75
Maintenance and inspection explosionproof industrial heater	0.5	4.00 Ea.	$339.09	$425.39	80.0000	80	80	$34,031.13	$34,031.13
Replace heater explosionproof industrial heater	15	12.00 Ea.	$75,675.12	$86,478.83	2.6667	2	2	$172,957.65	$172,957.65
Repair terminal reheat, 36" x 36" coil	10	12.00 Ea.	$2,069.46	$2,591.89	4.0000	4	4	$10,367.55	$10,367.55
Replace terminal reheat, 36" x 36" coil	15	12.00 Ea.	$46,888.41	$54,421.17	2.6667	2	2	$108,842.33	$108,842.33
Repair central station A.H.U., 16,000 CFM	10	2.00 Ea.	$4,262.30	$4,926.62	4.0000	4	3	$19,706.46	$14,779.85
Replace central station A.H.U., 16,000 CFM	15	2.00 Ea.	$150,264.75	$172,853.73	2.6667	2	2	$345,707.45	$345,707.45
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	40.0000	40	40	$1,816.40	$1,816.40
Replace sprinkler head	20	276.00 Ea.	$25,306.62	$31,187.24	2.0000	2	2	$62,374.48	$62,374.48
Rebuild double check 4" backflow preventer sprinkler system	1	1.00 Ea.	$803.27	$965.51	40.0000	40	40	$38,620.32	$38,620.32
Rebuild double check 6" backflow preventer sprinkler system	1	1.00 Ea.	$925.07	$1,109.95	40.0000	40	40	$44,397.86	$44,397.86
Replace fire pump / electric motor assembly 100 H.P.	25	1.00 Ea.	$46,050.08	$53,152.38	1.6000	1	1	$53,152.38	$53,152.38
Replace switchgear 1200 A mainframe	20	1.00 Ea.	$4,508.06	$5,431.65	2.0000	2	2	$10,863.30	$10,863.30
Repair switchgear, - (5% of total C.B.), indoor, less than 600 V	10	1.00 Ea.	$891.97	$1,029.49	4.0000	4	4	$4,117.98	$4,117.98
Maintenance and inspection switchgear, indoor, less than 600 V	3	1.00 Ea.	$43.82	$54.97	13.3333	13	13	$714.57	$714.57
Replace switchgear, 225 A	30	1.00 Ea.	$480.76	$603.11	1.3333	1	1	$603.11	$603.11
Maintenance and repair inverter	1	4.00 Ea.	$3,531.08	$4,219.64	40.0000	40	40	$168,785.60	$168,785.60
Maintenance and inspection inverter	0.25	4.00 Ea.	$559.87	$702.36	160.0000	160	160	$112,377.48	$112,377.48
Replace 1 KVA inverter	20	4.00 Ea.	$18,409.72	$21,006.98	2.0000	2	2	$42,013.96	$42,013.96
Maintenance and repair motor starter, up to 600 V	5	6.00 Ea.	$2,097.31	$2,513.58	8.0000	8	8	$20,108.62	$20,108.62
Maintenance and inspection motor starter, up to 600 V	0.5	6.00 Ea.	$350.53	$439.74	80.0000	80	80	$35,179.04	$35,179.04
Replace starter motor starter, up to 600 V	18	6.00 Ea.	$4,913.74	$5,864.71	2.2222	2	2	$11,729.41	$11,729.41
Maintenance and repair secondary transformer, dry	10	1.00 Ea.	$295.51	$351.26	4.0000	4	4	$1,405.05	$1,405.05
Maintenance and inspection secondary transformer, dry	0.5	2.00 Ea.	$174.05	$218.34	80.0000	80	80	$17,467.37	$17,467.37
Maintenance and inspection lighting panel, indoor	3	10.00 Ea.	$438.16	$549.67	13.3333	13	13	$7,145.74	$7,145.74
Maintenance and repair breaker, enclosed, 240 V, 1 pole	25	8.00 Ea.	$618.29	$775.65	1.6000	1	1	$775.65	$775.65
Maintenance and inspection circuit breaker, enclosed, 240 V, 1 pole	1	8.00 Ea.	$277.50	$348.13	40.0000	40	40	$13,925.04	$13,925.04
Replace circuit breaker enclosed, 240 V, 1 pole circuit breaker	50	45.00 Ea.	$23,601.32	$28,108.00	0.8000	0	0	$0.00	$0.00
Replace safety switch, heavy duty 30 A	25	4.00 Ea.	$3,070.28	$3,644.16	1.6000	1	1	$3,644.16	$3,644.16
Maintenance and repair receptacles and plugs	20	48.00 Ea.	$2,196.44	$2,744.42	2.0000	2	2	$5,488.83	$5,488.83
Replace receptacle/plug receptacles and plugs	20	48.00 Ea.	$3,875.67	$4,767.41	2.0000	2	2	$9,534.82	$9,534.82
Maintenance and repair wiring devices, switches	10	44.00 Ea.	$2,013.40	$2,515.71	4.0000	4	4	$10,062.86	$10,062.86
Replace wiring devices, switches	15	44.00 Ea.	$3,059.52	$3,809.70	2.6667	2	2	$7,619.40	$7,619.40

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Maintenance and repair incandescent lighting fixtures	10	20.00 Ea.	$1,486.63	$1,770.30	4.0000	4	2	$7,081.21	$3,540.60
Replace incandescent lighting fixture lamp	5	20.00 Ea.	$272.65	$327.78	8.0000	8	8	$2,622.23	$2,622.23
Replace incandescent lighting fixture	20	20.00 Ea.	$2,957.74	$3,583.39	2.0000	2	2	$7,166.79	$7,166.79
Replace fluorescent light fixture ballast, 80 W	10	76.00 Ea.	$8,278.83	$10,208.88	4.0000	4	2	$40,835.50	$20,417.75
Replace lamps (2 lamps), 4', 34 W energy saver	10	76.00 Ea.	$2,063.52	$2,587.51	4.0000	4	4	$10,350.04	$10,350.04
Replace fluorescent fixture, lay-in, recess mtd, 2' x 4', two 40 W	20	76.00 Ea.	$20,565.69	$24,947.08	2.0000	2	2	$49,894.16	$49,894.16
Replace high pressure sodium ballast, 250 W	10	24.00 Ea.	$4,881.54	$5,800.19	4.0000	4	2	$23,200.77	$11,600.39
Replace high pressure sodium fixture lamp, 250 W	10	24.00 Ea.	$1,657.74	$1,998.71	4.0000	4	4	$7,994.85	$7,994.85
Replace high pressure sodium fixture, 250 W	20	24.00 Ea.	$30,130.98	$35,122.51	2.0000	2	2	$70,245.03	$70,245.03
Maintenance and repair TV cable outlet	10	44.00 Ea.	$2,450.52	$3,063.05	4.0000	4	4	$12,252.21	$12,252.21
Repair smoke detector	10	55.00 Ea.	$3,342.08	$4,136.29	4.0000	4	3	$16,545.14	$12,408.86
Check operation smoke detector	1	55.00 Ea.	$960.61	$1,205.08	40.0000	40	40	$48,203.22	$48,203.22
Replace smoke detector	15	55.00 Ea.	$18,558.18	$22,082.90	2.6667	2	2	$44,165.80	$44,165.80
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	4.0000	4	3	$2,805.76	$2,104.32
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	2.6667	2	2	$3,318.05	$3,318.05
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	8.0000	8	8	$1,563.40	$1,563.40
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	80.0000	80	80	$4,641.68	$4,641.68
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	2.6667	2	2	$5,682.79	$5,682.79
Minor repairs to annunciation panel	5	2.00 Ea.	$320.55	$390.85	8.0000	8	8	$3,126.80	$3,126.80
Maintenance and inspection annunciation panel	0.5	2.00 Ea.	$92.50	$116.04	80.0000	80	80	$9,283.36	$9,283.36
Replace annunciation panel	15	2.00 Ea.	$2,500.81	$3,004.99	2.6667	2	2	$6,009.97	$6,009.97
Replace fire alarm bell, 6"	20	8.00 Ea.	$1,603.48	$1,942.57	2.0000	2	2	$3,885.15	$3,885.15
Maintenance and repair of general wiring lightning protection system	1	1.00 M.L.F.	$111.32	$137.36	40.0000	40	40	$5,494.37	$5,494.37
Replace lightning protection general wiring system	25	1.00 M.L.F.	$13,424.28	$15,895.64	1.6000	1	1	$15,895.64	$15,895.64
Maintenance and repair lightning ground rod	1	1.00 Ea.	$95.46	$119.33	40.0000	40	39	$4,773.32	$4,653.98
Replace lightning ground rod	25	1.00 Ea.	$257.78	$318.56	1.6000	1	1	$318.56	$318.56
Maintenance and repair special ground system	4	1.00 Ea.	$23.25	$29.16	10.0000	10	10	$291.63	$291.63
Replace special ground system	50	1.00 M.L.F.	$2,658.64	$3,194.88	0.8000	0	0	$0.00	$0.00
Maintenance and repair voice/data outlet	10	14.00 Ea.	$779.71	$974.61	4.0000	4	4	$3,898.43	$3,898.43
Maintenance and inspection patch panel	0.5	2.00 Ea.	$185.00	$232.08	80.0000	80	80	$18,566.71	$18,566.71
			$1,981,169.99	$2,325,842.54				MR Subtotal:	$4,527,504.41
								MR Per Year:	$113,187.61
								PM Total:	$21,515.49
								Subtotal:	$134,703.10
								Total Per Unit:	$4.64

FAC 2111 Aircraft Maintenance Hangar

Release:	2024 Qtr 3	FY25 SUC:	$4.64
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	40
		Model Size:	29046

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Hanger doors, sliding, annualized	8	18.06	$423.36	$816.52	$0.0000	1,239.88	1,527.17	1,835.63
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Fire doors, swinging, annualized	4	1.57	$57.96	$64.30	$0.0000	122.26	147.34	175.32
Urinals, annualized	8	1.82	$54.71	$98.14	$0.0000	152.85	187.76	225.41
Toilet (vacuum breaker type), annualized	12	2.12	$110.21	$114.72	$0.0000	224.92	270.36	321.31
Lavatories, annualized	14	4.87	$108.06	$307.94	$0.0000	416.00	519.19	627.78
Showers, annualized	8	1.82	$112.16	$115.39	$0.0000	227.55	273.39	324.83
Drink fountain, annualized	3	1.86	$108.45	$100.25	$0.0000	208.70	249.62	295.96
Water heater, gas, to 120 gal., annualized	1	1.72	$88.42	$92.21	$0.0000	180.63	217.14	258.07
Boiler, hot water, oil, gas, or comb. fired, over 1000 MBH, annualized	1	19.70	$90.37	$1,269.00	$0.0000	1,359.37	1,749.11	2,143.37
Chiller, centrif., water cooled, up to 100 tons, annualized	1	26.77	$112.36	$1,713.15	$0.0000	1,825.50	2,350.69	2,881.48
Air handling unit, 3 thru 24 tons, annualized	1	2.06	$163.16	$110.83	$0.0000	273.98	323.55	381.27
Centrifugal, over 1 HP, annualized	2	2.39	$27.55	$128.59	$0.0000	156.14	197.48	240.19
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, deluge / preaction, annualized	2	23.17	$109.42	$1,463.58	$0.0000	1,573.00	2,023.02	2,478.51
Fire pump, electric motor driven, annualized	1	47.75	$61.55	$3,003.30	$0.0000	3,064.85	3,972.00	4,882.22
Extinguishing system, dry pipe, annualized	1	13.02	$114.31	$820.62	$0.0000	934.93	1,192.55	1,455.88
Switchboard, with air circuit breaker, annualized	1	13.32	$19.11	$951.18	$0.0000	970.29	1,257.56	1,545.78
Switch, interrupt, high voltage, fused air, annualized	4	1.46	$66.07	$103.58	$0.0000	169.65	207.33	248.32
Motor control center, over 400 A, annualized	1	0.39	$25.95	$27.89	$0.0000	53.84	64.80	77.06
Security, intrusion alarm system, annualized	1	3.83	$178.64	$242.03	$0.0000	420.67	511.14	610.55
Emergency diesel or gas generator, up to 15 KVA, annually	1	1.49	$119.76	$94.12	$0.0000	213.88	254.09	300.30
						$13,934.82	$17,669.43	$21,515.49

FAC 2112 Aircraft Maintenance Shop

FY25 SUC:	$4.52 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2113 Aircraft Corrosion Control Hangar

FY25 SUC:	$3.75 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2114 Aircraft Engine Test Building

FY25 SUC:	$7.81 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2115 Aircraft Maintenance Hangar, Depot

FY25 SUC:	$2.33 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2116 Aircraft Maintenance Shop, Depot

FY25 SUC:	$3.63 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 2116 Aircraft Maintenance Shop, Depot

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $3.63
UM: SF
Expected Service Life: 40
Model Size: 21826

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Refinish fire escape balcony, 2' wide	7	128.00 L.F.	$3,065.74	$3,703.62	5.7143	5	5	$18,518.09	$18,518.09
Replace fire escape balcony, 2' wide	25	128.00 L.F.	$32,248.00	$38,972.76	1.6000	1	1	$38,972.76	$38,972.76
Refinish fire escape stair and platform	7	3.00 Flight	$1,724.19	$2,083.02	5.7143	5	5	$10,415.08	$10,415.08
Repair clay brick wall, 1st floor	25	492.00 S.F.	$23,434.30	$28,751.27	1.6000	1	1	$28,751.27	$28,751.27
Replace aluminum siding, 1st floor	35	14.30 C.S.F.	$9,103.44	$10,965.71	1.1429	1	1	$10,965.71	$10,965.71
Replace aluminum siding, 2nd floor	35	14.30 C.S.F.	$11,142.65	$13,502.30	1.1429	1	1	$13,502.30	$13,502.30
Replace aluminum siding, 3rd floor	35	14.30 C.S.F.	$12,374.85	$15,035.03	1.1429	1	1	$15,035.03	$15,035.03
Replace glass - 1st floor (1% of glass) - steel frame window	1	4.92 S.F.	$67.16	$78.86	40.0000	40	40	$3,154.54	$3,154.54
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	4.80 S.F.	$65.53	$76.94	40.0000	40	40	$3,077.60	$3,077.60
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	20.00 Ea.	$3,229.96	$3,849.12	2.0000	2	2	$7,698.24	$7,698.24
Repair 2'-0" x 3'-0" aluminum window - 2nd floor	20	12.00 Ea.	$2,551.56	$3,072.71	2.0000	2	2	$6,145.43	$6,145.43
Replace 2'-0" x 3'-0" aluminum window - 2nd floor	50	12.00 Ea.	$10,474.75	$12,284.60	0.8000	0	0	$0.00	$0.00
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	2.8571	2	2	$5,524.61	$5,524.61
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	10.0000	10	10	$1,762.58	$1,762.58
Replace tempered glass - (3% of glass) steel painted door	1	1.89 S.F.	$62.27	$73.51	40.0000	40	40	$2,940.37	$2,940.37
Remove and replace electric bi-folding hangar door motor	15	2.00 Ea.	$1,642.21	$1,907.69	2.6667	2	2	$3,815.39	$3,815.39
Remove and replace electric bi-folding hangar door cables	15	2.00 Ea.	$1,370.71	$1,662.00	2.6667	2	2	$3,324.00	$3,324.00
Remove and replace electric bi-folding hangar door	20	2.00 Ea.	$123,379.11	$142,865.91	2.0000	2	2	$285,731.81	$285,731.81
Non - destructive moisture inspection, thermosetting	5	0.02 M.S.F.	$2.53	$3.09	8.0000	8	8	$24.70	$24.70
Minor membrane repairs, 2% of roof area, thermoset	1	4.20 Sq.	$1,572.16	$1,872.47	40.0000	40	40	$74,898.73	$74,898.73
Flashing repairs, 2 S.F. per sq. repaired, thermoset	1	64.00 S.F.	$170.23	$207.09	40.0000	40	40	$8,283.43	$8,283.43
Minor replacement, 25% of roof area, thermoset	10	28.00 Sq.	$14,151.38	$16,642.10	4.0000	4	4	$66,568.41	$66,568.41
Total thermoset roof replacement	20	21.00 Sq.	$20,967.17	$24,627.48	2.0000	2	2	$49,254.97	$49,254.97
Replace Roof edges, aluminum, duranodic, .050" thick, 6" face	25	380.00 L.F.	$11,655.61	$13,765.99	1.6000	1	1	$13,765.99	$13,765.99
Replace aluminum gutter, enameled, 5" K type, .027 " thick	40	120.00 L.F.	$1,298.17	$1,564.61	1.0000	1	1	$1,564.61	$1,564.61
Replace roof hatch and structure single unit	40	2.00 Ea.	$3,797.91	$4,368.33	1.0000	1	1	$4,368.33	$4,368.33
Replace galvanized roof hatch and structure single unit	40	2.00 Ea.	$5,283.79	$6,056.83	1.0000	1	1	$6,056.83	$6,056.83
Repair steel painted interior door	14	7.00 Ea.	$2,077.95	$2,424.25	2.8571	2	2	$4,848.50	$4,848.50
Refinish 3'-0" x 7'-0" steel painted interior door	4	7.00 Ea.	$421.42	$518.17	10.0000	10	10	$5,181.71	$5,181.71
Safety glass replacement, (3% of glass) steel painted interior door	1	4.41 S.F.	$113.24	$133.58	40.0000	40	40	$5,343.31	$5,343.31
Repair solid core wood door, interior	11	6.00 Ea.	$1,781.10	$2,077.93	3.6364	3	3	$6,233.79	$6,233.79
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	6.00 Ea.	$328.09	$399.13	10.0000	10	9	$3,991.32	$3,592.19
Replace 3'-0" x 7'-0" solid core wood door, interior	40	6.00 Ea.	$3,862.66	$4,453.80	1.0000	1	1	$4,453.80	$4,453.80
Prepare and refinish interior metal gate	5	16.00 Ea.	$383.86	$470.46	8.0000	8	8	$3,763.68	$3,763.68
Repair medium weight vinyl wall covering - (2% of walls)	1	0.03 C.S.F.	$15.88	$18.53	40.0000	40	40	$741.08	$741.08
Replace medium weight vinyl wall covering	15	1.60 C.S.F.	$965.22	$1,135.56	2.6667	2	2	$2,271.13	$2,271.13
Repair 5/8" drywall - (2% of walls)	20	497.00 S.F.	$928.40	$1,129.25	2.0000	2	2	$2,258.51	$2,258.51
Refinish drywall	4	497.00 S.F.	$358.86	$440.05	10.0000	10	10	$4,400.46	$4,400.46
Refinish concrete floor finished	25	68.00 C.S.F.	$31,178.86	$37,459.42	1.6000	1	1	$37,459.42	$37,459.42
Replace vinyl tile flooring	18	30.55 S.Y.	$1,727.86	$2,114.95	2.2222	2	2	$4,229.90	$4,229.90
Replace vinyl sheet flooring	18	32.11 S.Y.	$2,561.52	$3,106.21	2.2222	2	2	$6,212.42	$6,212.42
Replace carpet	8	32.60 S.Y.	$1,815.77	$2,099.79	5.0000	5	5	$10,498.96	$10,498.96
Repair gypsum board ceiling - (2% of ceilings)	20	0.31 C.S.F.	$125.05	$153.33	2.0000	2	2	$306.66	$306.66
Refinish gypsum board ceiling, up to 12' high	20	15.32 C.S.F.	$2,330.74	$2,865.51	2.0000	2	1	$5,731.02	$2,865.51
Replace gypsum board ceiling, up to 12' high	40	15.32 C.S.F.	$6,417.07	$7,871.08	1.0000	1	1	$7,871.08	$7,871.08
Replace acoustic tile ceiling, fire-rated	20	9.03 C.S.F.	$5,640.98	$6,633.76	2.0000	2	2	$13,267.52	$13,267.52
Replace flush valve diaphragm tankless water closet	10	7.00 Ea.	$193.13	$239.93	4.0000	4	4	$959.73	$959.73
Rebuild flush valve tankless water closet	20	7.00 Ea.	$1,352.90	$1,630.68	2.0000	2	2	$3,261.36	$3,261.36
Unplug clogged line tankless water closet	5	7.00 Ea.	$1,608.47	$2,014.52	8.0000	8	8	$16,116.12	$16,116.12
Replace tankless water closet	35	7.00 Ea.	$9,636.60	$11,152.37	1.1429	1	1	$11,152.37	$11,152.37
Replace tankless flush valve	25	7.00 Ea.	$1,908.59	$2,240.20	1.6000	1	1	$2,240.20	$2,240.20
Replace wax ring gasket for tankless water closet	5	7.00 Ea.	$1,048.28	$1,311.67	8.0000	8	8	$10,493.39	$10,493.39
Replace flush valve diaphragm for a urinal	7	4.00 Ea.	$110.36	$137.10	5.7143	5	5	$685.52	$685.52
Rebuild flush valve for a urinal	20	4.00 Ea.	$773.08	$931.82	2.0000	2	2	$1,863.63	$1,863.63
Unplug line urinal	5	4.00 Ea.	$611.61	$766.01	8.0000	8	8	$6,128.09	$6,128.09
Replace wall-hung urinal	35	4.00 Ea.	$4,369.16	$5,257.55	1.1429	1	1	$5,257.55	$5,257.55
Replace washer in spud connection lavatory, vitreous china	7	10.00 Ea.	$173.93	$212.34	5.7143	5	5	$1,061.68	$1,061.68
Replace washer in faucet lavatory, vitreous china	2	10.00 Ea.	$135.98	$169.63	20.0000	20	20	$3,392.57	$3,392.57
Replace faucets lavatory, vitreous china	10	10.00 Ea.	$1,986.23	$2,387.83	4.0000	4	4	$9,551.34	$9,551.34
Clean out strainer and P trap lavatory, vitreous china	2	10.00 Ea.	$370.88	$464.51	20.0000	20	20	$9,290.20	$9,290.20
Replace lavatory, vitreous china	35	10.00 Ea.	$7,513.76	$9,008.85	1.1429	1	1	$9,008.85	$9,008.85
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	20.0000	20	20	$336.92	$336.92
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	13.3333	13	13	$146.82	$146.82
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	4.0000	4	4	$955.13	$955.13
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	20.0000	20	20	$1,105.98	$1,105.98
Replace sink, P.E.C.I. sink, iron enamel kitchen	35	1.00 Ea.	$910.17	$1,070.70	1.1429	1	1	$1,070.70	$1,070.70
Inspect / clean shower head fiberglass	3	4.00 Ea.	$208.23	$260.80	13.3333	13	13	$3,390.43	$3,390.43
Replace mixing valve barrel shower, fiberglass	2	4.00 Ea.	$1,204.17	$1,416.33	20.0000	20	20	$28,326.65	$28,326.65
Replace shower and fittings, fiberglass	20	4.00 Ea.	$4,754.07	$5,649.81	2.0000	2	2	$11,299.61	$11,299.61
Check / minor repairs drinking fountain	1	3.00 Ea.	$155.83	$195.17	40.0000	40	40	$7,806.89	$7,806.89
Repair internal leaks drinking fountain	4	3.00 Ea.	$143.37	$179.56	10.0000	10	10	$1,795.58	$1,795.58
Correct water pressure drinking fountain	2	3.00 Ea.	$132.46	$165.90	20.0000	20	20	$3,317.93	$3,317.93
Replace refrigerant drinking fountain	2	3.00 Ea.	$110.31	$128.99	20.0000	20	20	$2,579.83	$2,579.83
Repair drain leak drinking fountain	4	3.00 Ea.	$91.53	$110.43	10.0000	10	8	$1,104.25	$883.40
Replace fountain drinking fountain	10	3.00 Ea.	$4,570.18	$5,383.32	4.0000	4	4	$21,533.28	$21,533.28
Inspect and clean shower head emergency shower station	3	2.00 Ea.	$104.12	$130.40	13.3333	13	13	$1,695.21	$1,695.21
Replace shower emergency shower station	25	2.00 Ea.	$2,111.80	$2,526.39	1.6000	1	1	$2,526.39	$2,526.39
Inspect and clean spray heads, emergency eye wash	3	2.00 Ea.	$104.12	$130.40	13.3333	13	13	$1,695.21	$1,695.21
Replace eye wash station, emergency eye wash	25	2.00 Ea.	$1,580.90	$1,923.10	1.6000	1	1	$1,923.10	$1,923.10
Resolder joint pipe & fittings, copper	10	2.00 Ea.	$101.81	$125.57	4.0000	4	4	$502.29	$502.29
Replace pipe and fittings, copper 3/4"	20	16.00 L.F.	$385.58	$468.64	2.0000	2	2	$937.28	$937.28
Replace pipe and fittings, copper 2"	25	16.00 L.F.	$904.99	$1,084.54	1.6000	1	1	$1,084.54	$1,084.54
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	16.00 L.F.	$165.02	$201.61	2.6667	2	2	$403.21	$403.21
Remove old insulation & replace with new, pipe 1-1/2", wall 1"	15	16.00 L.F.	$184.99	$225.37	2.6667	2	2	$450.73	$450.73
Drain and flush water heater, electric, 120 gallon	7	1.00 Ea.	$310.63	$389.04	5.7143	5	5	$1,945.22	$1,945.22
Check operation water heater, electric, 120 gallon	3	1.00 Ea.	$2.72	$3.41	13.3333	13	13	$44.32	$44.32
Replace water heater, electric, 120 gallon	15	1.00 Ea.	$15,946.05	$18,237.49	2.6667	2	2	$36,474.98	$36,474.98
Unclog floor drain, PVC	20	4.00 Ea.	$201.54	$252.42	2.0000	2	2	$504.85	$504.85
Repair joint pipe and fittings, PVC	10	8.00 Ea.	$1,257.64	$1,567.29	4.0000	4	4	$6,269.16	$6,269.16
Replace pipe, 4" pipe and fittings, PVC	30	16.00 L.F.	$1,499.18	$1,834.72	1.3333	1	1	$1,834.72	$1,834.72
General maintenance & repair drain: roof, scupper, area	1	12.00 Ea.	$470.62	$589.42	40.0000	40	40	$23,576.80	$23,576.80
Replace drain: roof, scupper, area	40	12.00 Ea.	$13,156.28	$15,182.59	1.0000	1	1	$15,182.59	$15,182.59
Maintenance and repair standard suspended heater	2	4.00 Ea.	$475.76	$561.54	20.0000	20	20	$11,230.80	$11,230.80
Maintenance and inspection standard suspended heater	0.5	4.00 Ea.	$339.09	$425.39	80.0000	80	80	$34,031.13	$34,031.13
Replace heater standard suspended heater	15	4.00 Ea.	$3,667.05	$4,237.21	2.6667	2	2	$8,474.41	$8,474.41
Repair single zone rooftop unit, 25 ton	10	2.00 Ea.	$110,145.67	$126,807.84	4.0000	4	3	$507,231.36	$380,423.52
Replace single zone rooftop unit, 25 ton	15	2.00 Ea.	$103,991.80	$120,837.62	2.6667	2	2	$241,675.24	$241,675.24
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	4.0000	4	4	$4,698.57	$4,698.57
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	40.0000	40	40	$1,816.40	$1,816.40
Replace sprinkler head	20	50.00 Ea.	$4,584.53	$5,649.86	2.0000	2	2	$11,299.72	$11,299.72
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	40.0000	40	40	$36,122.11	$36,122.11
Replace fire pump / electric motor assembly 100 H.P.	25	1.00 Ea.	$46,050.08	$53,152.38	1.6000	1	1	$53,152.38	$53,152.38
Repair switchgear 1200 A mainframe	5	1.00 Ea.	$2,068.68	$2,420.08	8.0000	8	6	$19,360.60	$14,520.45
Maintenance and inspection switchgear, mainframe	1	1.00 Ea.	$69.98	$87.79	40.0000	40	40	$3,511.80	$3,511.80
Replace switchgear 1200 A mainframe	20	1.00 Ea.	$4,508.06	$5,431.65	2.0000	2	2	$10,863.30	$10,863.30
Repair switchboard meter	10	4.00 Ea.	$5,287.56	$6,215.64	4.0000	4	4	$24,862.56	$24,862.56
Maintenance and repair inverter	1	2.00 Ea.	$1,765.54	$2,109.82	40.0000	40	40	$84,392.80	$84,392.80
Maintenance and inspection inverter	0.25	2.00 Ea.	$279.94	$351.18	160.0000	160	160	$56,188.74	$56,188.74
Maintenance and repair rectifier, up to 600 V	2	2.00 Ea.	$1,489.04	$1,774.62	20.0000	20	20	$35,492.44	$35,492.44
Maintenance and repair motor starter, 600 V	3	2.00 Ea.	$1,489.46	$1,831.18	13.3333	13	13	$23,805.35	$23,805.35
Maintenance and inspection lighting panel, indoor	3	3.00 Ea.	$131.45	$164.90	13.3333	13	13	$2,143.72	$2,143.72
Maintenance and repair breaker, molded case, 480 V, 2 pole	20	12.00 Ea.	$927.44	$1,163.47	2.0000	2	2	$2,326.95	$2,326.95
Replace safety switch, heavy duty 30 A	25	12.00 Ea.	$9,210.84	$10,932.49	1.6000	1	1	$10,932.49	$10,932.49
Maintenance and repair safety switch general, 2 pole	8	2.00 Ea.	$87.63	$109.93	5.0000	5	5	$549.67	$549.67
Maintenance and inspection safety switch, 2 pole	1	2.00 Ea.	$87.63	$109.93	40.0000	40	40	$4,397.38	$4,397.38
Maintenance and repair receptacles and plugs	20	52.00 Ea.	$2,379.48	$2,973.12	2.0000	2	2	$5,946.23	$5,946.23
Replace 4-pin receptacle	20	24.00 Ea.	$3,838.57	$4,563.37	2.0000	2	2	$9,126.73	$9,126.73
Maintenance and repair wiring devices, switches	10	28.00 Ea.	$1,281.26	$1,600.91	4.0000	4	4	$6,403.64	$6,403.64
Maintenance and repair incandescent lighting fixtures	10	14.00 Ea.	$1,040.64	$1,239.21	4.0000	4	4	$4,956.84	$4,956.84
Replace incandescent lighting fixture lamp	5	14.00 Ea.	$190.86	$229.44	8.0000	8	8	$1,835.56	$1,835.56
Replace fluorescent light fixture ballast, 80 W	10	32.00 Ea.	$3,485.82	$4,298.47	4.0000	4	4	$17,193.90	$17,193.90
Replace lamps (2 lamps), 4', 34 W energy saver	10	32.00 Ea.	$868.85	$1,089.48	4.0000	4	4	$4,357.91	$4,357.91
Replace metal halide ballast, 175 W	10	24.00 Ea.	$4,117.48	$4,931.93	4.0000	4	4	$19,727.73	$19,727.73
Replace metal halide fixture lamp, 175 W	5	24.00 Ea.	$1,460.14	$1,774.16	8.0000	8	8	$14,193.30	$14,193.30
Repair smoke detector	10	29.00 Ea.	$1,762.19	$2,180.95	4.0000	4	3	$8,723.80	$6,542.85
Check operation smoke detector	1	29.00 Ea.	$506.50	$635.41	40.0000	40	40	$25,416.24	$25,416.24
Replace smoke detector	15	29.00 Ea.	$9,785.22	$11,643.71	2.6667	2	2	$23,287.42	$23,287.42
Check and repair manual pull station	10	8.00 Ea.	$759.91	$935.25	4.0000	4	3	$3,741.02	$2,805.76

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Replace manual pull station	15	8.00 Ea.	$1,840.61	$2,212.03	2.6667	2	2	$4,424.07	$4,424.07
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	8.0000	8	8	$1,563.40	$1,563.40
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	80.0000	80	80	$4,641.68	$4,641.68
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	2.6667	2	2	$5,682.79	$5,682.79
Minor repairs to annunciation panel	5	2.00 Ea.	$320.55	$390.85	8.0000	8	8	$3,126.80	$3,126.80
Maintenance and inspection annunciation panel	0.5	2.00 Ea.	$92.50	$116.04	80.0000	80	80	$9,283.36	$9,283.36
Replace fire alarm bell, 6"	20	4.00 Ea.	$801.74	$971.29	2.0000	2	2	$1,942.57	$1,942.57
Maintenance and repair special ground system	4	1.00 Ea.	$23.25	$29.16	10.0000	10	10	$291.63	$291.63
Maintenance and repair voice/data outlet	10	12.00 Ea.	$668.32	$835.38	4.0000	4	4	$3,341.51	$3,341.51
Replace voice/data outlet	20	12.00 Ea.	$339.80	$413.83	2.0000	2	2	$827.67	$827.67
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	80.0000	80	80	$9,283.36	$9,283.36
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	2.6667	2	2	$2,276.61	$2,276.61
Remove and replace 50 HP pump motor	25	1.00 Ea.	$10,424.40	$11,906.01	1.6000	1	1	$11,906.01	$11,906.01
			$791,200.17	$929,933.82				MR Subtotal:	$2,339,280.29
								MR Per Year:	$58,482.01
								PM Total:	$20,724.01
								Subtotal:	$79,206.02
								Total Per Unit:	$3.63

FAC 2116 Aircraft Maintenance Shop, Depot

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $3.63
UM: SF
Expected Service Life: 40
Model Size: 21826

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Hanger doors, sliding, annualized	2	4.51	$105.84	$204.13	$0.0000	309.97	381.79	458.91
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Fire doors, swinging, annualized	4	1.57	$57.96	$64.30	$0.0000	122.26	147.34	175.32
Urinals, annualized	3	0.68	$20.52	$36.80	$0.0000	57.32	70.41	84.53
Toilet (vacuum breaker type), annualized	7	1.24	$64.29	$66.92	$0.0000	131.21	157.71	187.43
Lavatories, annualized	10	3.48	$77.18	$219.96	$0.0000	297.14	370.85	448.41
Showers, annualized	4	0.91	$56.08	$57.70	$0.0000	113.78	136.69	162.42
Drink fountain, annualized	3	1.86	$108.45	$100.25	$0.0000	208.70	249.62	295.96
Fan, axial, up to 5,000 CFM, annualized	4	4.98	$55.10	$267.34	$0.0000	322.44	408.15	496.62
Package unit, air cooled, 3 thru 24 ton, annualized	2	4.79	$330.23	$307.94	$0.0000	638.17	763.58	905.49
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Fire pump, electric motor driven, annualized	1	47.75	$61.55	$3,003.30	$0.0000	3,064.85	3,972.00	4,882.22
Extinguishing system, dry pipe, annualized	1	13.02	$114.31	$820.62	$0.0000	934.93	1,192.55	1,455.88
Extinguishing system, foam pump electric, annualized	2	35.44	$713.21	$1,903.50	$0.0000	2,616.71	3,259.08	3,937.11
Switchboard, annualized	4	2.80	$19.00	$201.19	$0.0000	220.19	282.45	345.66
Circuit breaker, high voltage air, annualized	2	0.94	$33.03	$66.73	$0.0000	99.77	123.09	148.06
Switch, selector, high voltage, air, annualized	4	1.63	$66.07	$117.53	$0.0000	183.60	225.46	270.63
Transformer, dry type 500 KVA and over, annualized	2	1.54	$33.03	$109.56	$0.0000	142.59	178.77	216.59
Panelboard, 225 A and above, annualized	4	1.76	$103.79	$125.50	$0.0000	229.29	277.32	330.53
Fire alarm annuciator system, annualized	2	22.10	$391.22	$1,394.40	$0.0000	1,785.62	2,243.06	2,720.06
Security, intrusion alarm system, annualized	1	3.83	$178.64	$242.03	$0.0000	420.67	511.14	610.55
Light, emergency, hardwired system, annually	14	1.75	$97.11	$110.85	$0.0000	207.96	250.93	298.75
Crane, electric bridge, up to 5 ton, annualized	1	2.92	$247.45	$113.21	$0.0000	360.66	419.37	490.45
Crane, electric bridge, 5 to 15 ton, annualized	1	7.67	$606.00	$299.50	$0.0000	905.50	1,055.95	1,236.70
Pump, air lift, well, annualized	2	3.63	$36.17	$196.42	$0.0000	232.59	295.13	359.48
						$13,751.85	$17,146.58	$20,724.01

FAC 2118 Aircraft Engine Test Facility

FY25 SUC:	$25,271.23 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2121 Missile Maintenance/Assembly Building

FY25 SUC:	$3.73 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2123 Missile/Launcher Maintenance Support Facility

FY25 SUC:	$6.17 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2124 Missile Test Tower

FY25 SUC:	$7,028.18 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2125 Missile Maintenance/Assembly Building, Depot

FY25 SUC:	$4.95 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2125 Missile Maintenance/Assembly Building, Depot

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.95
UM: SF
Expected Service Life: 31
Model Size: 24606

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	1,450.00 S.F.	$58,992.34	$71,847.99	2.0667	2	2	$143,695.99	$143,695.99
Repair concrete stairs	30	64.00 S.F.	$2,040.15	$2,361.22	1.0333	1	1	$2,361.22	$2,361.22
Refinish metal hand rail	7	46.00 L.F.	$96.42	$118.99	4.4286	4	4	$475.95	$475.95
Waterproof concrete block wall, 1st floor	10	65.00 C.S.F.	$12,612.79	$15,198.68	3.1000	3	3	$45,596.05	$45,596.05
Waterproof concrete block wall, 2nd floor	10	65.00 C.S.F.	$52,409.77	$62,607.35	3.1000	3	3	$187,822.05	$187,822.05
Point and refinish painted concrete block wall, 1st floor	25	65.00 C.S.F.	$35,634.60	$43,794.98	1.2400	1	1	$43,794.98	$43,794.98
Point and refinish painted concrete block wall, 2nd floor	25	65.00 C.S.F.	$41,292.77	$50,819.22	1.2400	1	1	$50,819.22	$50,819.22
Replace glass - 2nd floor (1% of glass) - steel frame window	1	6.60 S.F.	$765.05	$945.36	31.0000	31	31	$29,306.17	$29,306.17
Repair 3'-9" x 5'-5" steel frame window - 2nd floor.	20	33.00 Ea.	$13,008.87	$15,378.46	1.5500	1	1	$15,378.46	$15,378.46
Refinish 3'-9" x 5'-5" steel frame window - 2nd floor.	5	33.00 Ea.	$5,432.80	$6,736.85	6.2000	6	6	$40,421.11	$40,421.11
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	14.00 S.F.	$191.12	$224.41	31.0000	31	31	$6,956.66	$6,956.66
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	22.00 Ea.	$3,552.96	$4,234.03	1.5500	1	1	$4,234.03	$4,234.03
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	22.00 Ea.	$18,078.80	$21,122.49	0.6200	0	0	$0.00	$0.00
Repair steel, painted, door	14	8.00 Ea.	$6,220.47	$7,366.14	2.2143	2	2	$14,732.29	$14,732.29
Refinish 3'-0" x 7'-0" steel, painted, door	4	8.00 Ea.	$383.94	$470.02	7.7500	7	7	$3,290.14	$3,290.14
Refinish 12' x 24' steel double roll-up door	5	4.00 Ea.	$2,051.41	$2,488.90	6.2000	6	6	$14,933.42	$14,933.42
Replace 12' x 24' steel double roll-up door	35	4.00 Ea.	$28,869.39	$34,019.91	0.8857	0	0	$0.00	$0.00
Debris removal, by hand and visual inspection, metal panel roofing	1	24.60 M.S.F.	$604.56	$738.33	31.0000	31	31	$22,888.17	$22,888.17
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	492.00 S.F.	$2,385.34	$2,830.76	6.2000	6	6	$16,984.56	$16,984.56
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	5.10 S.F.	$144.12	$171.50	31.0000	31	31	$5,316.64	$5,316.64
Minor metal roof panel replacement, 2.5% of roof area	20	615.00 S.F.	$8,505.91	$10,061.44	1.5500	1	1	$10,061.44	$10,061.44
Total metal roof panel replacement	30	246.00 Sq.	$236,458.92	$279,619.13	1.0333	1	1	$279,619.13	$279,619.13
Repair 8" concrete block wall - (2% of walls) painted	25	3.50 C.S.F.	$4,255.79	$5,111.83	1.2400	1	1	$5,111.83	$5,111.83
Refinish concrete block wall painted	4	175.00 C.S.F.	$24,001.78	$28,855.21	7.7500	7	7	$201,986.48	$201,986.48
Replace 8" concrete block wall painted	75	175.00 C.S.F.	$225,937.12	$271,913.80	0.4133	0	0	$0.00	$0.00
Replace insulating glass (3% of glass) fully glazed wooden doors	1	0.06 S.F.	$3.66	$4.26	31.0000	31	31	$131.93	$131.93
Repair fully glazed wood door	10	2.00 Ea.	$593.70	$692.64	3.1000	3	3	$2,077.93	$2,077.93
Refinish 3'-0" x 7'-0" fully glazed wood door	4	2.00 Ea.	$161.48	$199.55	7.7500	7	7	$1,396.82	$1,396.82
Replace 3'-0" x 7'-0" fully glazed wood door	40	2.00 Ea.	$11,195.38	$12,788.22	0.7750	0	0	$0.00	$0.00
Repair steel painted interior door	14	11.00 Ea.	$3,265.35	$3,809.54	2.2143	2	2	$7,619.08	$7,619.08
Refinish 3'-0" x 7'-0" steel painted interior door	4	11.00 Ea.	$662.24	$814.27	7.7500	7	7	$5,699.88	$5,699.88
Repair solid core wood door, interior	11	5.00 Ea.	$1,484.25	$1,731.61	2.8182	2	2	$3,463.22	$3,463.22
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	5.00 Ea.	$273.41	$332.61	7.7500	7	7	$2,328.27	$2,328.27
Replace 3'-0" x 7'-0" solid core wood door, interior	40	5.00 Ea.	$3,218.89	$3,711.50	0.7750	0	0	$0.00	$0.00
Repair 5/8" drywall - (2% of walls)	20	790.00 S.F.	$1,475.72	$1,794.99	1.5500	1	1	$1,794.99	$1,794.99
Replace 5/8" drywall	75	398.00 SF.	$1,026.45	$1,256.31	0.4133	0	0	$0.00	$0.00
Refinish concrete floor finished	25	220.00 C.S.F.	$100,872.77	$121,192.25	1.2400	1	1	$121,192.25	$121,192.25
Replace vinyl tile flooring	18	11.50 S.Y.	$650.42	$796.13	1.7222	1	1	$796.13	$796.13
Acoustic tile repairs - (2% of ceilings)	9	5.28 C.S.F.	$6,075.76	$7,041.86	3.4444	3	3	$21,125.58	$21,125.58
Replace acoustic tile ceiling, fire-rated	20	264.00 C.S.F.	$164,918.88	$193,943.82	1.5500	1	1	$193,943.82	$193,943.82
Replace flush valve diaphragm tankless water closet	10	8.00 Ea.	$220.72	$274.21	3.1000	3	3	$822.63	$822.63
Rebuild flush valve tankless water closet	20	8.00 Ea.	$1,546.17	$1,863.63	1.5500	1	1	$1,863.63	$1,863.63
Replace tankless water closet	35	8.00 Ea.	$11,013.25	$12,745.57	0.8857	0	0	$0.00	$0.00
Replace tankless flush valve	25	8.00 Ea.	$2,181.24	$2,560.22	1.2400	1	1	$2,560.22	$2,560.22
Replace wax ring gasket for tankless water closet	5	8.00 Ea.	$1,198.04	$1,499.06	6.2000	6	6	$8,994.33	$8,994.33
Replace flush valve diaphragm for a urinal	7	6.00 Ea.	$165.54	$205.66	4.4286	4	4	$822.63	$822.63
Rebuild flush valve for a urinal	20	6.00 Ea.	$1,159.63	$1,397.72	1.5500	1	1	$1,397.72	$1,397.72
Replace wall-hung urinal	35	6.00 Ea.	$6,553.74	$7,886.33	0.8857	0	0	$0.00	$0.00
Replace washer in spud connection lavatory, vitreous china	7	8.00 Ea.	$139.14	$169.87	4.4286	4	4	$679.48	$679.48
Replace washer in faucet lavatory, vitreous china	2	8.00 Ea.	$108.78	$135.70	15.5000	15	15	$2,035.54	$2,035.54
Replace faucets lavatory, vitreous china	10	8.00 Ea.	$1,588.98	$1,910.27	3.1000	3	3	$5,730.80	$5,730.80
Replace lavatory, vitreous china	35	8.00 Ea.	$6,011.00	$7,207.08	0.8857	0	0	$0.00	$0.00
Replace faucet washer sink, iron enamel	2	2.00 Ea.	$27.01	$33.69	15.5000	15	15	$505.37	$505.37
Clean trap sink, iron enamel	3	2.00 Ea.	$18.04	$22.59	10.3333	10	10	$225.88	$225.88
Replace faucets sink, iron enamel	10	2.00 Ea.	$397.25	$477.57	3.1000	3	3	$1,432.70	$1,432.70
Unstop sink, iron enamel	2	2.00 Ea.	$88.31	$110.60	15.5000	15	15	$1,658.96	$1,658.96
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	2.00 Ea.	$1,820.34	$2,141.40	3.1000	3	3	$6,424.21	$6,424.21
Inspect / clean shower head fiberglass	3	2.00 Ea.	$104.12	$130.40	10.3333	10	10	$1,304.01	$1,304.01
Replace mixing valve shower, fiberglass	10	2.00 Ea.	$587.65	$715.04	3.1000	3	3	$2,145.11	$2,145.11
Replace shower and fittings, fiberglass	20	2.00 Ea.	$2,377.03	$2,824.90	1.5500	1	1	$2,824.90	$2,824.90
Inspect and clean spray heads, emergency eye wash	3	4.00 Ea.	$208.23	$260.80	10.3333	10	10	$2,608.02	$2,608.02
Replace eye wash station, emergency eye wash	25	4.00 Ea.	$3,161.79	$3,846.19	1.2400	1	1	$3,846.19	$3,846.19
Replace pipe and fittings, copper 3/4"	20	132.00 L.F.	$3,181.01	$3,866.29	1.5500	1	1	$3,866.29	$3,866.29
Replace pipe and fittings, copper 2"	25	48.00 L.F.	$2,714.97	$3,253.63	1.2400	1	1	$3,253.63	$3,253.63
Minor repairs, adjustments water heater, gas / oil, 1150 GPH	2	1.00 Ea.	$103.37	$129.46	15.5000	15	14	$1,941.96	$1,812.50
Clean & service water heater, gas / oil, 1150 GPH	2	1.00 Ea.	$618.14	$774.18	15.5000	15	15	$11,612.75	$11,612.75
Replace water heater, gas / oil, 1150 GPH	20	1.00 Ea.	$39,199.74	$45,178.28	1.5500	1	1	$45,178.28	$45,178.28
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	1.5500	1	1	$63.11	$63.11
Repair joint pipe and fittings, PVC	10	2.00 Ea.	$314.41	$391.82	3.1000	3	3	$1,175.47	$1,175.47
Replace pipe, 4" pipe and fittings, PVC	30	300.00 L.F.	$28,109.55	$34,400.96	1.0333	1	1	$34,400.96	$34,400.96
General maintenance & repair drain: roof, scupper, area	1	12.00 Ea.	$470.62	$589.42	31.0000	31	31	$18,272.02	$18,272.02
Replace drain: roof, scupper, area	40	12.00 Ea.	$13,156.28	$15,182.59	0.7750	0	0	$0.00	$0.00
Insp/chk pump/mtr oper, lub, chk align, rainwater sump pump	1	1.00 Ea.	$12.60	$15.78	31.0000	31	31	$489.27	$489.27
Replace rainwater sump pump / motor assembly	20	1.00 Ea.	$632.57	$749.22	1.5500	1	1	$749.22	$749.22
Replace pipe and fittings, oxygen	25	16.00 L.F.	$383.91	$466.56	1.2400	1	1	$466.56	$466.56
Repair boiler, gas, 2000 MBH	7	1.00 Ea.	$5,513.06	$6,436.35	4.4286	4	3	$25,745.41	$19,309.05
Replace boiler, gas, 2000 MBH	30	1.00 Ea.	$47,742.79	$55,703.30	1.0333	1	1	$55,703.30	$55,703.30
Replace metal flue, all fuel SS, 10" diameter metal flue / chimney	15	1.00 L.F.	$275.91	$317.24	2.0667	2	2	$634.48	$634.48
Repair condenser, air cooled, 20 ton	10	2.00 Ea.	$2,564.43	$3,054.61	3.1000	3	3	$9,163.84	$9,163.84
Replace condenser, air cooled, 20 ton	15	2.00 Ea.	$45,909.08	$52,683.14	2.0667	2	2	$105,366.28	$105,366.28
Replace fan coil, DX 10 ton, with heat	10	6.00 Ea.	$34,378.48	$40,358.74	3.1000	3	3	$121,076.22	$121,076.22
Repair fan, induced draft, 2000 CFM	10	1.00 Ea.	$320.21	$391.19	3.1000	3	3	$1,173.57	$1,173.57
Replace fan, induced draft, 2000 CFM	20	1.00 Ea.	$5,295.32	$6,090.44	1.5500	1	1	$6,090.44	$6,090.44
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	4.00 Ea.	$17,377.45	$20,158.61	1.5500	1	1	$20,158.61	$20,158.61
Repair damaged pipe insulation, fiberglass 3/4"	5	4.00 Ea.	$91.82	$111.96	6.2000	6	6	$671.74	$671.74
Repair damaged pipe insulation, fiberglass 2"	5	2.00 Ea.	$54.99	$66.89	6.2000	6	6	$401.34	$401.34
Replace pipe insulation, fiberglass 3/4"	5	0.03 M.L.F.	$284.00	$344.73	6.2000	6	6	$2,068.39	$2,068.39
Replace pipe insulation, fiberglass 2"	5	0.01 M.L.F.	$114.07	$138.06	6.2000	6	6	$828.38	$828.38
Maintenance and repair explosionproof industrial heater	2	2.00 Ea.	$440.91	$515.28	15.5000	15	14	$7,729.24	$7,213.96
Maintenance and inspection explosionproof industrial heater	0.5	2.00 Ea.	$169.55	$212.69	62.0000	62	62	$13,187.06	$13,187.06
Replace heater explosionproof industrial heater	15	2.00 Ea.	$12,612.52	$14,413.14	2.0667	2	2	$28,826.28	$28,826.28
Repair terminal reheat, 36" x 36" coil	10	6.00 Ea.	$1,034.73	$1,295.94	3.1000	3	3	$3,887.83	$3,887.83
Replace terminal reheat, 36" x 36" coil	15	6.00 Ea.	$23,444.20	$27,210.58	2.0667	2	2	$54,421.17	$54,421.17
Repair central station A.H.U., 1300 CFM	10	2.00 Ea.	$1,202.74	$1,427.77	3.1000	3	2	$4,283.31	$2,855.54
Replace central station A.H.U., 1300 CFM	15	2.00 Ea.	$21,346.09	$24,682.61	2.0667	2	2	$49,365.23	$49,365.23
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	31.0000	31	31	$1,407.71	$1,407.71
Replace sprinkler head	20	264.00 Ea.	$24,206.33	$29,831.27	1.5500	1	1	$29,831.27	$29,831.27
Replace fuse	25	56.00 Ea.	$34,031.79	$38,988.93	1.2400	1	1	$38,988.93	$38,988.93
Repair switchboard meter	10	2.00 Ea.	$2,643.78	$3,107.82	3.1000	3	3	$9,323.46	$9,323.46
Maintenance and repair motor starter, up to 600 V	5	6.00 Ea.	$2,097.31	$2,513.58	6.2000	6	6	$15,081.46	$15,081.46
Maintenance and inspection motor starter, up to 600 V	0.5	6.00 Ea.	$350.53	$439.74	62.0000	62	62	$27,263.76	$27,263.76
Replace starter motor starter, up to 600 V	18	6.00 Ea.	$4,913.74	$5,864.71	1.7222	1	1	$5,864.71	$5,864.71
Replace transformer 500 KVA	30	1.00 Ea.	$31,076.78	$35,894.73	1.0333	1	1	$35,894.73	$35,894.73
Maintenance and inspection lighting panel, indoor	3	3.00 Ea.	$131.45	$164.90	10.3333	10	10	$1,649.02	$1,649.02
Maintenance and repair breaker, molded case, 480 V, 3 pole	20	8.00 Ea.	$618.29	$775.65	1.5500	1	1	$775.65	$775.65
Maintenance and inspection circuit breaker, molded case, 480 V, 3 pole	0.5	8.00 Ea.	$277.50	$348.13	62.0000	62	62	$21,583.81	$21,583.81
Maintenance and repair breaker, enclosed, 240 V, 3 pole	25	12.00 Ea.	$927.44	$1,163.47	1.2400	1	1	$1,163.47	$1,163.47
Maintenance and inspection circuit breaker, enclosed, 240 V, 3 pole	1	12.00 Ea.	$416.25	$522.19	31.0000	31	31	$16,187.85	$16,187.85
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	12.00 Ea.	$525.79	$659.61	3.8750	3	3	$1,978.82	$1,978.82
Maintenance and inspection safety switch, 3 pole, heavy duty	1	12.00 Ea.	$525.79	$659.61	31.0000	31	31	$20,447.82	$20,447.82
Replace safety switch, heavy duty 30 A	25	12.00 Ea.	$9,210.84	$10,932.49	1.2400	1	1	$10,932.49	$10,932.49
Replace safety switch, heavy duty 200 A	25	6.00 Ea.	$15,744.42	$18,420.76	1.2400	1	1	$18,420.76	$18,420.76
Maintenance and repair safety switch general, 3 pole	8	6.00 Ea.	$262.90	$329.80	3.8750	3	3	$989.41	$989.41
Maintenance and repair receptacles and plugs	20	84.00 Ea.	$3,843.77	$4,802.73	1.5500	1	1	$4,802.73	$4,802.73
Replace receptacle/plug receptacles and plugs	20	84.00 Ea.	$6,782.43	$8,342.97	1.5500	1	1	$8,342.97	$8,342.97
Maintenance and repair wiring devices, switches	10	28.00 Ea.	$1,281.26	$1,600.91	3.1000	3	3	$4,802.73	$4,802.73
Replace wiring devices, switches	15	28.00 Ea.	$1,946.97	$2,424.35	2.0667	2	2	$4,848.71	$4,848.71
Replace fluorescent light fixture ballast, 80 W	10	120.00 Ea.	$13,071.84	$16,119.28	3.1000	3	2	$48,357.83	$32,238.56
Replace lamps (2 lamps), 4', 34 W energy saver	10	120.00 Ea.	$3,258.19	$4,085.54	3.1000	3	3	$12,256.62	$12,256.62
Replace fluorescent fixture, lay-in, recess mtd, 2' x 4', two 40 W	20	120.00 Ea.	$32,472.14	$39,390.13	1.5500	1	1	$39,390.13	$39,390.13
Replace metal halide ballast, 175 W	10	44.00 Ea.	$7,548.71	$9,041.88	3.1000	3	2	$27,125.63	$18,083.75
Replace metal halide fixture lamp, 175 W	5	44.00 Ea.	$2,676.92	$3,252.63	6.2000	6	6	$19,515.79	$19,515.79
Replace metal halide fixture, 175 W	20	44.00 Ea.	$35,626.94	$41,926.43	1.5500	1	1	$41,926.43	$41,926.43
Repair smoke detector	10	26.00 Ea.	$1,579.89	$1,955.34	3.1000	3	2	$5,866.01	$3,910.67
Check operation smoke detector	1	26.00 Ea.	$454.10	$569.67	31.0000	31	31	$17,659.91	$17,659.91
Replace smoke detector	15	26.00 Ea.	$8,772.96	$10,439.19	2.0667	2	2	$20,878.38	$20,878.38
Check and repair manual pull station	10	4.00 Ea.	$379.95	$467.63	3.1000	3	2	$1,402.88	$935.25
Replace manual pull station	15	4.00 Ea.	$920.30	$1,106.02	2.0667	2	2	$2,212.03	$2,212.03
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	6.2000	6	6	$1,172.55	$1,172.55
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	62.0000	62	62	$3,597.30	$3,597.30
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	2.0667	2	2	$5,682.79	$5,682.79

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to annunciation panel	5	2.00 Ea.	$320.55	$390.85	6.2000	6	6	$2,345.10	$2,345.10
Maintenance and inspection annunciation panel	0.5	2.00 Ea.	$92.50	$116.04	62.0000	62	62	$7,194.60	$7,194.60
Replace fire alarm bell, 6"	20	4.00 Ea.	$801.74	$971.29	1.5500	1	1	$971.29	$971.29
Maintenance and repair electrical service ground	25	6.20 M.L.F.	$591.85	$739.86	1.2400	1	1	$739.86	$739.86
Replace electrical service ground	50	6.20 M.L.F.	$30,003.68	$36,495.83	0.6200	0	0	$0.00	$0.00
Replace building structure ground	50	1.00 M.L.F.	$5,828.43	$7,049.47	0.6200	0	0	$0.00	$0.00
Maintenance and repair of general wiring lightning protection system	1	3.60 M.L.F.	$400.76	$494.49	31.0000	31	31	$15,329.30	$15,329.30
Replace lightning protection general wiring system	25	0.60 M.L.F.	$8,054.57	$9,537.39	1.2400	1	1	$9,537.39	$9,537.39
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	31.0000	31	30	$14,797.28	$14,319.95
Replace lightning ground rod	25	1.00 Ea.	$257.78	$318.56	1.2400	1	1	$318.56	$318.56
Maintenance and repair special ground system	4	4.00 Ea.	$92.99	$116.65	7.7500	7	7	$816.57	$816.57
Replace special ground system	50	1.00 M.L.F.	$2,658.64	$3,194.88	0.6200	0	0	$0.00	$0.00
Maintenance and repair transfer switch	5	1.00 Ea.	$387.26	$467.53	6.2000	6	6	$2,805.18	$2,805.18
Maintenance and inspection transfer switch	0.5	1.00 Ea.	$43.82	$54.97	62.0000	62	62	$3,407.97	$3,407.97
Replace lamp emergency lighting fixture	2	40.00 Ea.	$2,292.62	$2,767.15	15.5000	15	15	$41,507.30	$41,507.30
Replace emergency lighting fixture	20	40.00 Ea.	$24,951.27	$29,459.78	1.5500	1	1	$29,459.78	$29,459.78
Maintenance and repair exit light	20	40.00 Ea.	$1,596.61	$1,976.24	1.5500	1	1	$1,976.24	$1,976.24
Replace lamp exit light	5	40.00 Ea.	$731.93	$867.63	6.2000	6	6	$5,205.79	$5,205.79
Maintenance and inspection battery, wet	0.02	1.00 Ea.	$43.82	$54.97	1550.0000	1550	1550	$85,199.23	$85,199.23
Replace battery, wet	10	1.00 Ea.	$769.79	$878.81	3.1000	3	3	$2,636.42	$2,636.42
Maintenance and repair battery charger	2	1.00 Ea.	$326.62	$402.93	15.5000	15	15	$6,043.97	$6,043.97
Maintenance and inspection battery charger	0.25	1.00 Ea.	$139.97	$175.59	124.0000	124	124	$21,773.14	$21,773.14
Maintenance and inspection UPS battery	0.17	1.00 Ea.	$69.98	$87.79	182.3529	182	182	$15,978.67	$15,978.67
Maintenance and repair voice/data outlet	10	26.00 Ea.	$1,448.03	$1,809.99	3.1000	3	3	$5,429.96	$5,429.96
Replace voice/data outlet	20	26.00 Ea.	$736.24	$896.64	1.5500	1	1	$896.64	$896.64
Maintenance and inspection patch panel	0.5	4.00 Ea.	$370.00	$464.17	62.0000	62	62	$28,778.41	$28,778.41
Replace patch panel	15	4.00 Ea.	$3,788.72	$4,553.23	2.0667	2	2	$9,106.45	$9,106.45
Remove and replace hydraulic dock leveler lift cylinder	15	2.00 Ea.	$16,605.83	$18,912.06	2.0667	2	2	$37,824.13	$37,824.13
Remove and replace hydraulic dock leveler hydraulic pump	20	2.00 Ea.	$4,350.90	$4,976.29	1.5500	1	1	$4,976.29	$4,976.29
Remove and replace 50 HP pump motor	25	2.00 Ea.	$20,848.80	$23,812.02	1.2400	1	1	$23,812.02	$23,812.02
			$1,809,744.35	$2,150,042.41				MR Subtotal:	$3,057,413.63
								MR Per Year:	$98,626.25
								PM Total:	$23,230.11
								Subtotal:	$121,856.36
								Total Per Unit:	$4.95

FAC 2125 Missile Maintenance/Assembly Building, Depot

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $4.95
UM: SF
Expected Service Life: 31
Model Size: 24606

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Door, overhead, electric, roll up, to 24' high x 25' wide, annually	4	8.16	$164.16	$369.52	$0.0000	533.68	660.95	796.43
Fire doors, swinging, annualized	14	5.49	$202.84	$225.05	$0.0000	427.89	515.69	613.63
Urinals, annualized	6	1.37	$41.03	$73.60	$0.0000	114.64	140.82	169.06
Toilet (vacuum breaker type), annualized	8	1.42	$73.47	$76.48	$0.0000	149.95	180.24	214.20
Lavatories, annualized	8	2.78	$61.75	$175.97	$0.0000	237.71	296.68	358.73
Showers, annualized	2	0.46	$28.04	$28.85	$0.0000	56.89	68.35	81.21
Water heater, gas, to 120 gal., annualized	1	1.72	$88.42	$92.21	$0.0000	180.63	217.14	258.07
Boiler, hot water, oil, gas, or comb. fired, 500 -1000 MBH, annualized	1	17.38	$90.37	$1,120.95	$0.0000	1,211.32	1,556.64	1,906.49
Condenser, air cooled, 3 tons to 25 tons, annualized	2	3.42	$108.45	$218.27	$0.0000	326.72	403.04	484.79
Fan coil unit, annualized	8	26.70	$687.81	$1,434.82	$0.0000	2,122.62	2,621.85	3,155.47
VAV Boxes, annualized	26	24.28	$247.67	$1,550.72	$0.0000	1,798.39	2,288.37	2,790.74
Fan, centrifugal, up to 5,000 CFM, annualized	2	2.16	$71.32	$116.75	$0.0000	188.07	230.23	275.95
Controls, central system, electro/pneumatic, annualized	2	3.84	$359.54	$245.34	$0.0000	604.88	714.43	841.96
Fire pump, electric motor driven, annualized	1	47.75	$61.55	$3,003.30	$0.0000	3,064.85	3,972.00	4,882.22
Extinguishing system, FM200, annualized	1	9.26	$664.36	$499.14	$0.0000	1,163.50	1,379.68	1,629.07
Panelboard, 225 A and above, annualized	3	1.32	$77.84	$94.12	$0.0000	171.97	207.99	247.90
Uninterrupted power system, up to 200 KVA, annually	1	3.01	$201.60	$191.23	$0.0000	392.83	470.36	557.97
Battery system and charger, annually	1	1.41	$14.37	$89.14	$0.0000	103.51	131.69	160.59
Light, emergency, hardwired system, annualized	40	10.00	$363.27	$631.46	$0.0000	994.74	1,220.50	1,464.43
Crane, electric bridge, over 15 tons, annualized	2	16.53	$929.20	$640.93	$0.0000	1,570.13	1,855.33	2,186.99
						$15,525.14	$19,262.61	$23,230.11

FAC 2126 Intercontinental Ballistic Missile Processing Facility

FY25 SUC:	$38.07 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2131 Graving Dry-dock

FY25 SUC:	$42.23 / SF
Source:	FY25 Navy Study

Dry Dock

Average Dry Dock

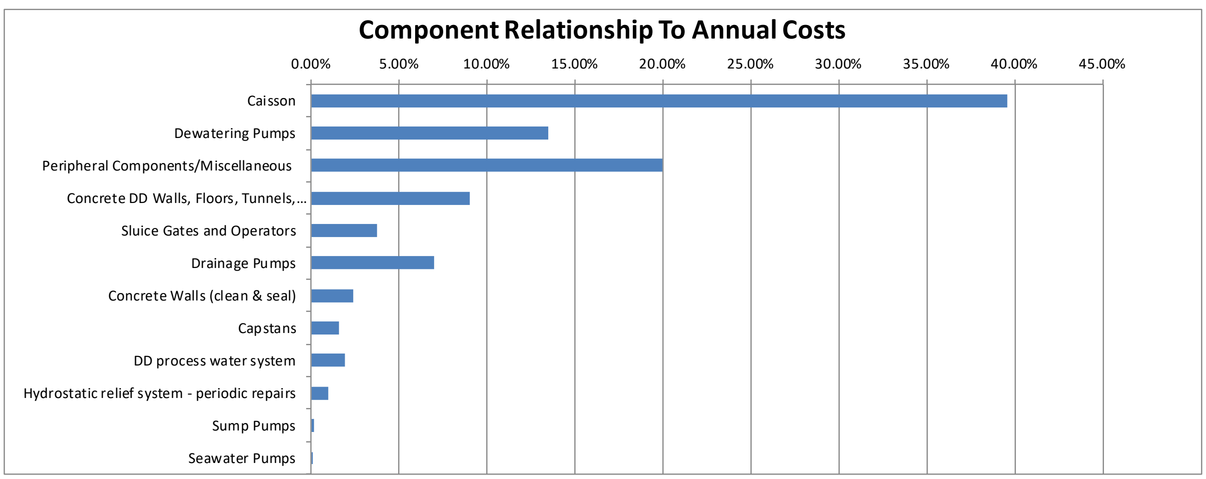
Width	ft	131
Lenth	ft	816
Depth	ft	40
Volume	cu ft	4,930,153
Area	sq ft	108,241
Construction Material		Concrete
Capstans	ea	9.1
Drainage Pumps	ea	2.4
Dewatering Pumps	ea	2.9
Average PRV EOY FY23	ea	$433,031,876
Total PRV EOY FY23	ea	$7,794,573,776
Expected Service Life	yr	150

Component (In order by cost)	Annual Cost ($000)	Pct
Caisson	192,888	39.60%
Dewatering Pumps	65,601	13.47%
Peripheral Components/Miscellaneous	97,409	20.00%
Concrete DD Walls, Floors, Tunnels, Pump	44,003	9.03%
Sluice Gates and Operators	18,269	3.75%
Drainage Pumps	34,097	7.00%
Concrete Walls (clean & seal)	11,837	2.43%
Capstans	7,884	1.62%
DD process water system	9,341	1.92%
Hydrostatic relief system - periodic repairs	4,632	0.95%
Sump Pumps	825	0.17%
Seawater Pumps	301	0.06%

150 Year Cost Summary

Task Type	150 Year Total Cost	Annual Cost per GSFT (FY24)	Annual Cost as % of Replacement
PM & Minor Repair	$181,728,043	$11.19	0.02%
Unscheduled Maintenance	$0	$0.00	0.00%
Renewal & Replacement	$487,088,859	$30.00	0.04%
Total in FY24 dollars	$668,816,902	$41.19	
Total in FY25 dollars	ENR Inflat: 1.0251	**$42.23**	

iNFADS SF
108,241



FAC 2132 Marine Railway

FY25 SUC:	$978.85 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Cost calculated from multiple sources

FAC 2132 Marine Railway V13 Sustainment Unit Cost

References:
FSM FMM FOM Version 12, Common References Tables, 4-09-10
Real Property Classification System Version 2010-2
UFC 2-000-05N Facilities Planning Criteria for Navy/Marine Corps Shore Installations

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UM= Each

SUSTAINMENT UNIT COST = $594.80

Cost Elements

Annual Inspection (includes 2 divers):

2 hours per facility:
1 GS-12 (9) Hourly Rate: Basic Rate 36.70/hour x 1.325 (fringe) x 1.12 (overhead) = $54.46
3 WG9 (5) Hourly Rate: Basic Rate $28.02/hour x 1.325 (fringe) x 1.12 (overhead) = $124.74
1 WG7 (5) Hourly Rate: Basic Rate $24.07/hour x 1.325 (fringe) x 1.12 (overhead) = $36.61
Total/Hour = $215.81
1 Pickup Truck/Motor launch = $1.70/Hour

Total Cost per hour = $217.51
Total Cost per inspection = $435.02

Annual Preventive Maintenance consisting of servicing fastening devices, corrosion, debris, marine organism control.

Details:
2 hours per PM Service:
1 WG9 (5) Hourly Rate: Basic Rate $28.02/hour x 1.325 (fringe) x 1.12 (overhead) = $41.58
1 WG7 (5) Hourly Rate: Basic Rate $24.07/hour x 1.325 (fringe) x 1.12 (overhead) = $36.61
Total/Hour = $78.19
1 Pickup Truck/Small Boat = $1.70/Hour
Cost per Hour = $79.89
Cost per PM Service= $159.78

Total Annual Maintenance and Repair for Marine Railway = $594.80

FAC 2133 Marine Maintenance Shop

FY25 SUC:	$5.51 / SF
Source:	FY25 Navy Study

FAC 2133 **Marine Maintenance Shop**

Expected Service Life 50 Years
Model Size 35,947 SF

UNIFORMAT Lvl 2	LEVEL 2 GROUP TITLE	Average of Normalized Cost	Ave Cost per SF w/OP	Frequency (Average from RS Means Model)	Average Occurrences	Lifetime Cost /SF
AB10	Shell Structure	$4,155,265.02	$115.60	45	1.1	$64.22
B10	Superstructure	$37,771.48	$1.05	7.0	1.0	$1.05
B20	Exterior Enclosure	$253,457.31	$7.05	14.4	3.5	$24.44
B30	Roofing	$195,491.01	$5.44	17.7	2.8	$15.34
C10	Interior Construction	$95,109.08	$2.65	11.8	4.3	$11.26
C20	Stairs	$35,583.60	$0.99	25	2.0	$1.98
C30	Interior Finishes	$156,742.83	$4.36	9.0	5.6	$24.22
D10	Conveying	$173,868.26	$4.84	5	10.0	$48.37
D20	Plumbing	$48,479.58	$1.35	14.7	3.4	$4.60
D30	HVAC	$46,994.83	$1.31	13.8	3.6	$4.73
D40	Fire Protection	$150,098.27	$4.18	17.9	2.8	$11.70
D50	Electrical	$55,211.06	$1.54	9.2	5.4	$8.33
			$150.34		Per Year	$4.40
					PM/SC/SW/Repairs	$0.97
					FY24 SUC	$5.37
					FY25 SUC	**$5.51**

FAC 2134 Marine Maintenance Support Facility

FY25 SUC:	$5.59 / SF
Source:	FY25 Navy Study

FAC 2134 Marine Maintenance Support Facility

Expected Service Life	50	Years
Model Size	28,289	SF

UNIFORMAT Lvl 2	LEVEL 2 GROUP TITLE	Average of Normalized Cost	Ave Cost per SF w/OP	Frequency (Average from RS Means Model)	Average Occurrences	Lifetime Cost /SF
AB10	Shell Structure	$3,314,567	$117.17	50.0	1.0	$58.58
B20	Exterior Enclosure	$184,695	$6.53	21.7	2.3	$15.03
B30	Roofing	$133,044	$4.70	24.8	2.0	$9.50
C10	Interior Construction	$86,802	$3.07	13.8	3.6	$11.11
C20	Stairs	$78,329	$2.77	19.5	2.6	$7.09
C30	Interior Finishes	$139,234	$4.92	11.5	4.4	$21.42
D10	Conveying	$172,307	$6.09	5	10.0	$60.91
D20	Plumbing	$49,508	$1.75	11.0	4.5	$7.92
D30	HVAC	$49,449	$1.75	14.4	3.5	$6.05
D40	Fire Protection	$101,401	$3.58	17.7	2.8	$10.13
D50	Electrical	$46,695	$1.65	15.9	3.2	$5.21
				$153.98	Subtotal	$212.96
					Per Year	$4.26
					PM/SC/SW/Repairs	$1.19
					FY24 SUC	$5.45
					FY25 SUC	**$5.59**

FAC 2135 Landing Craft Wash Facility

FY25 SUC:	$13,221.39 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2136 Surety Repair Shop

FY25 SUC:	$5.23 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2137 Fixed Crane Structure

FY25 SUC:	$102,179.14 / EA
Source:	FY25 study with data provided by NAVFAC's Public Works Departments with analysis by NAVFAC in coordination with R&K Solutions.

FAC 2137 Fixed Crane Structure

FY25 SUC Remodel

SUC	**$102,179.14**
ESL	**45**
UM	**EA**

Maintenance and Repair (MR)

Component NBR	Description	Unit	Total In-House	Total Incl. OP	Freq	Occurrences	Life Cost	Adjusted Cost < 10 Tons	Adjusted Cost > 10 Tons < 50 Tons	Adjusted Cost > 50 Tons
FCS1	**Hoist Replacement (Based on > 50 Tons Capacity)**	EA	$500,000.00	$700,000.00	15	3	$2,100,000.00	$200,000.00	$420,000.00	$2,100,000.00
FCS3	**Wire Rope Replacement (Based on > 50 Tons Capacity)**	EA	$50,000.00	$70,000.00	8	6	$392,000.00	$12,000.00	$200,000.00	$392,000.00
FCS4	**Control Drive Replacement (Based on > 50 Tons Capacity)**	EA	$250,000.00	$350,000.00	15	3	$1,050,000.00	$0.00	$0.00	$1,050,000.00
FCS8	**Structural Repair and Full Repaint (Based on HammerHead Crane type > 50 Tons)**	EA	$1,500,000.00	$2,100,000.00	15	3	$6,300,000.00	$5,000.00	$0.00	$6,300,000.00
							MR Subtotal	$217,000.00	$620,000.00	$9,842,000.00
							MR Per Year	$4,822.22	$13,777.78	$218,711.11
							PM Total	$6,623.08	$95,180.33	$95,180.33
							Subtotal	$11,445.30	$108,958.10	$313,891.44
							Total Per Unit	$11,445.30	$108,958.10	$313,891.44
							% Navy	70.00%	0.00%	30.00%
									Weighted Cost /	$102,179.14

Preventive Maintenance (PM) $88 per hour labor

	Description	Annual Quantit	Labor Hours	Bare Materials	Bare Labor	Bare Equipment	Bare Total	Total In-House	Total Incl. OP
	Sum Annual P-307 Category 3 (< 10 ton) and Category 2 (> 10 Ton) Costs	**1.25**	**41**	**$700.00**	**$3,608.00**	**$700.00**	**$5,008.00**	**$5,759.20**	**$6,623.08**
	Annual Inspection and Certification	1	40.00	$500.00	$3,520.00	$500.00	$4,520.00	$5,198.00	$5,977.70
	Quadrennial Load Test	0.25	1.00	$200.00	$88.00	$200.00	$488.00	$561.20	$645.38
	Sum Annual P-307 Category 1 Cranes	**5.3**	**440**	**$26,000.00**	**$38,720.00**	**$7,250.00**	**$71,970.00**	**$82,765.50**	**$95,180.33**
	"A" PM (4 month)	3	40.00	$5,000.00	$3,520.00	$3,000.00	$11,520.00	$13,248.00	$15,235.20
	"B" PM (3rd "A" PM)	1	160.00	$8,000.00	$14,080.00	$1,000.00	$23,080.00	$26,542.00	$30,523.30
	"C" PM (3rd "B" PM)	0.3	200.00	$3,000.00	$17,600.00	$250.00	$20,850.00	$23,977.50	$27,574.13
	Annual Load Test & Certification	1	40.00	$10,000.00	$3,520.00	$3,000.00	$16,520.00	$18,998.00	$21,847.70

FAC 2141 Vehicle Maintenance Shop

FY25 SUC:	$5.83 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2142 Vehicle Maintenance Shop, Depot

FY25 SUC:	$3.34 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2143 Vehicle Maintenance Shop, National Guard

FY25 SUC:	$5.07 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 2143 Vehicle Maintenance Shop, National Guard

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $5.07
UM: SF
Expected Service Life: 50
Model Size: 15974

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	120.00 S.F.	$4,882.12	$5,946.04	3.3333	3	3	$17,838.12	$17,838.12
Repair 8" concrete block wall, 1st floor	25	3,860.00 S.F.	$103,345.32	$126,426.85	2.0000	2	2	$252,853.70	$252,853.70
Waterproof concrete block wall, 1st floor	10	86.00 C.S.F.	$16,687.69	$20,109.03	5.0000	5	5	$100,545.13	$100,545.13
Waterproof concrete block wall, 2nd floor	10	86.00 C.S.F.	$69,342.16	$82,834.34	5.0000	5	5	$414,171.70	$414,171.70
Replace glass - 1st floor (1% of glass) - steel frame window	1	1.68 S.F.	$22.93	$26.93	50.0000	50	50	$1,346.45	$1,346.45
Repair 3'-9" x 5'-5" steel frame window - 1st floor.	20	7.00 Ea.	$2,401.53	$2,816.87	2.5000	2	2	$5,633.74	$5,633.74
Replace 3'-9" x 5'-5" steel frame window - 1st floor.	45	7.00 Ea.	$13,353.65	$15,367.53	1.1111	1	1	$15,367.53	$15,367.53
Repair 2'-0" x 3'-0" steel frame window - 2nd floor.	20	12.00 Ea.	$2,551.56	$3,072.71	2.5000	2	2	$6,145.43	$6,145.43
Replace 2'-0" x 3'-0" steel frame window - 2nd floor.	45	12.00 Ea.	$10,675.15	$12,527.58	1.1111	1	1	$12,527.58	$12,527.58
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	3.5714	3	3	$11,049.22	$11,049.22
Replace 3'-0" x 7'-0" steel, painted, door	45	4.00 Ea.	$2,943.44	$3,426.28	1.1111	1	1	$3,426.28	$3,426.28
Refinish 12' x 24' steel double roll-up door	5	12.00 Ea.	$6,154.22	$7,466.71	10.0000	10	10	$74,667.08	$74,667.08
Replace 12' x 24' steel double roll-up door	35	12.00 Ea.	$86,608.17	$102,059.74	1.4286	1	1	$102,059.74	$102,059.74
Debris removal and visual inspection of built-up roofing	0.5	16.10 M.S.F.	$654.66	$799.52	100.0000	100	100	$79,951.99	$79,951.99
Minor BUR membrane repairs, 2% of roof area	1	3.20 Sq.	$1,869.06	$2,209.42	50.0000	50	50	$110,470.84	$110,470.84
Total BUR roof replacement	28	160.00 Sq.	$155,575.02	$183,098.50	1.7857	1	1	$183,098.50	$183,098.50
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	11.00 S.F.	$310.85	$369.91	50.0000	50	50	$18,495.57	$18,495.57
Repair fully glazed wood door	10	2.00 Ea.	$593.70	$692.64	5.0000	5	5	$3,463.22	$3,463.22
Refinish 3'-0" x 7'-0" fully glazed wood door	4	2.00 Ea.	$161.48	$199.55	12.5000	12	12	$2,394.55	$2,394.55
Repair steel painted interior door	14	10.00 Ea.	$2,968.50	$3,463.22	3.5714	3	3	$10,389.65	$10,389.65
Refinish 3'-0" x 7'-0" steel painted interior door	4	10.00 Ea.	$602.03	$740.24	12.5000	12	12	$8,882.94	$8,882.94
Safety glass replacement, (3% of glass) steel painted interior door	1	6.30 S.F.	$161.77	$190.83	50.0000	50	50	$9,541.63	$9,541.63
Refinish concrete floor finished	25	103.70 C.S.F.	$47,547.76	$57,125.62	2.0000	2	2	$114,251.24	$114,251.24
Replace vinyl tile flooring	18	117.00 S.Y.	$6,617.32	$8,099.80	2.7778	2	2	$16,199.60	$16,199.60
Replace acoustic tile ceiling, fire-rated	20	14.00 C.S.F.	$8,745.70	$10,284.90	2.5000	2	2	$20,569.80	$20,569.80
Replace flush valve diaphragm tankless water closet	10	4.00 Ea.	$110.36	$137.10	5.0000	5	5	$685.52	$685.52
Rebuild flush valve tankless water closet	20	4.00 Ea.	$773.08	$931.82	2.5000	2	2	$1,863.63	$1,863.63
Unplug clogged line tankless water closet	5	4.00 Ea.	$919.12	$1,151.15	10.0000	10	10	$11,511.52	$11,511.52
Replace tankless water closet	35	4.00 Ea.	$5,506.63	$6,372.78	1.4286	1	1	$6,372.78	$6,372.78
Replace tankless flush valve	25	4.00 Ea.	$1,090.62	$1,280.11	2.0000	2	2	$2,560.22	$2,560.22
Replace wax ring gasket for tankless water closet	5	4.00 Ea.	$599.02	$749.53	10.0000	10	10	$7,495.28	$7,495.28
Replace flush valve diaphragm for a urinal	7	3.00 Ea.	$82.77	$102.83	7.1429	7	7	$719.80	$719.80
Rebuild flush valve for a urinal	20	3.00 Ea.	$579.81	$698.86	2.5000	2	2	$1,397.72	$1,397.72
Unplug line urinal	5	3.00 Ea.	$458.71	$574.51	10.0000	10	10	$5,745.09	$5,745.09
Replace wall-hung urinal	35	3.00 Ea.	$3,276.87	$3,943.16	1.4286	1	1	$3,943.16	$3,943.16
Replace washer in spud connection lavatory, vitreous china	7	6.00 Ea.	$104.36	$127.40	7.1429	7	7	$891.82	$891.82
Replace faucets lavatory, vitreous china	10	6.00 Ea.	$1,191.74	$1,432.70	5.0000	5	5	$7,163.50	$7,163.50
Clean out strainer and P trap lavatory, vitreous china	2	6.00 Ea.	$222.53	$278.71	25.0000	25	25	$6,967.65	$6,967.65
Replace lavatory, vitreous china	35	6.00 Ea.	$4,508.25	$5,405.31	1.4286	1	1	$5,405.31	$5,405.31
Replace faucet washer sink, iron enamel	2	4.00 Ea.	$54.02	$67.38	25.0000	25	25	$1,684.58	$1,684.58
Clean trap sink, iron enamel	3	4.00 Ea.	$36.07	$45.18	16.6667	16	16	$722.81	$722.81
Replace faucets sink, iron enamel	10	4.00 Ea.	$794.49	$955.13	5.0000	5	5	$4,775.67	$4,775.67
Unstop sink, iron enamel	2	4.00 Ea.	$176.61	$221.20	25.0000	25	25	$5,529.88	$5,529.88
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	4.00 Ea.	$3,640.69	$4,282.81	5.0000	5	5	$21,414.03	$21,414.03
Inspect / clean shower head fiberglass	3	2.00 Ea.	$104.12	$130.40	16.6667	16	16	$2,086.42	$2,086.42
Replace mixing valve barrel shower, fiberglass	2	2.00 Ea.	$602.08	$708.17	25.0000	25	25	$17,704.16	$17,704.16
Replace mixing valve shower, fiberglass	10	2.00 Ea.	$587.65	$715.04	5.0000	5	5	$3,575.19	$3,575.19
Replace shower and fittings, fiberglass	20	2.00 Ea.	$2,377.03	$2,824.90	2.5000	2	2	$5,649.81	$5,649.81
Check / minor repairs drinking fountain	1	1.00 Ea.	$51.94	$65.06	50.0000	50	50	$3,252.87	$3,252.87
Repair internal leaks drinking fountain	4	1.00 Ea.	$47.79	$59.85	12.5000	12	12	$718.23	$718.23
Replace refrigerant drinking fountain	2	1.00 Ea.	$36.77	$43.00	25.0000	25	25	$1,074.93	$1,074.93
Repair drain leak drinking fountain	4	1.00 Ea.	$30.51	$36.81	12.5000	12	10	$441.70	$368.08
Replace fountain drinking fountain	10	1.00 Ea.	$1,523.39	$1,794.44	5.0000	5	5	$8,972.20	$8,972.20
Inspect and clean spray heads, emergency eye wash	3	2.00 Ea.	$104.12	$130.40	16.6667	16	16	$2,086.42	$2,086.42
Replace eye wash station, emergency eye wash	25	2.00 Ea.	$1,580.90	$1,923.10	2.0000	2	2	$3,846.19	$3,846.19
Resolder joint pipe & fittings, copper	10	2.00 Ea.	$101.81	$125.57	5.0000	5	5	$627.86	$627.86
Replace pipe and fittings, copper 3/4"	20	16.00 L.F.	$385.58	$468.64	2.5000	2	2	$937.28	$937.28
Replace pipe and fittings, copper 2"	25	16.00 L.F.	$904.99	$1,084.54	2.0000	2	2	$2,169.09	$2,169.09
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	16.00 L.F.	$165.02	$201.61	3.3333	3	3	$604.82	$604.82
Remove old insulation & replace with new, pipe 1-1/2", wall 1"	15	16.00 L.F.	$184.99	$225.37	3.3333	3	3	$676.10	$676.10
Clean & service water heater, gas / oil, 70 gallon	1	1.00 Ea.	$206.74	$258.93	50.0000	50	50	$12,946.42	$12,946.42
Replace water heater, gas / oil, 70 gallon	12	1.00 Ea.	$5,470.45	$6,302.52	4.1667	4	4	$25,210.08	$25,210.08
Unclog main drain pipe & fittings, cast iron	10	1.00 Ea.	$48.83	$61.15	5.0000	5	5	$305.77	$305.77
Replace pipe & fittings, cast iron, 4"	40	16.00 L.F.	$975.43	$1,182.15	1.2500	1	1	$1,182.15	$1,182.15
Repair joint pipe and fittings, PVC	10	1.00 Ea.	$157.21	$195.91	5.0000	5	5	$979.56	$979.56
Replace pipe, 4" pipe and fittings, PVC	30	16.00 L.F.	$1,499.18	$1,834.72	1.6667	1	1	$1,834.72	$1,834.72
Unclog floor drain	10	6.00 Ea.	$2,050.55	$2,547.24	5.0000	5	5	$12,736.18	$12,736.18
General maintenance & repair drain: roof, scupper, area	1	2.00 Ea.	$78.44	$98.24	50.0000	50	50	$4,911.83	$4,911.83
Replace drain: roof, scupper, area	40	2.00 Ea.	$2,192.71	$2,530.43	1.2500	1	1	$2,530.43	$2,530.43
Resolder joint pipe & fittings, oxygen	12	1.00 Ea.	$83.56	$102.73	4.1667	4	4	$410.93	$410.93
Replace pipe and fittings, oxygen	25	116.00 L.F.	$2,783.38	$3,382.56	2.0000	2	2	$6,765.11	$6,765.11
Check and adjust 10 H.P. compressor	1	1.00 Ea.	$89.20	$111.72	50.0000	50	50	$5,585.83	$5,585.83
Replace 10 H.P. compressor	25	1.00 Ea.	$15,913.66	$18,508.80	2.0000	2	2	$37,017.59	$37,017.59
Check and adjust 25 H.P. compressor	1	1.00 Ea.	$89.20	$111.72	50.0000	50	50	$5,585.83	$5,585.83
Replace 25 H.P. compressor	25	1.00 Ea.	$27,745.23	$32,191.94	2.0000	2	2	$64,383.88	$64,383.88
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	4.00 Ea.	$17,377.45	$20,158.61	2.5000	2	2	$40,317.22	$40,317.22
Maintenance and repair standard suspended heater	2	12.00 Ea.	$1,427.27	$1,684.62	25.0000	25	25	$42,115.49	$42,115.49
Maintenance and inspection standard suspended heater	0.5	12.00 Ea.	$1,017.27	$1,276.17	100.0000	100	100	$127,616.73	$127,616.73
Replace heater standard suspended heater	15	12.00 Ea.	$11,001.15	$12,711.62	3.3333	3	3	$38,134.85	$38,134.85
Repair single zone rooftop unit, 5 ton	10	1.00 Ea.	$2,912.53	$3,474.76	5.0000	5	5	$17,373.78	$17,373.78
Replace single zone rooftop unit, 5 ton	15	1.00 Ea.	$8,648.69	$10,289.33	3.3333	3	3	$30,867.99	$30,867.99
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	5.0000	5	5	$5,873.21	$5,873.21
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	50.0000	50	50	$2,270.50	$2,270.50
Replace sprinkler head	20	124.00 Ea.	$11,369.64	$14,011.66	2.5000	2	2	$28,023.32	$28,023.32
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	50.0000	50	50	$45,152.64	$45,152.64
Replace fire pump / electric motor assembly 100 H.P.	25	1.00 Ea.	$46,050.08	$53,152.38	2.0000	2	2	$106,304.77	$106,304.77
Maintenance and repair motor starter, up to 600 V	5	4.00 Ea.	$1,398.21	$1,675.72	10.0000	10	10	$16,757.18	$16,757.18
Maintenance and inspection motor starter, up to 600 V	0.5	4.00 Ea.	$233.69	$293.16	100.0000	100	100	$29,315.87	$29,315.87
Replace starter motor starter, up to 600 V	18	4.00 Ea.	$3,275.83	$3,909.80	2.7778	2	2	$7,819.61	$7,819.61
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	16.6667	16	16	$1,758.95	$1,758.95
Maintenance and repair breaker, molded case, 480 V, 2 pole	20	14.00 Ea.	$1,082.01	$1,357.39	2.5000	2	2	$2,714.77	$2,714.77
Replace circuit breaker enclosed, 240 V, 2 pole circuit breaker	50	22.00 Ea.	$20,170.52	$23,592.01	1.0000	1	1	$23,592.01	$23,592.01
Replace safety switch, heavy duty 30 A	25	4.00 Ea.	$3,070.28	$3,644.16	2.0000	2	2	$7,288.32	$7,288.32
Replace safety switch, heavy duty 600 A	25	1.00 Ea.	$8,417.44	$9,751.06	2.0000	2	2	$19,502.12	$19,502.12
Maintenance and repair safety switch general, 2 pole	8	1.00 Ea.	$43.82	$54.97	6.2500	6	6	$329.80	$329.80
Maintenance and inspection safety switch, 2 pole	1	1.00 Ea.	$43.82	$54.97	50.0000	50	50	$2,748.36	$2,748.36
Replace receptacle/plug receptacles and plugs	20	29.00 Ea.	$2,341.55	$2,880.31	2.5000	2	2	$5,760.62	$5,760.62
Replace 4-pin receptacle	20	36.00 Ea.	$5,757.85	$6,845.05	2.5000	2	2	$13,690.10	$13,690.10
Replace wiring devices, switches	15	16.00 Ea.	$1,112.55	$1,385.35	3.3333	3	3	$4,156.04	$4,156.04
Replace fluorescent light fixture ballast, 80 W	10	47.00 Ea.	$5,119.80	$6,313.38	5.0000	5	5	$31,566.92	$31,566.92
Replace lamps (2 lamps), 4', 34 W energy saver	10	47.00 Ea.	$1,276.13	$1,600.17	5.0000	5	5	$8,000.85	$8,000.85
Replace metal halide ballast, 175 W	10	48.00 Ea.	$8,234.95	$9,863.87	5.0000	5	5	$49,319.33	$49,319.33
Replace metal halide fixture lamp, 175 W	5	48.00 Ea.	$2,920.28	$3,548.33	10.0000	10	10	$35,483.26	$35,483.26
Check and repair manual pull station	10	3.00 Ea.	$284.97	$350.72	5.0000	5	4	$1,753.60	$1,402.88
Replace manual pull station	15	3.00 Ea.	$690.23	$829.51	3.3333	3	3	$2,488.54	$2,488.54
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	10.0000	10	10	$1,954.25	$1,954.25
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	100.0000	100	100	$5,802.10	$5,802.10
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.3333	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.5000	2	2	$971.29	$971.29
			$810,292.79	$962,275.76				MR Subtotal:	$2,693,925.02
								MR Per Year:	$53,878.50
								PM Total:	$27,060.06
								Subtotal:	$80,938.56
								Total Per Unit:	$5.07

FAC 2143 Vehicle Maintenance Shop, National Guard

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM
FY25 SUC: $5.07
UM: SF
Expected Service Life: 50
Model Size: 15974

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	12	48.84	$991.44	$2,208.18	$0.0000	3,199.62	3,961.22	4,772.39
Urinals, annualized	3	0.68	$20.52	$36.80	$0.0000	57.32	70.41	84.53
Toilet (vacuum breaker type), annualized	4	0.71	$36.74	$38.24	$0.0000	74.97	90.12	107.10
Lavatories, annualized	6	2.09	$46.31	$131.98	$0.0000	178.29	222.51	269.05
Showers, annualized	2	0.46	$28.04	$28.85	$0.0000	56.89	68.35	81.21
Drink fountain, annualized	1	0.62	$36.15	$33.42	$0.0000	69.57	83.21	98.65
Water heater, gas, to 120 gal., annualized	1	1.72	$88.42	$92.21	$0.0000	180.63	217.14	258.07
Fan coil unit, annualized	4	13.35	$343.90	$717.41	$0.0000	1,061.31	1,310.92	1,577.73
Fan, axial, up to 5,000 CFM, annualized	2	2.49	$27.55	$133.67	$0.0000	161.22	204.07	248.31
Unit heater, gas infrared, annualized	12	18.06	$797.23	$969.52	$0.0000	1,766.75	2,137.33	2,547.77
Package unit, air cooled, 3 thru 24 ton, annually	1	1.00	$115.29	$63.87	$0.0000	179.16	209.85	246.30
Air compressor, centrifugal, to 40 H.P., annualized	2	6.82	$136.78	$436.54	$0.0000	573.32	717.95	869.43
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Fire pump, electric motor driven, annualized	1	47.75	$61.55	$3,003.30	$0.0000	3,064.85	3,972.00	4,882.22
Extinguishing system, foam pump electric, annualized	1	17.72	$356.60	$951.75	$0.0000	1,308.36	1,629.54	1,968.56
Circuit breaker, high voltage air, annualized	4	1.88	$66.07	$133.46	$0.0000	199.53	246.18	296.13
Transformer, dry type 500 KVA and over, annualized	1	0.77	$16.52	$54.78	$0.0000	71.30	89.38	108.29
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Motor control center, over 400 A, annualized	4	1.56	$103.79	$111.55	$0.0000	215.34	259.19	308.22
Hydraulic lift, annualized	4	6.18	$2,807.80	$234.81	$0.0000	3,042.61	3,393.83	3,885.44
Crane, electric bridge, over 15 tons, annualized	2	16.53	$929.20	$640.93	$0.0000	1,570.13	1,855.33	2,186.99
Hoist, pneumatic, annualized	2	2.62	$454.50	$102.43	$0.0000	556.93	633.11	732.01
						$18,582.54	$22,630.44	$27,060.06

FAC 2144 Vehicle Maintenance Shop, Reserve

FY25 SUC:	$5.43 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 2144 Vehicle Maintenance Shop, Reserve

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $5.43
UM: SF
Expected Service Life: 50
Model Size: 7857

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	128.00 S.F.	$5,207.60	$6,342.44	3.3333	3	3	$19,027.33	$19,027.33
Replace metal floor grating	30	14.00 S.F.	$402.78	$464.73	1.6667	1	1	$464.73	$464.73
Point and refinish painted concrete block wall, 1st floor	25	32.90 C.S.F.	$18,036.59	$22,167.00	2.0000	2	2	$44,333.99	$44,333.99
Waterproof clay brick wall, 1st floor	10	46.00 C.S.F.	$8,925.98	$10,755.99	5.0000	5	5	$53,779.96	$53,779.96
Repair painted clay brick wall, 1st floor	25	336.00 S.F.	$16,393.80	$20,095.97	2.0000	2	2	$40,191.94	$40,191.94
Point painted clay brick wall - 1st floor	25	36.00 C.S.F.	$32,998.82	$40,561.13	2.0000	2	2	$81,122.27	$81,122.27
Repair 3'-9" x 5'-5" steel frame window - 1st floor.	20	8.00 Ea.	$2,744.61	$3,219.28	2.5000	2	2	$6,438.56	$6,438.56
Replace 3'-9" x 5'-5" steel frame window - 1st floor.	45	8.00 Ea.	$15,261.31	$17,562.89	1.1111	1	1	$17,562.89	$17,562.89
Replace glass - 2nd floor (1% of glass) - steel frame window	1	1.80 S.F.	$208.65	$257.83	50.0000	50	50	$12,891.28	$12,891.28
Repair 2'-0" x 3'-0" steel frame window - 2nd floor.	20	12.00 Ea.	$2,551.56	$3,072.71	2.5000	2	2	$6,145.43	$6,145.43
Replace 2'-0" x 3'-0" steel frame window - 2nd floor.	45	12.00 Ea.	$10,675.15	$12,527.58	1.1111	1	1	$12,527.58	$12,527.58
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	3.5714	3	3	$11,049.22	$11,049.22
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.00 Ea.	$191.97	$235.01	12.5000	12	12	$2,820.12	$2,820.12
Replace 3'-0" x 7'-0" steel, painted, door	45	4.00 Ea.	$2,943.44	$3,426.28	1.1111	1	1	$3,426.28	$3,426.28
Replace tempered glass - (3% of glass) steel painted door	1	5.04 S.F.	$166.06	$196.02	50.0000	50	50	$9,801.25	$9,801.25
Repair 12' x 12' aluminum single roll-up door	10	6.00 Ea.	$6,630.10	$7,710.62	5.0000	5	5	$38,553.08	$38,553.08
Refinish 12' x 12' aluminum single roll-up door	5	6.00 Ea.	$1,536.29	$1,863.86	10.0000	10	10	$18,638.61	$18,638.61
Replace 12' x 12' aluminum single roll-up door	35	6.00 Ea.	$25,732.75	$29,808.65	1.4286	1	1	$29,808.65	$29,808.65
Debris removal, by hand and visual inspection, metal panel roofing	1	7.90 M.S.F.	$194.15	$237.11	50.0000	50	50	$11,855.27	$11,855.27
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	158.00 S.F.	$766.02	$909.07	10.0000	10	10	$9,090.65	$9,090.65
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	1.58 S.F.	$44.65	$53.13	50.0000	50	50	$2,656.64	$2,656.64
Minor metal roof panel replacement, 2.5% of roof area	20	198.00 S.F.	$2,738.49	$3,239.29	2.5000	2	2	$6,478.59	$6,478.59
Total metal roof panel replacement	30	79.00 Sq.	$75,936.00	$89,796.39	1.6667	1	1	$89,796.39	$89,796.39
Repair fully glazed wood door	10	2.00 Ea.	$593.70	$692.64	5.0000	5	5	$3,463.22	$3,463.22
Refinish 3'-0" x 7'-0" fully glazed wood door	4	2.00 Ea.	$161.48	$199.55	12.5000	12	12	$2,394.55	$2,394.55
Replace 3'-0" x 7'-0" fully glazed wood door	40	2.00 Ea.	$11,195.38	$12,788.22	1.2500	1	1	$12,788.22	$12,788.22
Repair steel painted interior door	14	5.00 Ea.	$1,484.25	$1,731.61	3.5714	3	3	$5,194.83	$5,194.83
Refinish 3'-0" x 7'-0" steel painted interior door	4	5.00 Ea.	$301.02	$370.12	12.5000	12	12	$4,441.47	$4,441.47
Safety glass replacement, (3% of glass) steel painted interior door	1	6.30 S.F.	$161.77	$190.83	50.0000	50	50	$9,541.63	$9,541.63
Repair concrete steps	15	33.00 S.F.	$1,017.86	$1,174.16	3.3333	3	3	$3,522.48	$3,522.48
Repair 5/8" drywall - (2% of walls)	20	1,240.00 S.F.	$2,316.33	$2,817.45	2.5000	2	2	$5,634.91	$5,634.91
Office painting, 10' x 12', 10' high walls	5	4.00 Ea.	$1,042.71	$1,273.82	10.0000	10	10	$12,738.21	$12,738.21
Refinish concrete floor finished	25	48.50 C.S.F.	$22,237.86	$26,717.38	2.0000	2	2	$53,434.77	$53,434.77
Replace vinyl sheet flooring	18	14.50 S.Y.	$1,156.71	$1,402.68	2.7778	2	2	$2,805.36	$2,805.36
Replace acoustic tile ceiling, fire-rated	20	6.96 C.S.F.	$4,347.86	$5,113.06	2.5000	2	2	$10,226.13	$10,226.13
Replace flush valve diaphragm tankless water closet	10	4.00 Ea.	$110.36	$137.10	5.0000	5	5	$685.52	$685.52
Rebuild flush valve tankless water closet	20	4.00 Ea.	$773.08	$931.82	2.5000	2	2	$1,863.63	$1,863.63
Replace tankless water closet	35	4.00 Ea.	$5,506.63	$6,372.78	1.4286	1	1	$6,372.78	$6,372.78
Replace tankless flush valve	25	4.00 Ea.	$1,090.62	$1,280.11	2.0000	2	2	$2,560.22	$2,560.22
Replace wax ring gasket for tankless water closet	5	4.00 Ea.	$599.02	$749.53	10.0000	10	10	$7,495.28	$7,495.28
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	7.1429	7	7	$479.87	$479.87
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.5000	2	2	$931.82	$931.82
Replace wall-hung urinal	35	2.00 Ea.	$2,184.58	$2,628.78	1.4286	1	1	$2,628.78	$2,628.78
Replace washer in spud connection lavatory, vitreous china	7	4.00 Ea.	$69.57	$84.93	7.1429	7	7	$594.54	$594.54
Replace washer in faucet lavatory, vitreous china	2	4.00 Ea.	$54.39	$67.85	25.0000	25	25	$1,696.29	$1,696.29
Replace faucets lavatory, vitreous china	10	4.00 Ea.	$794.49	$955.13	5.0000	5	5	$4,775.67	$4,775.67
Clean out strainer and P trap lavatory, vitreous china	2	4.00 Ea.	$148.35	$185.80	25.0000	25	25	$4,645.10	$4,645.10
Replace lavatory, vitreous china	35	4.00 Ea.	$3,005.50	$3,603.54	1.4286	1	1	$3,603.54	$3,603.54
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	25.0000	25	25	$421.14	$421.14
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	16.6667	16	16	$180.70	$180.70
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	5.0000	5	5	$1,193.92	$1,193.92
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	25.0000	25	25	$1,382.47	$1,382.47
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	1.00 Ea.	$910.17	$1,070.70	5.0000	5	5	$5,353.51	$5,353.51
Inspect and clean spray heads, emergency eye wash	3	2.00 Ea.	$104.12	$130.40	16.6667	16	16	$2,086.42	$2,086.42
Replace eye wash station, emergency eye wash	25	2.00 Ea.	$1,580.90	$1,923.10	2.0000	2	2	$3,846.19	$3,846.19
Overhaul water heater, gas / oil, 70 gallon	5	1.00 Ea.	$173.21	$216.94	10.0000	10	10	$2,169.40	$2,169.40
Clean & service water heater, gas / oil, 70 gallon	1	1.00 Ea.	$206.74	$258.93	50.0000	50	50	$12,946.42	$12,946.42
Replace water heater, gas / oil, 70 gallon	12	1.00 Ea.	$5,470.45	$6,302.52	4.1667	4	4	$25,210.08	$25,210.08
Unclog main drain pipe & fittings, cast iron	10	1.00 Ea.	$48.83	$61.15	5.0000	5	5	$305.77	$305.77
Replace pipe & fittings, cast iron, 4"	40	16.00 L.F.	$975.43	$1,182.15	1.2500	1	1	$1,182.15	$1,182.15
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.5000	2	2	$126.21	$126.21
Repair joint pipe and fittings, PVC	10	1.00 Ea.	$157.21	$195.91	5.0000	5	5	$979.56	$979.56
Replace pipe, 4" pipe and fittings, PVC	30	16.00 L.F.	$1,499.18	$1,834.72	1.6667	1	1	$1,834.72	$1,834.72
Replace pipe or gutter distribution	20	98.00 L.F.	$5,625.74	$6,830.75	2.5000	2	2	$13,661.50	$13,661.50
General maintenance & repair drain: roof, scupper, area	1	4.00 Ea.	$156.87	$196.47	50.0000	50	50	$9,823.67	$9,823.67
Replace drain: roof, scupper, area	40	4.00 Ea.	$4,385.43	$5,060.86	1.2500	1	1	$5,060.86	$5,060.86
Check and adjust 10 H.P. compressor	1	1.00 Ea.	$89.20	$111.72	50.0000	50	50	$5,585.83	$5,585.83
Replace 10 H.P. compressor	25	1.00 Ea.	$15,913.66	$18,508.80	2.0000	2	2	$37,017.59	$37,017.59
Replace fan & motor, propeller exhaust, 4700 CFM exhaust fan	15	2.00 Ea.	$4,525.85	$5,266.51	3.3333	3	3	$15,799.52	$15,799.52
Maintenance and repair standard suspended heater	2	4.00 Ea.	$475.76	$561.54	25.0000	25	25	$14,038.50	$14,038.50
Replace heater standard suspended heater	15	4.00 Ea.	$3,667.05	$4,237.21	3.3333	3	3	$12,711.62	$12,711.62
Repair single zone rooftop unit, 10 ton	10	1.00 Ea.	$24,855.18	$28,715.89	5.0000	5	5	$143,579.47	$143,579.47
Replace single zone rooftop unit, 10 ton	15	1.00 Ea.	$14,838.99	$17,558.91	3.3333	3	3	$52,676.73	$52,676.73
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	50.0000	50	50	$2,270.50	$2,270.50
Replace sprinkler head	20	20.00 Ea.	$1,833.81	$2,259.94	2.5000	2	2	$4,519.89	$4,519.89
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	50.0000	50	50	$45,152.64	$45,152.64
Replace fuse	25	22.00 Ea.	$13,369.63	$15,317.08	2.0000	2	2	$30,634.16	$30,634.16
Maintenance and repair motor starter, up to 600 V	5	2.00 Ea.	$699.10	$837.86	10.0000	10	10	$8,378.59	$8,378.59
Maintenance and inspection motor starter, up to 600 V	0.5	2.00 Ea.	$116.84	$146.58	100.0000	100	100	$14,657.93	$14,657.93
Replace starter motor starter, up to 600 V	18	2.00 Ea.	$1,637.91	$1,954.90	2.7778	2	2	$3,909.80	$3,909.80
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	16.6667	16	16	$1,758.95	$1,758.95
Maintenance and repair breaker, molded case, 480 V, 2 pole	20	9.00 Ea.	$695.58	$872.61	2.5000	2	2	$1,745.21	$1,745.21
Maintenance and repair breaker, enclosed, 240 V, 2 pole	25	26.00 Ea.	$2,009.45	$2,520.86	2.0000	2	2	$5,041.72	$5,041.72
Maintenance and repair safety switch general, 2 pole	8	1.00 Ea.	$43.82	$54.97	6.2500	6	6	$329.80	$329.80
Maintenance and inspection safety switch, 2 pole	1	1.00 Ea.	$43.82	$54.97	50.0000	50	50	$2,748.36	$2,748.36
Maintenance and repair receptacles and plugs	20	26.00 Ea.	$1,189.74	$1,486.56	2.5000	2	2	$2,973.12	$2,973.12
Maintenance and repair contactors and relays	3	12.00 Ea.	$3,283.06	$4,051.68	16.6667	16	16	$64,826.87	$64,826.87
Maintenance and repair wiring devices, switches	10	22.00 Ea.	$1,006.70	$1,257.86	5.0000	5	5	$6,289.29	$6,289.29
Replace fluorescent light fixture ballast, 80 W	10	18.00 Ea.	$1,960.78	$2,417.89	5.0000	5	5	$12,089.46	$12,089.46
Replace lamps (2 lamps), 4', 34 W energy saver	10	18.00 Ea.	$488.73	$612.83	5.0000	5	5	$3,064.16	$3,064.16
Replace metal halide ballast, 175 W	10	12.00 Ea.	$2,058.74	$2,465.97	5.0000	5	5	$12,329.83	$12,329.83
Replace metal halide fixture lamp, 175 W	5	12.00 Ea.	$730.07	$887.08	10.0000	10	10	$8,870.81	$8,870.81
Check and repair manual pull station	10	3.00 Ea.	$284.97	$350.72	5.0000	5	4	$1,753.60	$1,402.88
Replace manual pull station	15	3.00 Ea.	$690.23	$829.51	3.3333	3	3	$2,488.54	$2,488.54
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	10.0000	10	10	$1,954.25	$1,954.25
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	100.0000	100	100	$5,802.10	$5,802.10
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.3333	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.5000	2	2	$971.29	$971.29
Maintenance and repair electrical service ground	25	1.20 M.L.F.	$114.55	$143.20	2.0000	2	2	$286.40	$286.40
Remove and replace vehicle lift hydraulic pump	15	1.00 Ea.	$4,914.37	$5,605.41	3.3333	3	3	$16,816.22	$16,816.22
			$421,159.75	$499,567.27				MR Subtotal:	$1,331,990.44
								MR Per Year:	$26,639.81
								PM Total:	$15,994.62
								Subtotal:	$42,634.43
								Total Per Unit:	$5.43

FAC 2144 Vehicle Maintenance Shop, Reserve

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $5.43
UM: SF
Expected Service Life: 50
Model Size: 7857

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	3	0.78	$47.47	$35.20	$0.0000	82.67	97.97	115.65
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	6	24.42	$495.72	$1,104.09	$0.0000	1,599.81	1,980.61	2,386.19
Fire doors, swinging, annualized	2	0.78	$28.98	$32.15	$0.0000	61.13	73.67	87.66
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (vacuum breaker type), annualized	4	0.71	$36.74	$38.24	$0.0000	74.97	90.12	107.10
Lavatories, annualized	4	1.39	$30.87	$87.98	$0.0000	118.86	148.34	179.37
Drink fountain, annualized	2	1.24	$72.30	$66.83	$0.0000	139.13	166.41	197.31
Water heater, gas, to 120 gal., annualized	1	1.72	$88.42	$92.21	$0.0000	180.63	217.14	258.07
VAV Boxes, annualized	4	3.74	$38.10	$238.57	$0.0000	276.68	352.06	429.34
Unit heater, gas infrared, annualized	4	6.02	$265.74	$323.17	$0.0000	588.92	712.44	849.26
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Controls, central system, electro/pneumatic, annualized	8	15.37	$1,438.14	$981.36	$0.0000	2,419.50	2,857.73	3,367.86
Air compressor, centrifugal, to 40 H.P., annualized	1	3.41	$68.39	$218.27	$0.0000	286.66	358.98	434.72
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Extinguishing system, foam pump electric, annualized	1	17.72	$356.60	$951.75	$0.0000	1,308.36	1,629.54	1,968.56
Switchboard, annualized	2	1.40	$9.50	$100.60	$0.0000	110.10	141.23	172.83
Circuit breaker, high voltage air, annualized	8	3.76	$132.14	$266.93	$0.0000	399.06	492.36	592.25
Switch, interrupt, high voltage, w/ aux fuses, air, annualized	2	0.73	$33.03	$51.79	$0.0000	84.83	103.67	124.16
Motor control center, over 400 A, annualized	2	0.78	$51.90	$55.78	$0.0000	107.67	129.59	154.11
Hydraulic lift, annualized	1	1.55	$701.95	$58.70	$0.0000	760.65	848.46	971.36
Crane, electric bridge, over 15 tons, annualized	1	8.27	$464.60	$320.46	$0.0000	785.06	927.66	1,093.49
Hoist, pneumatic, annualized	2	2.62	$454.50	$102.43	$0.0000	556.93	633.11	732.01
						$11,104.21	$13,422.84	$15,994.62

FAC 2145 Vehicle Maintenance Facility

FY25 SUC:	$3,013.56 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2146 Launch Vehicle Test Facility

FY25 SUC:	$9,439.87 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Composite of multiple FACs

FAC 2146 SUC FY16v18 - Launch Vehicle Test Facility
UM: EA

Design Size: 1
ESL 50

Component	FAC	UM	Unit Cost (FY16)	Quantity	Labor Rate (+ Fringe and Overhead)
Missile Launch Pad	1162	SY	1.67	2500	$ 4,175.00
Miscellanious Operations Support Building	1444	SF	3.85	600	$ 2,310.00
				SUC	$ 6,485.00

References
FY15 Real Property Categization System

This SUC was determined using a combination of two other FACs; FAC 1162, Missile Launch Pad, and FAC 1444, Miscellaneous Operations Support Building. This is based on information received from Arnold AFB missile and civil engineering personnel. All other components of the test facility are considered equipment and not real property. The pad area is assumed to be 2,500 SY. The support facility is assumed to be 600 SF.

FAC 2147 Vehicle Maintenance Shed

FY25 SUC:	$0.44 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2151 Weapon Maintenance Shop

FY25 SUC:	$3.78 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2152 Weapon Maintenance Shop, Depot

FY25 SUC:	$3.39 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2153 Special Weapon Maintenance Shop

FY25 SUC:	$4.05 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2154 Weapon Maintenance Facility, Depot

FY25 SUC:	$4.92 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2161 Ammunition Maintenance Shop

FY25 SUC:	$6.14 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2162 Ammunition Maintenance Shop, Depot

FY25 SUC:	$6.40 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2163 Ammunition Maintenance Facility, Depot

FY25 SUC:	$7.62 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2171 Electronic and Communication Maintenance Shop

FY25 SUC:	$5.01 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2172 Electronic and Communication Maintenance Shop, Depot

FY25 SUC:	$3.77 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2173 Electronic and Communication Maintenance Facility

FY25 SUC:	$14,233.84 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2181 Installation Support Vehicle Maintenance Shop

FY25 SUC:	$5.24 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2182 Installation Support Equipment Maintenance Shop

FY25 SUC:	$5.01 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2183 Railroad Equipment Shop

FY25 SUC:	$5.22 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2184 Parachute And Dinghy Maintenance Shop

FY25 SUC:	$6.08 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2185 Installation Support Equipment Maintenance Shed

FY25 SUC:	$0.91 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2191 Facility Engineer Maintenance Shop

FY25 SUC:	$6.59 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2192 Facility Engineer Maintenance Facility

FY25 SUC:	$12,112.42 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2211 Aircraft Production Plant

FY25 SUC:	$2.37 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2213 Aircraft Production Structure

FY25 SUC:	$3.79 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2221 Missile Production Plant

FY25 SUC:	$3.71 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2231 Ship Production Plant

FY25 SUC:	$3.41 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2241 Tank/Automotive Production Plant

FY25 SUC:	$2.86 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2242 Tank/Automotive Production Structure

FY25 SUC:	$2.78 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2251 Weapon Production Plant

FY25 SUC:	$2.85 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2252 Weapon Production Structure

FY25 SUC:	$2.12 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2261 Ammunition Production Plant

FY25 SUC:	$7.69 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2262 Ammunition Production Structure

FY25 SUC:	$3.79 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2264 Ammunition Demilitarization Plant

FY25 SUC:	$14.34 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2265 Ammunition Demilitarization Structure

FY25 SUC:	$3,345.97 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2271 Electronic and Communication Production Plant

FY25 SUC:	$2.53 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2281 Miscellaneous Support Production Plant

FY25 SUC:	$5.94 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 2291 Construction Material Production Structure

FY25 SUC:	$44,582.50 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Commercial Sources

Original Source: R&K Study of Sustainment Activities of a Rock Quarry, 2021.

CostWorks 2020 Quarter 3 - FAC 2291Construction Material Production Plant									
Qty	Description	Labor Hours	Unit	Bare Mat.	Bare Labor	Bare Equip.	Total	Total Incl. O&P	Release
1.0	Conveyors, material handling, inclined belt, 10' rise with horizontal loader, 24" belt, 27.5' length	107	Ea.	9,475.00	5,000.00	0.00	14,475.00	18,200.00	2020 Qtr 3
2.0	Conveyors, material handling, gravity fed, 600 lb capacity, 24" wide		Ea.	1,130.00	0.00	0.00	1,130.00	1,250.00	2020 Qtr 3
1,200.0	Topsoil stripping and stockpiling, topsoil, clay, medium hard, adverse conditions, 300 HP dozer	0.011	C.Y.	0.00	576.00	1,932.00	2,508.00	3,036.00	2020 Qtr 3
2.0	Rough grading sites, open, 20,100-25,000 S.F, grader	11.429	Ea.	0.00	950.00	1,530.00	2,480.00	3,200.00	2020 Qtr 3
240.0	Rock removal, drilling only for rock quarry for hole for pre-splitting, 2-1/2" hole	0.096	L.F.	0.00	902.40	1,500.00	2,402.40	3,084.00	2020 Qtr 3
2.0	Public water supply wells, wells domestic water, pumps, 1 HP, 4" submersible, installed in wells to 1	6.987	Ea.	2,400.00	640.00	0.00	3,040.00	3,650.00	2020 Qtr 3
60.0	Public water supply wells, wells domestic water, well casing or drop pipe, PVC, 6" diameter	0.185	L.F.	639.00	417.00	411.00	1,467.00	1,800.00	2020 Qtr 3
760.0	Synthetic erosion control, tobacco netting, or jute mesh #2, stapled	0.01	S.Y.	334.40	266.00	0.00	600.40	790.40	2020 Qtr 3
	Totals			**$13,978.40**	**$8,751.40**	**$5,373.00**	**$28,102.80**	**$35,010.40**	

Notes: FAC 2291 continues to be modeled as a rock quarry. Sustainment activities include those activities necessary to maintain the quarry itself, not the rock crushing equipment operating in the quarry, as those are considered not real property, and an operational activity, not a sustainment activity.

Study Sources include:

- Quarry best practices published by the Natural Stone Council
- ANSI/NSC 373 Sustainability Assessment for Natural Dimensional Stone Products
- EPA BMPs for erosion control

FAC 3101 RDT&E Laboratory

FY25 SUC:	$8.52 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3102 Medical Research Laboratory

FY25 SUC:	$13.13 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3103 Biosafety Level 3 Laboratory

FY25 SUC:	$19.57 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3104 Biosafety Level 4 Laboratory

FY25 SUC:	$28.59 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 3104 Biosafety Level 4 Laboratory

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $28.59
UM: SF
Expected Service Life: 30
Model Size: 420

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair 3'-0" x 7'-0" steel sliding door steel painted	14	4.00 Ea.	$252.63	$303.88	2.1429	2	2	$607.77	$607.77
Refinish 3'-0" x 7'-0" steel sliding door steel painted	4	4.00 Ea.	$240.81	$296.10	7.5000	7	7	$2,072.68	$2,072.68
Replace epoxy flooring	15	3.60 C.S.F.	$4,541.09	$5,429.65	2.0000	2	2	$10,859.30	$10,859.30
Repair gypsum board ceiling - (2% of ceilings)	20	3.60 C.S.F.	$1,471.15	$1,803.86	1.5000	1	1	$1,803.86	$1,803.86
Replace faucet washer sink, laboratory	2	4.00 Ea.	$54.02	$67.38	15.0000	15	15	$1,010.75	$1,010.75
Replace faucets sink, laboratory	10	4.00 Ea.	$794.49	$955.13	3.0000	3	3	$2,865.40	$2,865.40
Inspect / clean shower head shower, terrazzo	3	1.00 Ea.	$52.06	$65.20	10.0000	10	10	$652.01	$652.01
Replace mixing valve shower, terrazzo	10	1.00 Ea.	$293.82	$357.52	3.0000	3	3	$1,072.56	$1,072.56
Replace terrazzo shower surface	30	1.00 Ea.	$1,402.04	$1,687.55	1.0000	1	1	$1,687.55	$1,687.55
Inspect and clean shower head emergency shower station	3	1.00 Ea.	$52.06	$65.20	10.0000	10	10	$652.01	$652.01
Replace shower emergency shower station	25	1.00 Ea.	$1,055.90	$1,263.20	1.2000	1	1	$1,263.20	$1,263.20
Inspect and clean spray heads, emergency eye wash	3	1.00 Ea.	$52.06	$65.20	10.0000	10	10	$652.01	$652.01
Replace eye wash station, emergency eye wash	25	1.00 Ea.	$790.45	$961.55	1.2000	1	1	$961.55	$961.55
Resolder joint pipe & fittings, copper	10	4.00 Ea.	$203.61	$251.14	3.0000	3	3	$753.43	$753.43
Inspect for leaks steam converter, domestic hot water	1	1.00 Ea.	$7.15	$8.95	30.0000	30	30	$268.56	$268.56
Replace steam converter, domestic hot water	20	1.00 Ea.	$3,334.62	$3,833.36	1.5000	1	1	$3,833.36	$3,833.36
Clean floor drain w/o bucket	4	2.00 Ea.	$247.26	$309.67	7.5000	7	7	$2,167.71	$2,167.71
General maintenance pipe & fittings, industrial gas	2	0.25 M.L.F.	$9.74	$12.20	15.0000	15	15	$182.97	$182.97
Resolder joint pipe & fittings, oxygen	12	4.00 Ea.	$334.23	$410.93	2.5000	2	2	$821.85	$821.85
Replace pipe and fittings, oxygen	25	14.00 L.F.	$335.93	$408.24	1.2000	1	1	$408.24	$408.24
General maintenance pipe & fittings, compressed air	2	0.25 M.L.F.	$9.74	$12.20	15.0000	15	15	$182.97	$182.97
Replace fan & motor, propeller exhaust, 375 CFM exhaust fan	15	2.00 Ea.	$1,264.50	$1,498.80	2.0000	2	2	$2,997.60	$2,997.60
Repack gate valve gland, 3/8" - 1-1/2" valves	10	2.00 Ea.	$59.12	$70.76	3.0000	3	3	$212.29	$212.29
Replace gate valve, partial, 3/8" - 1-1/2" valves	20	2.00 Ea.	$1,178.71	$1,363.99	1.5000	1	1	$1,363.99	$1,363.99
Repair circulator pump, 1/12 - 3/4 H.P.	5	1.00 Ea.	$104.83	$123.65	6.0000	6	6	$741.88	$741.88
Repair damaged pipe insulation, fiberglass 2"	5	2.00 Ea.	$54.99	$66.89	6.0000	6	6	$401.34	$401.34
Repair damaged pipe insulation, fiberglass 3"	5	2.00 Ea.	$62.58	$76.00	6.0000	6	6	$456.03	$456.03
Rebuild 4" diameter reduced pressure backflow preventer	10	0.10 Ea.	$101.06	$117.46	3.0000	3	3	$352.39	$352.39
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	30.0000	30	30	$1,362.30	$1,362.30
Replace sprinkler head	20	6.00 Ea.	$550.14	$677.98	1.5000	1	1	$677.98	$677.98
Maintenance and repair breaker, enclosed, 240 V, 2 pole	25	6.00 Ea.	$463.72	$581.74	1.2000	1	1	$581.74	$581.74
Maintenance and repair safety switch general, 2 pole	8	2.00 Ea.	$87.63	$109.93	3.7500	3	3	$329.80	$329.80
Replace 4-pin receptacle	20	6.00 Ea.	$959.64	$1,140.84	1.5000	1	1	$1,140.84	$1,140.84
Replace lamps (2 lamps), 4', 34 W energy saver	10	6.00 Ea.	$162.91	$204.28	3.0000	3	3	$612.83	$612.83
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	6.0000	6	6	$1,172.55	$1,172.55
Maintenance and inspection annunciation panel	0.5	0.50 Ea.	$23.13	$29.01	60.0000	60	60	$1,740.63	$1,740.63
Replace annunciation panel	15	0.50 Ea.	$625.20	$751.25	2.0000	2	2	$1,502.49	$1,502.49
Maintenance and repair electrical service ground	25	0.15 M.L.F.	$14.32	$17.90	1.2000	1	1	$17.90	$17.90
Maintenance and inspection generator, diesel, 750 KW	0.08	0.01 Ea.	$0.70	$0.88	375.0000	375	375	$329.23	$329.23
Replace diesel generator component, 750 KW	25	0.01 Ea.	$2,670.90	$3,057.54	1.2000	1	1	$3,057.54	$3,057.54
Maintenance and repair transfer switch	5	0.10 Ea.	$38.73	$46.75	6.0000	6	6	$280.52	$280.52
Replace transfer switch	18	0.10 Ea.	$3,073.40	$3,517.09	1.6667	1	1	$3,517.09	$3,517.09
Replace lamp emergency lighting fixture	2	2.00 Ea.	$114.63	$138.36	15.0000	15	15	$2,075.37	$2,075.37
Replace emergency lighting fixture	20	2.00 Ea.	$1,247.56	$1,472.99	1.5000	1	1	$1,472.99	$1,472.99
Maintenance and inspection UPS battery	0.17	1.00 Ea.	$69.98	$87.79	176.4706	176	176	$15,451.90	$15,451.90
Replace motor generator UPS battery	15	1.00 Ea.	$1,195.58	$1,413.61	2.0000	2	2	$2,827.23	$2,827.23
Maintenance and repair voice/data outlet	10	6.00 Ea.	$334.16	$417.69	3.0000	3	3	$1,253.07	$1,253.07
Replace glove box gloves	5	2.00 Ea.	$789.98	$923.87	6.0000	6	6	$5,543.25	$5,543.25
Replace fume hood sash	20	4.00 Ea.	$5,021.85	$5,769.35	1.5000	1	1	$5,769.35	$5,769.35
Remove and replace darkroom dryer fan	10	4.00 Ea.	$1,420.40	$1,647.66	3.0000	3	3	$4,942.99	$4,942.99
			$37,421.75	$44,133.01				MR Subtotal:	$96,964.85
								MR Per Year:	$3,232.16
								PM Total:	$8,777.03
								Subtotal:	$12,009.19
								Total Per Unit:	$28.59

FAC 3104 Biosafety Level 4 Laboratory

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $28.59
UM: SF
Expected Service Life: 30
Model Size: 420

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Fire doors, sliding, annually	4	1.66	$42.72	$64.30	$0.0000	107.02	130.59	156.29
Valve, butterfly, above 4", annually	1	0.17	$6.89	$8.93	$0.0000	15.81	19.18	22.89
Valve, check, above 4", annually	1	0.26	$6.89	$13.79	$0.0000	20.68	25.50	30.67
Oxygen monitor, annualized	1	5.00	$493.38	$270.72	$0.0000	764.10	894.66	1,049.88
Air handling unit, 3 thru 24 tons, annually	1	0.80	$76.69	$42.72	$0.0000	119.42	139.90	164.22
Fan coil unit, annually	1	1.46	$33.71	$78.68	$0.0000	112.38	139.36	168.02
Air filter, electrostatic, annually	4	8.72	$45.92	$466.99	$0.0000	512.91	657.60	804.59
Fan, axial, up to 5,000 CFM, annually	2	1.25	$13.78	$66.83	$0.0000	80.61	102.04	124.15
Hood and blower, annually	4	5.70	$181.72	$306.25	$0.0000	487.97	598.02	717.16
Controls, central system, electro/pneumatic, annualized	1	1.92	$179.77	$122.67	$0.0000	302.44	357.22	420.98
Air compressor, centrifugal, to 40 H.P., annualized	1	3.41	$68.39	$218.27	$0.0000	286.66	358.98	434.72
Steam humidification system, annualized	1	2.54	$28.33	$162.43	$0.0000	190.76	242.33	295.31
Dehumidifier, desiccant wheel, annualized	1	5.06	$73.27	$270.72	$0.0000	343.99	432.54	524.75
Backflow prevention device, up to 4", annually	2	0.67	$29.11	$42.30	$0.0000	71.41	87.02	104.07
Switchboard, annualized	1	0.70	$4.75	$50.30	$0.0000	55.05	70.61	86.41
Switch, interrupt, high voltage, w/ aux fuses, air, annualized	2	0.73	$33.03	$51.79	$0.0000	84.83	103.67	124.16
Motor control center, over 400 A, annualized	1	0.39	$25.95	$27.89	$0.0000	53.84	64.80	77.06
Emergency diesel or gas generator, up to 15 KVA, annually	1	1.49	$119.76	$94.12	$0.0000	213.88	254.09	300.30
Dishwasher, steam, annualized	2	9.46	$337.34	$359.40	$0.0000	696.74	838.29	996.71
Oven, convection, gas / electric, annualized	2	22.48	$105.04	$856.57	$0.0000	961.61	1,229.08	1,501.81
Vacuum, annualized	1	1.23	$26.26	$46.72	$0.0000	72.98	89.62	107.58
Reverse osmosis system, annualized	1	3.73	$193.17	$202.40	$0.0000	395.57	475.60	565.30
						$5,950.66	$7,310.70	$8,777.03

FAC 3111 Aircraft RDT&E Facility

FY25 SUC:	$8.33 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3121 Missile and Space RDT&E Facility

FY25 SUC:	$7.66 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3131 Ship and Marine RDT&E Facility

FY25 SUC:	$5.70 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3141 Tank and Automotive RDT&E Facility

FY25 SUC:	$6.26 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3151 Weapons RDT&E Facility

FY25 SUC:	$7.51 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 3151 Weapons RDT&E Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $7.51
UM: SF
Expected Service Life: 55
Model Size: 10713

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	455.00 S.F.	$18,511.39	$22,545.41	3.6667	3	3	$67,636.22	$67,636.22
Metal floor grating repairs - (2% of grating)	10	26.00 S.F.	$898.95	$1,082.55	5.5000	5	5	$5,412.76	$5,412.76
Replace metal floor grating	30	26.00 S.F.	$748.03	$863.08	1.8333	1	1	$863.08	$863.08
Repair 8" concrete block wall, 1st floor	25	1,233.00 S.F.	$33,011.60	$40,384.54	2.2000	2	2	$80,769.07	$80,769.07
Replace 8" concrete block wall, 1st floor	60	12.30 C.S.F.	$16,575.12	$20,004.22	0.9167	0	0	$0.00	$0.00
Waterproof concrete block wall, 1st floor	10	62.50 C.S.F.	$12,127.68	$14,614.12	5.5000	5	5	$73,070.59	$73,070.59
Replace 8" concrete block wall, 2nd floor	60	62.50 C.S.F.	$89,663.70	$108,401.55	0.9167	0	0	$0.00	$0.00
Waterproof concrete block wall, 2nd floor	10	62.50 C.S.F.	$50,394.01	$60,199.38	5.5000	5	5	$300,996.88	$300,996.88
Replace glass - 1st floor (1% of glass) - steel frame window	1	17.04 S.F.	$232.62	$273.14	55.0000	55	55	$15,022.54	$15,022.54
Repair 2'-0" x 3'-0" steel frame window - 1st floor.	20	22.00 Ea.	$3,552.96	$4,234.03	2.7500	2	2	$8,468.06	$8,468.06
Refinish 2'-0" x 3'-0" steel frame window - 1st floor.	5	22.00 Ea.	$1,999.23	$2,472.56	11.0000	11	11	$27,198.16	$27,198.16
Repair 2'-0" x 3'-0" steel frame window - 2nd floor.	20	35.00 Ea.	$7,442.06	$8,962.08	2.7500	2	2	$17,924.17	$17,924.17
Refinish 2'-0" x 3'-0" steel frame window - 2nd floor.	5	35.00 Ea.	$5,762.06	$7,145.14	11.0000	11	11	$78,596.59	$78,596.59
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	3.9286	3	3	$8,286.91	$8,286.91
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	1.2222	1	1	$2,569.71	$2,569.71
Replace tempered glass - (3% of glass) steel painted door	1	1.89 S.F.	$62.27	$73.51	55.0000	55	55	$4,043.02	$4,043.02
Repair 12' x 12' steel roll-up door	10	4.00 Ea.	$3,608.67	$4,252.49	5.5000	5	5	$21,262.45	$21,262.45
Refinish 12' x 12' steel roll-up door	5	4.00 Ea.	$1,024.19	$1,242.57	11.0000	11	11	$13,668.31	$13,668.31
Replace 12' x 12' steel roll-up door	35	4.00 Ea.	$14,434.69	$17,009.96	1.5714	1	1	$17,009.96	$17,009.96
Repair 12' x 12' aluminum single roll-up door	10	6.00 Ea.	$6,630.10	$7,710.62	5.5000	5	5	$38,553.08	$38,553.08
Replace 12' x 12' aluminum single roll-up door	35	6.00 Ea.	$25,732.75	$29,808.65	1.5714	1	1	$29,808.65	$29,808.65
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	214.00 S.F.	$1,037.53	$1,231.27	11.0000	11	11	$13,543.92	$13,543.92
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	4.20 S.F.	$118.69	$141.24	55.0000	55	55	$7,768.14	$7,768.14
Minor metal roof panel replacement, 2.5% of roof area	20	267.00 S.F.	$3,692.81	$4,368.14	2.7500	2	2	$8,736.28	$8,736.28
Total metal roof panel replacement	30	108.00 Sq.	$103,811.23	$122,759.62	1.8333	1	1	$122,759.62	$122,759.62
Repair steel painted interior door	14	3.00 Ea.	$890.55	$1,038.97	3.9286	3	3	$3,116.90	$3,116.90
Refinish 3'-0" x 7'-0" steel painted interior door	4	3.00 Ea.	$180.61	$222.07	13.7500	13	13	$2,886.95	$2,886.95
Replace 3'-0" x 7'-0" steel painted interior door	60	3.00 Ea.	$4,228.55	$4,898.40	0.9167	0	0	$0.00	$0.00
Safety glass replacement, (3% of glass) steel painted interior door	1	1.89 S.F.	$48.53	$57.25	55.0000	55	55	$3,148.74	$3,148.74
Repair solid core wood door, interior	11	8.00 Ea.	$2,374.80	$2,770.57	5.0000	5	5	$13,852.87	$13,852.87
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	8.00 Ea.	$437.45	$532.18	13.7500	13	12	$6,918.29	$6,386.12
Replace 3'-0" x 7'-0" solid core wood door, interior	40	8.00 Ea.	$5,150.22	$5,938.40	1.3750	1	1	$5,938.40	$5,938.40
Repair 5/8" drywall - (2% of walls)	20	625.00 S.F.	$1,167.50	$1,420.09	2.7500	2	2	$2,840.18	$2,840.18
Refinish drywall	4	1,399.00 S.F.	$1,010.16	$1,238.68	13.7500	13	13	$16,102.84	$16,102.84
Replace 5/8" drywall	75	1,399.00 S.F.	$3,608.04	$4,416.04	0.7333	0	0	$0.00	$0.00
Refinish concrete floor finished	25	64.00 C.S.F.	$29,344.81	$35,255.93	2.2000	2	2	$70,511.86	$70,511.86
Replace vinyl tile flooring	18	35.78 S.Y.	$2,023.65	$2,477.02	3.0556	3	3	$7,431.05	$7,431.05
Replace carpet	8	81.78 S.Y.	$4,555.02	$5,267.52	6.8750	6	6	$31,605.10	$31,605.10
Replace acoustic tile ceiling, fire-rated	20	10.57 C.S.F.	$6,603.00	$7,765.10	2.7500	2	2	$15,530.20	$15,530.20
Replace flush valve diaphragm tankless water closet	10	7.00 Ea.	$193.13	$239.93	5.5000	5	5	$1,199.67	$1,199.67
Rebuild flush valve tankless water closet	20	7.00 Ea.	$1,352.90	$1,630.68	2.7500	2	2	$3,261.36	$3,261.36
Replace tankless water closet	35	7.00 Ea.	$9,636.60	$11,152.37	1.5714	1	1	$11,152.37	$11,152.37
Replace tankless flush valve	25	7.00 Ea.	$1,908.59	$2,240.20	2.2000	2	2	$4,480.39	$4,480.39
Replace wax ring gasket for tankless water closet	5	7.00 Ea.	$1,048.28	$1,311.67	11.0000	11	11	$14,428.41	$14,428.41
Replace flush valve diaphragm for a urinal	7	4.00 Ea.	$110.36	$137.10	7.8571	7	7	$959.73	$959.73
Rebuild flush valve for a urinal	20	4.00 Ea.	$773.08	$931.82	2.7500	2	2	$1,863.63	$1,863.63
Replace wall-hung urinal	35	4.00 Ea.	$4,369.16	$5,257.55	1.5714	1	1	$5,257.55	$5,257.55
Replace washer in spud connection lavatory, vitreous china	7	12.00 Ea.	$208.72	$254.80	7.8571	7	7	$1,783.63	$1,783.63
Replace washer in faucet lavatory, vitreous china	2	12.00 Ea.	$163.17	$203.55	27.5000	27	27	$5,495.97	$5,495.97
Replace faucets lavatory, vitreous china	10	12.00 Ea.	$2,383.47	$2,865.40	5.5000	5	5	$14,327.01	$14,327.01
Replace lavatory, vitreous china	35	12.00 Ea.	$9,016.51	$10,810.62	1.5714	1	1	$10,810.62	$10,810.62
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	27.5000	27	27	$454.84	$454.84
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	18.3333	18	18	$203.29	$203.29
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	5.5000	5	5	$1,193.92	$1,193.92
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	27.5000	27	27	$1,493.07	$1,493.07
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	1.00 Ea.	$910.17	$1,070.70	5.5000	5	5	$5,353.51	$5,353.51
Inspect and clean shower head emergency shower station	3	4.00 Ea.	$208.23	$260.80	18.3333	18	18	$4,694.44	$4,694.44
Replace shower emergency shower station	25	4.00 Ea.	$4,223.59	$5,052.79	2.2000	2	2	$10,105.57	$10,105.57
Inspect and clean spray heads, emergency eye wash	3	4.00 Ea.	$208.23	$260.80	18.3333	18	18	$4,694.44	$4,694.44
Replace eye wash station, emergency eye wash	25	4.00 Ea.	$3,161.79	$3,846.19	2.2000	2	2	$7,692.38	$7,692.38
Overhaul water heater, gas / oil, 70 gallon	5	2.00 Ea.	$346.43	$433.88	11.0000	11	11	$4,772.69	$4,772.69
Clean & service water heater, gas / oil, 70 gallon	1	2.00 Ea.	$413.48	$517.86	55.0000	55	55	$28,482.13	$28,482.13
Replace water heater, gas / oil, 70 gallon	12	2.00 Ea.	$10,940.89	$12,605.04	4.5833	4	4	$50,420.16	$50,420.16
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	1.00 Ea.	$8.47	$10.60	110.0000	110	110	$1,166.48	$1,166.48
Replace pump / motor assembly circulation pump, 1/12 HP	10	1.00 Ea.	$1,265.32	$1,479.95	5.5000	5	5	$7,399.75	$7,399.75
General maintenance & repair drain: roof, scupper, area	1	10.00 Ea.	$392.18	$491.18	55.0000	55	55	$27,015.09	$27,015.09
Replace drain: roof, scupper, area	40	10.00 Ea.	$10,963.57	$12,652.16	1.3750	1	1	$12,652.16	$12,652.16
Install new 4" gasket, 1 per M.L.F. natural gas, steel/iron	30	1.00 Ea.	$221.12	$274.79	1.8333	1	1	$274.79	$274.79
Replace 10' of buried 4" diam steel pipe/M.L.F. natural gas	12	1.00 Ea.	$914.79	$1,117.74	4.5833	4	4	$4,470.94	$4,470.94
Repair boiler, gas, 250 MBH	7	1.00 Ea.	$2,552.63	$2,989.56	7.8571	7	6	$20,926.92	$17,937.36
Replace boiler, gas, 250 MBH	30	1.00 Ea.	$1,636.25	$2,049.31	1.8333	1	1	$2,049.31	$2,049.31
Repair reciprocating chiller, air cooled, 50 ton	10	1.00 Ea.	$66,267.78	$77,438.92	5.5000	5	5	$387,194.59	$387,194.59
Replace chiller, air cooled, 50 ton	20	1.00 Ea.	$67,003.25	$78,054.47	2.7500	2	2	$156,108.95	$156,108.95
Replace roof mounted exhaust fan, 800 CFM exhaust fan	20	4.00 Ea.	$6,902.29	$8,090.51	2.7500	2	2	$16,181.03	$16,181.03
Replace roof mounted exhaust fan, 2000 CFM exhaust fan	20	4.00 Ea.	$12,060.61	$14,013.27	2.7500	2	2	$28,026.55	$28,026.55
Repair circulator pump, 1 H.P.	5	1.00 Ea.	$105.05	$123.93	11.0000	11	8	$1,363.26	$991.46
Replace circulator. pump, 1 H.P.	15	1.00 Ea.	$5,461.13	$6,269.02	3.6667	3	3	$18,807.06	$18,807.06
Repair terminal reheat, 36" x 36" coil	10	12.00 Ea.	$2,069.46	$2,591.89	5.5000	5	5	$12,959.43	$12,959.43
Replace terminal reheat, 36" x 36" coil	15	12.00 Ea.	$46,888.41	$54,421.17	3.6667	3	3	$163,263.50	$163,263.50
Repair central station A.H.U., 16,000 CFM	10	3.00 Ea.	$6,393.46	$7,389.92	5.5000	5	4	$36,949.62	$29,559.70
Replace central station A.H.U., 16,000 CFM	15	3.00 Ea.	$225,397.13	$259,280.59	3.6667	3	3	$777,841.76	$777,841.76
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	55.0000	55	55	$2,497.55	$2,497.55
Replace sprinkler head	20	48.00 Ea.	$4,401.15	$5,423.87	2.7500	2	2	$10,847.74	$10,847.74
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	55.0000	55	55	$49,667.91	$49,667.91
Repair switchgear 1200 A mainframe	5	2.00 Ea.	$4,137.36	$4,840.15	11.0000	11	9	$53,241.66	$43,561.36
Maintenance and inspection switchgear, mainframe	1	2.00 Ea.	$139.97	$175.59	55.0000	55	55	$9,657.44	$9,657.44
Replace switchgear 1200 A mainframe	20	2.00 Ea.	$9,016.12	$10,863.30	2.7500	2	2	$21,726.60	$21,726.60
Replace fuse	25	42.00 Ea.	$25,523.84	$29,241.70	2.2000	2	2	$58,483.40	$58,483.40
Repair switchboard meter	10	2.00 Ea.	$2,643.78	$3,107.82	5.5000	5	5	$15,539.10	$15,539.10
Maintenance and inspection lighting panel, indoor	3	3.00 Ea.	$131.45	$164.90	18.3333	18	18	$2,968.23	$2,968.23
Repair failed breaker, molded case, 600 V, 3 pole	10	5.00 Ea.	$2,022.21	$2,406.52	5.5000	5	5	$12,032.61	$12,032.61
Maintenance and inspection circuit breaker, enclosed, 240 V, 3 pole	1	12.00 Ea.	$416.25	$522.19	55.0000	55	55	$28,720.39	$28,720.39
Replace safety switch, heavy duty 100 A	25	4.00 Ea.	$6,648.89	$7,801.52	2.2000	2	2	$15,603.04	$15,603.04
Maintenance and repair safety switch general, 2 pole	8	3.00 Ea.	$131.45	$164.90	6.8750	6	6	$989.41	$989.41
Maintenance and inspection safety switch, 2 pole	1	3.00 Ea.	$131.45	$164.90	55.0000	55	55	$9,069.60	$9,069.60
Replace safety switch, 240 V, 2 pole	25	2.00 Ea.	$979.90	$1,184.41	2.2000	2	2	$2,368.82	$2,368.82
Replace fluorescent light fixture ballast, 80 W	10	48.00 Ea.	$5,228.74	$6,447.71	5.5000	5	5	$32,238.56	$32,238.56
Replace lamps (2 lamps), 4', 34 W energy saver	10	35.00 Ea.	$950.31	$1,191.62	5.5000	5	5	$5,958.08	$5,958.08
Replace metal halide ballast, 175 W	10	28.00 Ea.	$4,803.72	$5,753.92	5.5000	5	5	$28,769.61	$28,769.61
Replace metal halide fixture lamp, 175 W	5	28.00 Ea.	$1,703.50	$2,069.86	11.0000	11	11	$22,768.42	$22,768.42
Repair smoke detector	10	29.00 Ea.	$1,762.19	$2,180.95	5.5000	5	4	$10,904.75	$8,723.80
Replace smoke detector	15	29.00 Ea.	$9,785.22	$11,643.71	3.6667	3	3	$34,931.14	$34,931.14
Repair heat detector	10	34.00 Ea.	$2,252.64	$2,769.05	5.5000	5	5	$13,845.26	$13,845.26
Check operation heat detector	1	34.00 Ea.	$593.83	$744.96	55.0000	55	55	$40,972.74	$40,972.74
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	5.5000	5	4	$3,507.20	$2,805.76
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	3.6667	3	3	$4,977.08	$4,977.08
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.6667	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.7500	2	2	$971.29	$971.29
Maintenance and repair of general wiring lightning protection system	1	2.20 M.L.F.	$244.91	$302.19	55.0000	55	55	$16,620.47	$16,620.47
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	55.0000	55	55	$13,126.62	$13,126.62
Maintenance and repair special ground system	4	2.00 Ea.	$46.49	$58.33	13.7500	13	13	$758.24	$758.24
Replace special ground system	50	2.30 M.L.F.	$6,114.87	$7,348.21	1.1000	1	1	$7,348.21	$7,348.21
Replace lamp emergency lighting fixture	2	12.00 Ea.	$687.79	$830.15	27.5000	27	27	$22,413.94	$22,413.94
Maintenance and repair exit light	20	20.00 Ea.	$798.31	$988.12	2.7500	2	2	$1,976.24	$1,976.24
Replace lamp exit light	5	20.00 Ea.	$365.97	$433.82	11.0000	11	11	$4,771.97	$4,771.97
Maintenance and repair voice/data outlet	10	28.00 Ea.	$1,559.42	$1,949.21	5.5000	5	5	$9,746.07	$9,746.07
Replace voice/data outlet	20	28.00 Ea.	$792.88	$965.61	2.7500	2	2	$1,931.23	$1,931.23
Replace patch panel	15	4.00 Ea.	$3,788.72	$4,553.23	3.6667	3	3	$13,659.68	$13,659.68
			$1,079,257.42	$1,271,975.56				MR Subtotal:	$3,591,903.86
								MR Per Year:	$65,307.34
								PM Total:	$15,111.86
								Subtotal:	$80,419.20
								Total Per Unit:	$7.51

FAC 3151 Weapons RDT&E Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $7.51
UM: SF
Expected Service Life: 55
Model Size: 10713

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	7	28.49	$578.34	$1,288.10	$0.0000	1,866.45	2,310.71	2,783.89
Fire doors, swinging, annualized	3	1.18	$43.47	$48.22	$0.0000	91.69	110.51	131.49
Urinals, annualized	3	0.68	$20.52	$36.80	$0.0000	57.32	70.41	84.53
Toilet (vacuum breaker type), annualized	7	1.24	$64.29	$66.92	$0.0000	131.21	157.71	187.43
Lavatories, annualized	12	4.18	$92.62	$263.95	$0.0000	356.57	445.02	538.10
Valve, globe, above 4", annualized	4	0.64	$27.55	$34.18	$0.0000	61.73	74.74	89.12
Water heater, gas, to 120 gal., annualized	1	1.72	$88.42	$92.21	$0.0000	180.63	217.14	258.07
Valve, pressure relief, above 4", annualized	2	0.30	$12.21	$15.90	$0.0000	28.12	34.11	40.71
Boiler, hot water, oil, gas, or comb. fired, 120 - 500 MBH, annualized	1	15.88	$90.37	$1,015.20	$0.0000	1,105.57	1,419.17	1,737.29
Pump, condensate return, over 1 H.P., annualized	1	1.12	$68.88	$71.91	$0.0000	140.79	169.25	201.15
Chiller, recip., air cooled, over 25 tons, annualized	1	12.89	$98.68	$824.85	$0.0000	923.53	1,180.85	1,443.11
Air handling unit, 25 thru 50 tons, annualized	2	3.88	$457.24	$208.12	$0.0000	665.35	773.51	904.53
VAV Boxes, annualized	12	11.21	$114.31	$715.72	$0.0000	830.02	1,056.17	1,288.03
Fan, axial, up to 5,000 CFM, annualized	3	3.73	$41.33	$200.50	$0.0000	241.83	306.11	372.46
Hood and blower, annualized	2	4.64	$119.19	$248.72	$0.0000	367.92	454.45	546.95
Steam humidification system, annualized	1	2.54	$28.33	$162.43	$0.0000	190.76	242.33	295.31
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, deluge / preaction, annualized	1	11.59	$54.71	$731.79	$0.0000	786.50	1,011.51	1,239.25
Switchboard, annualized	3	2.10	$14.25	$150.89	$0.0000	165.15	211.84	259.24
Circuit breaker, high voltage air, annualized	7	3.29	$115.62	$233.56	$0.0000	349.18	430.81	518.22
Transformer, dry type 500 KVA and over, annualized	2	1.54	$33.03	$109.56	$0.0000	142.59	178.77	216.59
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Motor control center, over 400 A, annualized	1	0.39	$25.95	$27.89	$0.0000	53.84	64.80	77.06
Light, emergency, hardwired system, annualized	12	3.00	$108.98	$189.44	$0.0000	298.42	366.15	439.33
Crane, electric bridge, up to 5 ton, annualized	2	5.83	$494.90	$226.42	$0.0000	721.32	838.74	980.90
Vacuum, annualized	1	1.23	$26.26	$46.72	$0.0000	72.98	89.62	107.58
						$10,090.04	$12,527.23	$15,111.86

FAC 3161 Ammunition, Explosive, and Toxic RDT&E Facility

FY25 SUC:	$11.38 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3171 Electronic and Communication RDT&E Facility

FY25 SUC:	$7.86 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 3171 Electronic and Communication RDT&E Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $7.86
UM: SF
Expected Service Life: 55
Model Size: 11856

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	234.00 S.F.	$9,520.14	$11,594.78	3.6667	3	3	$34,784.34	$34,784.34
Refinish concrete steps	3	32.00 S.F.	$55.94	$68.81	18.3333	18	18	$1,238.56	$1,238.56
Refinish metal hand rail	7	12.00 L.F.	$25.15	$31.04	7.8571	7	7	$217.28	$217.28
Waterproof concrete block wall, 1st floor	10	32.40 C.S.F.	$6,286.99	$7,575.96	5.5000	5	5	$37,879.79	$37,879.79
Point and refinish painted concrete block wall, 1st floor	25	32.40 C.S.F.	$17,762.48	$21,830.11	2.2000	2	2	$43,660.23	$43,660.23
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	5.20 S.F.	$70.99	$83.35	55.0000	55	55	$4,584.34	$4,584.34
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	54.00 Ea.	$8,720.89	$10,392.62	2.7500	2	2	$20,785.24	$20,785.24
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	54.00 Ea.	$44,375.24	$51,846.12	1.1000	1	1	$51,846.12	$51,846.12
Repair aluminum storefront door	12	2.00 Ea.	$1,099.17	$1,310.67	4.5833	4	4	$5,242.68	$5,242.68
Replace insulating glass - (3% of glass) aluminum storefront door	1	1.20 S.F.	$81.12	$94.47	55.0000	55	55	$5,195.90	$5,195.90
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	3.9286	3	3	$11,049.22	$11,049.22
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.00 Ea.	$191.97	$235.01	13.7500	13	13	$3,055.13	$3,055.13
Replace 3'-0" x 7'-0" steel, painted, door	45	4.00 Ea.	$2,943.44	$3,426.28	1.2222	1	1	$3,426.28	$3,426.28
Replace tempered glass - (3% of glass) steel painted door	1	1.89 S.F.	$62.27	$73.51	55.0000	55	55	$4,043.02	$4,043.02
Repair 12' x 12' steel roll-up door	10	2.00 Ea.	$1,804.34	$2,126.24	5.5000	5	5	$10,631.22	$10,631.22
Replace 12' x 12' steel roll-up door	35	2.00 Ea.	$7,217.35	$8,504.98	1.5714	1	1	$8,504.98	$8,504.98
Debris removal and visual inspection of built-up roofing	0.5	11.90 M.S.F.	$483.88	$590.95	110.0000	110	110	$65,004.44	$65,004.44
BUR flashing repairs, 2 S.F. per sq. repaired	1	2.40 S.F.	$9.21	$11.19	55.0000	55	55	$615.49	$615.49
Minor BUR membrane replacement, 25% of roof area	15	29.70 Sq.	$29,906.65	$35,303.68	3.6667	3	3	$105,911.04	$105,911.04
Total BUR roof replacement	28	119.00 Sq.	$115,708.92	$136,179.51	1.9643	1	1	$136,179.51	$136,179.51
Replace Roof edges, aluminum, duranodic, .050" thick, 6" face	25	490.00 L.F.	$15,029.61	$17,750.88	2.2000	2	2	$35,501.76	$35,501.76
Replace aluminum gutter, enameled, 5" K type, .027 " thick	40	490.00 L.F.	$5,300.88	$6,388.83	1.3750	1	1	$6,388.83	$6,388.83
Replace aluminum downspout, 3" x 4", .024" thick	25	96.00 L.F.	$1,100.08	$1,311.30	2.2000	2	2	$2,622.60	$2,622.60
Repair steel painted interior door	14	4.00 Ea.	$1,187.40	$1,385.29	3.9286	3	3	$4,155.86	$4,155.86
Refinish 3'-0" x 7'-0" steel painted interior door	4	4.00 Ea.	$240.81	$296.10	13.7500	13	13	$3,849.27	$3,849.27
Replace 3'-0" x 7'-0" steel painted interior door	60	4.00 Ea.	$5,638.07	$6,531.20	0.9167	0	0	$0.00	$0.00
Safety glass replacement, (3% of glass) steel painted interior door	1	1.89 S.F.	$48.53	$57.25	55.0000	55	55	$3,148.74	$3,148.74
Repair solid core wood door, interior	11	18.00 Ea.	$5,343.30	$6,233.79	5.0000	5	5	$31,168.96	$31,168.96
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	18.00 Ea.	$984.27	$1,197.40	13.7500	13	12	$15,566.16	$14,368.77
Replace 3'-0" x 7'-0" solid core wood door, interior	40	18.00 Ea.	$11,587.99	$13,361.41	1.3750	1	1	$13,361.41	$13,361.41
Replace brass lockset interior	30	28.00 Ea.	$8,212.79	$9,564.03	1.8333	1	1	$9,564.03	$9,564.03
Repair 5/8" drywall - (2% of walls)	20	44.00 S.F.	$82.19	$99.97	2.7500	2	2	$199.95	$199.95
Refinish drywall	4	2,200.00 S.F.	$1,588.53	$1,947.89	13.7500	13	13	$25,322.55	$25,322.55
Repair 4" x 4" thin set ceramic tile - (2% of walls)	10	22.80 C.S.F.	$20,999.65	$25,274.32	5.5000	5	5	$126,371.60	$126,371.60
Refinish concrete floor finished	25	35.70 C.S.F.	$16,368.90	$19,666.20	2.2000	2	2	$39,332.40	$39,332.40
Replace vinyl sheet flooring	18	493.00 S.Y.	$39,328.18	$47,691.11	3.0556	3	3	$143,073.34	$143,073.34
Replace rubber tile floor	18	132.00 S.Y.	$15,225.63	$18,531.15	3.0556	3	3	$55,593.46	$55,593.46
Replace carpet	8	89.00 S.Y.	$4,957.17	$5,732.56	6.8750	6	6	$34,395.37	$34,395.37
Replace acoustic tile ceiling, fire-rated	20	79.30 C.S.F.	$49,538.13	$58,256.61	2.7500	2	2	$116,513.22	$116,513.22
Replace flush valve diaphragm tankless water closet	10	6.00 Ea.	$165.54	$205.66	5.5000	5	5	$1,028.29	$1,028.29
Rebuild flush valve tankless water closet	20	6.00 Ea.	$1,159.63	$1,397.72	2.7500	2	2	$2,795.45	$2,795.45
Unplug clogged line tankless water closet	5	6.00 Ea.	$1,378.69	$1,726.73	11.0000	11	11	$18,994.00	$18,994.00
Replace flush valve diaphragm for a urinal	7	4.00 Ea.	$110.36	$137.10	7.8571	7	7	$959.73	$959.73
Rebuild flush valve for a urinal	20	4.00 Ea.	$773.08	$931.82	2.7500	2	2	$1,863.63	$1,863.63
Replace washer in spud connection lavatory, vitreous china	7	6.00 Ea.	$104.36	$127.40	7.8571	7	7	$891.82	$891.82
Replace washer in faucet lavatory, vitreous china	2	6.00 Ea.	$81.59	$101.78	27.5000	27	27	$2,747.98	$2,747.98
Replace faucets lavatory, vitreous china	10	6.00 Ea.	$1,191.74	$1,432.70	5.5000	5	5	$7,163.50	$7,163.50
Clean out strainer and P trap lavatory, vitreous china	2	6.00 Ea.	$222.53	$278.71	27.5000	27	27	$7,525.06	$7,525.06
Replace faucet washer sink, iron enamel	2	2.00 Ea.	$27.01	$33.69	27.5000	27	27	$909.67	$909.67
Clean trap sink, iron enamel	3	2.00 Ea.	$18.04	$22.59	18.3333	18	18	$406.58	$406.58
Replace faucets sink, iron enamel	10	2.00 Ea.	$397.25	$477.57	5.5000	5	5	$2,387.83	$2,387.83
Unstop sink, iron enamel	2	2.00 Ea.	$88.31	$110.60	27.5000	27	27	$2,986.13	$2,986.13
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	2.00 Ea.	$1,820.34	$2,141.40	5.5000	5	5	$10,707.01	$10,707.01
Replace faucet washer sink, laboratory	2	2.00 Ea.	$27.01	$33.69	27.5000	27	27	$909.67	$909.67
Replace faucets sink, laboratory	10	2.00 Ea.	$397.25	$477.57	5.5000	5	5	$2,387.83	$2,387.83
Replace sink and fittings, polyethylene lab.	15	2.00 Ea.	$4,671.16	$5,451.16	3.6667	3	3	$16,353.48	$16,353.48
Inspect and clean shower head emergency shower station	3	2.00 Ea.	$104.12	$130.40	18.3333	18	18	$2,347.22	$2,347.22
Replace shower emergency shower station	25	2.00 Ea.	$2,111.80	$2,526.39	2.2000	2	2	$5,052.79	$5,052.79
Inspect and clean spray heads, emergency eye wash	3	2.00 Ea.	$104.12	$130.40	18.3333	18	18	$2,347.22	$2,347.22
Replace eye wash station, emergency eye wash	25	2.00 Ea.	$1,580.90	$1,923.10	2.2000	2	2	$3,846.19	$3,846.19
Replace pipe and fittings, copper 3/4"	20	136.00 L.F.	$3,277.40	$3,983.45	2.7500	2	2	$7,966.90	$7,966.90
Replace threaded steel pipe and fittings, 3/4"	75	28.00 L.F.	$693.92	$843.24	0.7333	0	0	$0.00	$0.00
Overhaul water heater, gas / oil, 70 gallon	5	2.00 Ea.	$346.43	$433.88	11.0000	11	11	$4,772.69	$4,772.69
Clean & service water heater, gas / oil, 70 gallon	1	2.00 Ea.	$413.48	$517.86	55.0000	55	55	$28,482.13	$28,482.13
Replace water heater, gas / oil, 70 gallon	12	2.00 Ea.	$10,940.89	$12,605.04	4.5833	4	4	$50,420.16	$50,420.16
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	2.00 Ea.	$16.93	$21.21	110.0000	110	110	$2,332.96	$2,332.96
Replace pump / motor assembly circulation pump, 1/12 HP	10	2.00 Ea.	$2,530.64	$2,959.90	5.5000	5	5	$14,799.51	$14,799.51
Unclog main drain pipe & fittings, cast iron	10	4.00 Ea.	$195.31	$244.62	5.5000	5	5	$1,223.08	$1,223.08
Unclog floor drain, PVC	20	4.00 Ea.	$201.54	$252.42	2.7500	2	2	$504.85	$504.85
Replace pipe, 4" pipe and fittings, PVC	30	26.00 L.F.	$2,436.16	$2,981.42	1.8333	1	1	$2,981.42	$2,981.42
Clean out bucket floor drain with bucket	5	1.00 Ea.	$310.63	$389.04	11.0000	11	11	$4,279.48	$4,279.48
General maintenance & repair drain: roof, scupper, area	1	4.00 Ea.	$156.87	$196.47	55.0000	55	55	$10,806.03	$10,806.03
Replace drain: roof, scupper, area	40	4.00 Ea.	$4,385.43	$5,060.86	1.3750	1	1	$5,060.86	$5,060.86
Replace 10' of buried 4" diam steel pipe/M.L.F. natural gas	12	1.00 Ea.	$914.79	$1,117.74	4.5833	4	4	$4,470.94	$4,470.94
Repair boiler, gas, 2000 MBH	7	1.00 Ea.	$5,513.06	$6,436.35	7.8571	7	6	$45,054.46	$38,618.11
Replace boiler, gas, 2000 MBH	30	1.00 Ea.	$47,742.79	$55,703.30	1.8333	1	1	$55,703.30	$55,703.30
Repair feed water supply pump	15	1.00 Ea.	$5,954.06	$6,852.08	3.6667	3	3	$20,556.25	$20,556.25
Replace metal flue, all fuel SS, 6" diameter metal flue / chimney	15	22.00 L.F.	$4,079.40	$4,701.41	3.6667	3	3	$14,104.22	$14,104.22
Repair fan coil unit, 30 ton	10	3.00 Ea.	$6,323.33	$7,302.10	5.5000	5	4	$36,510.48	$29,208.39
Replace fan coil unit, 30 ton	15	3.00 Ea.	$47,176.13	$55,006.07	3.6667	3	3	$165,018.22	$165,018.22
Repair fan, induced draft, 6700 CFM	10	1.00 Ea.	$320.21	$391.19	5.5000	5	5	$1,955.94	$1,955.94
Replace fan, induced draft, 6700 CFM	20	1.00 Ea.	$6,653.12	$7,665.34	2.7500	2	2	$15,330.67	$15,330.67
Replace fan & motor, propeller exhaust, 1000 CFM exhaust fan	15	1.00 Ea.	$930.97	$1,096.55	3.6667	3	3	$3,289.65	$3,289.65
Maintenance and repair explosionproof industrial heater	2	2.00 Ea.	$440.91	$515.28	27.5000	27	26	$13,912.64	$13,397.35
Replace heater explosionproof industrial heater	15	2.00 Ea.	$12,612.52	$14,413.14	3.6667	3	3	$43,239.41	$43,239.41
Repair computer room A/C, chilled water, 5 ton	10	1.00 Ea.	$8,563.09	$10,023.23	5.5000	5	3	$50,116.14	$30,069.68
Replace computer room A/C, chilled water, 5 ton	20	1.00 Ea.	$27,791.95	$31,888.67	2.7500	2	2	$63,777.34	$63,777.34
Repair multi-zone variable volume, 50 ton	10	1.00 Ea.	$67,021.73	$78,316.33	5.5000	5	4	$391,581.65	$313,265.32
Replace multi-zone variable volume, 50 ton	15	1.00 Ea.	$141,742.49	$164,363.22	3.6667	3	3	$493,089.65	$493,089.65
Repair central station A.H.U., 1300 CFM	10	1.00 Ea.	$601.37	$713.88	5.5000	5	4	$3,569.42	$2,855.54
Replace central station A.H.U., 1300 CFM	15	1.00 Ea.	$10,673.04	$12,341.31	3.6667	3	3	$37,023.92	$37,023.92
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	55.0000	55	55	$2,497.55	$2,497.55
Replace sprinkler head	20	60.00 Ea.	$5,501.44	$6,779.83	2.7500	2	2	$13,559.67	$13,559.67
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	55.0000	55	55	$49,667.91	$49,667.91
Repair 15 KV primary transformer, dry	15	1.00 Ea.	$245.95	$300.05	3.6667	3	3	$900.16	$900.16
Maintenance and inspection primary transformer, dry	0.5	1.00 Ea.	$43.82	$54.97	110.0000	110	110	$6,046.40	$6,046.40
Replace fuse	25	24.00 Ea.	$14,585.05	$16,709.54	2.2000	2	2	$33,419.08	$33,419.08
Repair switchboard meter	10	4.00 Ea.	$5,287.56	$6,215.64	5.5000	5	5	$31,078.20	$31,078.20
Maintenance and repair rectifier, up to 600 V	2	1.00 Ea.	$744.52	$887.31	27.5000	27	25	$23,957.40	$22,182.78
Replace rectifier, up to 600 V	20	2.00 Ea.	$2,782.73	$3,205.61	2.7500	2	2	$6,411.23	$6,411.23
Maintenance and repair motor starter, up to 600 V	5	4.00 Ea.	$1,398.21	$1,675.72	11.0000	11	11	$18,432.90	$18,432.90
Maintenance and repair secondary transformer, dry	10	4.00 Ea.	$1,182.04	$1,405.05	5.5000	5	5	$7,025.27	$7,025.27
Maintenance and inspection secondary transformer, dry	0.5	3.00 Ea.	$261.07	$327.51	110.0000	110	110	$36,026.45	$36,026.45
Maintenance and inspection lighting panel, indoor	3	4.00 Ea.	$175.26	$219.87	18.3333	18	18	$3,957.64	$3,957.64
Replace load center, 100 A	20	4.00 Ea.	$4,526.80	$5,554.37	2.7500	2	2	$11,108.73	$11,108.73
Replace EMT conduit, 1" diameter	50	0.70 M.L.F.	$8,091.47	$9,752.50	1.1000	1	1	$9,752.50	$9,752.50
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	8.00 Ea.	$618.29	$775.65	2.7500	2	2	$1,551.30	$1,551.30
Maintenance and repair breaker, enclosed, 240 V, 1 pole	25	44.00 Ea.	$3,400.61	$4,266.07	2.2000	2	2	$8,532.14	$8,532.14
Maintenance and repair breaker, enclosed, 240 V, 2 pole	25	44.00 Ea.	$3,400.61	$4,266.07	2.2000	2	2	$8,532.14	$8,532.14
Maintenance and repair safety switch general, 2 pole	8	6.00 Ea.	$262.90	$329.80	6.8750	6	6	$1,978.82	$1,978.82
Maintenance and inspection safety switch, 2 pole	1	6.00 Ea.	$262.90	$329.80	55.0000	55	55	$18,139.19	$18,139.19
Replace 4-pin receptacle	20	112.00 Ea.	$17,913.31	$21,295.71	2.7500	2	2	$42,591.42	$42,591.42
Maintenance and repair contactors and relays	3	4.00 Ea.	$1,094.35	$1,350.56	18.3333	18	18	$24,310.08	$24,310.08
Replace wiring devices, switches	15	18.00 Ea.	$1,251.62	$1,558.51	3.6667	3	3	$4,675.54	$4,675.54
Replace fluorescent light fixture ballast, 80 W	10	66.00 Ea.	$7,189.51	$8,865.60	5.5000	5	5	$44,328.01	$44,328.01
Replace lamps (2 lamps), 4', 34 W energy saver	10	66.00 Ea.	$1,792.01	$2,247.05	5.5000	5	5	$11,235.24	$11,235.24
Maintenance and repair TV cable outlet	10	12.00 Ea.	$668.32	$835.38	5.5000	5	5	$4,176.89	$4,176.89
Repair smoke detector	10	16.00 Ea.	$972.24	$1,203.28	5.5000	5	4	$6,016.42	$4,813.13
Check operation smoke detector	1	16.00 Ea.	$279.45	$350.57	55.0000	55	55	$19,281.29	$19,281.29
Replace smoke detector	15	16.00 Ea.	$5,398.74	$6,424.12	3.6667	3	3	$19,272.35	$19,272.35
Repair heat detector	10	12.00 Ea.	$795.05	$977.31	5.5000	5	5	$4,886.56	$4,886.56
Check and repair manual pull station	10	4.00 Ea.	$379.95	$467.63	5.5000	5	4	$2,338.13	$1,870.51
Replace manual pull station	15	4.00 Ea.	$920.30	$1,106.02	3.6667	3	3	$3,318.05	$3,318.05
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.6667	3	3	$8,524.19	$8,524.19
Minor repairs to annunciation panel	5	2.00 Ea.	$320.55	$390.85	11.0000	11	11	$4,299.35	$4,299.35
Maintenance and inspection annunciation panel	0.5	2.00 Ea.	$92.50	$116.04	110.0000	110	110	$12,764.62	$12,764.62
Replace fire alarm bell, 6"	20	4.00 Ea.	$801.74	$971.29	2.7500	2	2	$1,942.57	$1,942.57
Maintenance and repair building structure ground	7	1.10 M.L.F.	$105.01	$131.27	7.8571	7	7	$918.86	$918.86

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Replace building structure ground	50	1.10 M.L.F.	$6,411.27	$7,754.42	1.1000	1	1	$7,754.42	$7,754.42
Maintenance and repair of general wiring lightning protection system	1	1.10 M.L.F.	$122.46	$151.10	55.0000	55	55	$8,310.24	$8,310.24
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	55.0000	55	53	$26,253.24	$25,298.58
Replace lightning ground rod	25	4.00 Ea.	$1,031.13	$1,274.23	2.2000	2	2	$2,548.46	$2,548.46
Maintenance and repair computer ground system	4	1.00 Ea.	$23.25	$29.16	13.7500	13	13	$379.12	$379.12
Replace computer ground system	50	0.80 M.L.F.	$2,126.91	$2,555.90	1.1000	1	1	$2,555.90	$2,555.90
Maintenance and inspection generator, diesel, 750 KW	0.08	1.00 Ea.	$69.98	$87.79	687.5000	687	687	$60,315.10	$60,315.10
Replace diesel generator component, 750 KW	25	1.00 Ea.	$267,089.75	$305,754.14	2.2000	2	2	$611,508.28	$611,508.28
Maintenance and repair transfer switch	5	1.00 Ea.	$387.26	$467.53	11.0000	11	11	$5,142.82	$5,142.82
Replace transfer switch	18	1.00 Ea.	$30,733.98	$35,170.86	3.0556	3	3	$105,512.59	$105,512.59
Replace lamp emergency lighting fixture	2	8.00 Ea.	$458.52	$553.43	27.5000	27	27	$14,942.63	$14,942.63
Replace emergency lighting fixture	20	8.00 Ea.	$4,990.25	$5,891.96	2.7500	2	2	$11,783.91	$11,783.91
Maintenance and repair exit light	20	8.00 Ea.	$319.32	$395.25	2.7500	2	2	$790.50	$790.50
Replace lamp exit light	5	8.00 Ea.	$146.39	$173.53	11.0000	11	11	$1,908.79	$1,908.79
Maintenance and inspection UPS battery	0.17	1.00 Ea.	$69.98	$87.79	323.5294	323	323	$28,357.76	$28,357.76
Maintenance and repair voice/data outlet	10	24.00 Ea.	$1,336.65	$1,670.76	5.5000	5	5	$8,353.78	$8,353.78
Maintenance and inspection patch panel	0.5	4.00 Ea.	$370.00	$464.17	110.0000	110	110	$51,058.47	$51,058.47
Replace patch panel	15	4.00 Ea.	$3,788.72	$4,553.23	3.6667	3	3	$13,659.68	$13,659.68
			$1,305,628.90	$1,528,276.86				MR Subtotal:	$4,264,723.72
								MR Per Year:	$77,540.43
								PM Total:	$15,640.51
								Subtotal:	$93,180.94
								Total Per Unit:	$7.86

FAC 3171 Electronic and Communication RDT&E Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $7.86
UM: SF
Expected Service Life: 55
Model Size: 11856

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	2	8.14	$165.24	$368.03	$0.0000	533.27	660.20	795.40
Urinals, annualized	4	0.91	$27.36	$49.07	$0.0000	76.42	93.88	112.70
Toilet (vacuum breaker type), annualized	6	1.06	$55.10	$57.36	$0.0000	112.46	135.18	160.65
Lavatories, annualized	6	2.09	$46.31	$131.98	$0.0000	178.29	222.51	269.05
Showers, annualized	2	0.46	$28.04	$28.85	$0.0000	56.89	68.35	81.21
Water heater, gas, to 120 gal., annualized	2	3.44	$176.84	$184.43	$0.0000	361.26	434.28	516.13
Boiler, hot water, oil, gas, or comb. fired, 500 -1000 MBH, annualized	1	17.38	$90.37	$1,120.95	$0.0000	1,211.32	1,556.64	1,906.49
Air handling unit, 3 thru 24 tons, annualized	1	2.06	$163.16	$110.83	$0.0000	273.98	323.55	381.27
Fan coil unit, annualized	3	10.01	$257.93	$538.06	$0.0000	795.98	983.19	1,183.30
Air filter, electrostatic, annualized	2	15.20	$22.96	$820.62	$0.0000	843.58	1,092.06	1,341.69
Fire dampers, annualized	4	4.63	$33.61	$296.10	$0.0000	329.71	421.90	515.77
Fan, axial, up to 5,000 CFM, annualized	1	1.24	$13.78	$66.83	$0.0000	80.61	102.04	124.15
Package unit, air cooled, 25 thru 50 ton, annualized	1	3.25	$165.11	$208.12	$0.0000	373.23	452.18	539.38
Package unit, computer room, annualized	1	4.34	$134.83	$279.18	$0.0000	414.01	511.24	615.22
Controls, central system, electro/pneumatic, annualized	1	1.92	$179.77	$122.67	$0.0000	302.44	357.22	420.98
Dehumidifier, desiccant wheel, annualized	1	5.06	$73.27	$270.72	$0.0000	343.99	432.54	524.75
Backflow prevention device, up to 4", annually	4	1.33	$58.23	$84.60	$0.0000	142.83	174.03	208.15
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Transformer, dry type 500 KVA and over, annually	1	0.77	$16.52	$54.78	$0.0000	71.30	89.38	108.29
Panelboard, 225 A and above, annualized	4	1.76	$103.79	$125.50	$0.0000	229.29	277.32	330.53
Security, intrusion alarm system, annualized	1	3.83	$178.64	$242.03	$0.0000	420.67	511.14	610.55
Emergency diesel or gas generator, over 15 KVA, annualized	1	16.15	$88.82	$1,020.90	$0.0000	1,109.72	1,424.87	1,744.47
Power stablizer, annually	1	0.63	$10.98	$39.34	$0.0000	50.32	63.22	76.67
Uninterrupted power system, up to 200 KVA, annually	1	3.01	$201.60	$191.23	$0.0000	392.83	470.36	557.97
Light, emergency, hardwired system, annualized	8	2.00	$72.65	$126.29	$0.0000	198.95	244.10	292.89
Crane, electric bridge, up to 5 ton, annualized	1	2.92	$247.45	$113.21	$0.0000	360.66	419.37	490.45
Hoist, pneumatic, annualized	1	1.31	$227.25	$51.21	$0.0000	278.46	316.55	366.01
						$10,422.27	$12,957.44	$15,640.51

FAC 3181 Propulsion RDT&E Facility

FY25 SUC:	$10.83 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3191 Miscellaneous Item and Equipment RDT&E Facility

FY25 SUC:	$5.52 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 3191 Miscellaneous Item and Equipment RDT&E Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $5.52
UM: SF
Expected Service Life: 55
Model Size: 9217

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	240.00 S.F.	$9,764.25	$11,892.08	3.6667	3	3	$35,676.25	$35,676.25
Repair 8" concrete block wall, 1st floor	25	610.00 S.F.	$16,331.77	$19,979.37	2.2000	2	2	$39,958.75	$39,958.75
Waterproof concrete block wall, 1st floor	10	36.00 C.S.F.	$6,985.55	$8,417.73	5.5000	5	5	$42,088.66	$42,088.66
Refinish steel louver, 1st floor	5	2.00 Ea.	$220.97	$273.43	11.0000	11	11	$3,007.76	$3,007.76
Replace steel louver, 1st floor	40	2.00 Ea.	$1,288.25	$1,505.87	1.3750	1	1	$1,505.87	$1,505.87
Replace glass - 1st floor (1% of glass) - steel frame window	1	14.50 S.F.	$197.94	$232.42	55.0000	55	55	$12,783.27	$12,783.27
Repair 3'-9" x 5'-5" steel frame window - 1st floor.	20	23.00 Ea.	$7,890.74	$9,255.43	2.7500	2	2	$18,510.87	$18,510.87
Refinish 3'-9" x 5'-5" steel frame window - 1st floor.	5	23.00 Ea.	$2,090.11	$2,584.95	11.0000	11	11	$28,434.44	$28,434.44
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	3.10 S.F.	$42.32	$49.69	55.0000	55	55	$2,732.97	$2,732.97
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	14.00 Ea.	$2,260.97	$2,694.38	2.7500	2	2	$5,388.77	$5,388.77
Repair steel, painted, door	14	8.00 Ea.	$6,220.47	$7,366.14	3.9286	3	3	$22,098.43	$22,098.43
Refinish 3'-0" x 7'-0" steel, painted, door	4	8.00 Ea.	$383.94	$470.02	13.7500	13	13	$6,110.27	$6,110.27
Replace 3'-0" x 7'-0" steel, painted, door	45	8.00 Ea.	$5,886.87	$6,852.55	1.2222	1	1	$6,852.55	$6,852.55
Repair 12' x 12' steel roll-up door	10	6.00 Ea.	$5,413.01	$6,378.73	5.5000	5	5	$31,893.67	$31,893.67
Replace 12' x 12' steel roll-up door	35	6.00 Ea.	$21,652.04	$25,514.93	1.5714	1	1	$25,514.93	$25,514.93
Debris removal, by hand and visual inspection, metal panel roofing	1	9.20 M.S.F.	$226.09	$276.12	55.0000	55	55	$15,186.75	$15,186.75
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	184.00 S.F.	$892.08	$1,058.66	11.0000	11	11	$11,645.24	$11,645.24
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	6.80 S.F.	$192.16	$228.67	55.0000	55	55	$12,576.99	$12,576.99
Minor metal roof panel replacement, 2.5% of roof area	20	230.00 S.F.	$3,181.07	$3,762.82	2.7500	2	2	$7,525.63	$7,525.63
Total metal roof panel replacement	30	92.20 Sq.	$88,624.04	$104,800.34	1.8333	1	1	$104,800.34	$104,800.34
Repair 8" concrete block wall - (2% of walls) painted	25	26.70 C.S.F.	$32,465.56	$38,995.98	2.2000	2	2	$77,991.95	$77,991.95
Refinish concrete block wall painted	4	26.70 C.S.F.	$3,661.99	$4,402.48	13.7500	13	13	$57,232.25	$57,232.25
Repair steel painted interior door	14	2.00 Ea.	$593.70	$692.64	3.9286	3	3	$2,077.93	$2,077.93
Refinish 3'-0" x 7'-0" steel painted interior door	4	2.00 Ea.	$120.41	$148.05	13.7500	13	13	$1,924.64	$1,924.64
Repair solid core wood door, interior	11	14.00 Ea.	$4,155.90	$4,848.50	5.0000	5	5	$24,242.52	$24,242.52
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	14.00 Ea.	$765.54	$931.31	13.7500	13	12	$12,107.02	$11,175.71
Replace 3'-0" x 7'-0" solid core wood door, interior	40	14.00 Ea.	$9,012.88	$10,392.21	1.3750	1	1	$10,392.21	$10,392.21
Repair 5/8" drywall - (2% of walls)	20	24.00 S.F.	$44.83	$54.53	2.7500	2	2	$109.06	$109.06
Refinish concrete floor finished	25	46.00 C.S.F.	$21,091.58	$25,340.20	2.2000	2	2	$50,680.40	$50,680.40
Replace vinyl tile flooring	18	87.00 S.Y.	$4,920.57	$6,022.93	3.0556	3	3	$18,068.79	$18,068.79
Replace rubber tile floor	18	69.00 S.Y.	$7,958.85	$9,686.74	3.0556	3	3	$29,060.22	$29,060.22
Replace carpet	8	56.00 S.Y.	$3,119.12	$3,607.01	6.8750	6	6	$21,642.03	$21,642.03
Acoustic tile repairs - (2% of ceilings)	9	6.50 C.S.F.	$7,479.63	$8,668.96	6.1111	6	6	$52,013.74	$52,013.74
Replace acoustic tile ceiling, fire-rated	20	7.80 C.S.F.	$4,872.60	$5,730.16	2.7500	2	2	$11,460.32	$11,460.32
Replace flush valve diaphragm tankless water closet	10	4.00 Ea.	$110.36	$137.10	5.5000	5	5	$685.52	$685.52
Rebuild flush valve tankless water closet	20	4.00 Ea.	$773.08	$931.82	2.7500	2	2	$1,863.63	$1,863.63
Unplug clogged line tankless water closet	5	4.00 Ea.	$919.12	$1,151.15	11.0000	11	11	$12,662.67	$12,662.67
Replace tankless water closet	35	4.00 Ea.	$5,506.63	$6,372.78	1.5714	1	1	$6,372.78	$6,372.78
Replace wax ring gasket for tankless water closet	5	4.00 Ea.	$599.02	$749.53	11.0000	11	11	$8,244.81	$8,244.81
Replace flush valve diaphragm for a urinal	7	3.00 Ea.	$82.77	$102.83	7.8571	7	7	$719.80	$719.80
Rebuild flush valve for a urinal	20	3.00 Ea.	$579.81	$698.86	2.7500	2	2	$1,397.72	$1,397.72
Unplug line urinal	5	3.00 Ea.	$458.71	$574.51	11.0000	11	11	$6,319.60	$6,319.60
Replace washer in faucet lavatory, vitreous china	2	4.00 Ea.	$54.39	$67.85	27.5000	27	27	$1,831.99	$1,831.99
Replace faucets lavatory, vitreous china	10	4.00 Ea.	$794.49	$955.13	5.5000	5	5	$4,775.67	$4,775.67
Clean out strainer and P trap lavatory, vitreous china	2	4.00 Ea.	$148.35	$185.80	27.5000	27	27	$5,016.71	$5,016.71
Replace lavatory, vitreous china	35	4.00 Ea.	$3,005.50	$3,603.54	1.5714	1	1	$3,603.54	$3,603.54
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	27.5000	27	27	$454.84	$454.84
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	18.3333	18	18	$203.29	$203.29
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	5.5000	5	5	$1,193.92	$1,193.92
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	27.5000	27	27	$1,493.07	$1,493.07
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	1.00 Ea.	$910.17	$1,070.70	5.5000	5	5	$5,353.51	$5,353.51
Inspect and clean shower head emergency shower station	3	4.00 Ea.	$208.23	$260.80	18.3333	18	18	$4,694.44	$4,694.44
Replace shower emergency shower station	25	4.00 Ea.	$4,223.59	$5,052.79	2.2000	2	2	$10,105.57	$10,105.57
Inspect and clean spray heads, emergency eye wash	3	4.00 Ea.	$208.23	$260.80	18.3333	18	18	$4,694.44	$4,694.44
Replace eye wash station, emergency eye wash	25	4.00 Ea.	$3,161.79	$3,846.19	2.2000	2	2	$7,692.38	$7,692.38
Replace pipe and fittings, copper 3/4"	20	32.00 L.F.	$771.15	$937.28	2.7500	2	2	$1,874.56	$1,874.56
Replace pipe and fittings, copper 2"	25	16.00 L.F.	$904.99	$1,084.54	2.2000	2	2	$2,169.09	$2,169.09
Drain and flush water heater, electric, 120 gallon	7	1.00 Ea.	$310.63	$389.04	7.8571	7	7	$2,723.30	$2,723.30
Check operation water heater, electric, 120 gallon	3	1.00 Ea.	$2.72	$3.41	18.3333	18	18	$61.36	$61.36
Replace water heater, electric, 120 gallon	15	1.00 Ea.	$15,946.05	$18,237.49	3.6667	3	3	$54,712.47	$54,712.47
Unclog floor drain, PVC	20	2.00 Ea.	$100.77	$126.21	2.7500	2	2	$252.42	$252.42
Repair joint pipe and fittings, PVC	10	2.00 Ea.	$314.41	$391.82	5.5000	5	5	$1,959.11	$1,959.11
Replace pipe, 4" pipe and fittings, PVC	30	200.00 L.F.	$18,739.70	$22,933.98	1.8333	1	1	$22,933.98	$22,933.98
Replace roof mounted exhaust fan, 2000 CFM exhaust fan	20	6.00 Ea.	$18,090.91	$21,019.91	2.7500	2	2	$42,039.82	$42,039.82
Repair damaged pipe insulation, fiberglass 3/4"	5	2.00 Ea.	$45.91	$55.98	11.0000	11	11	$615.76	$615.76
Repair damaged pipe insulation, fiberglass 2"	5	2.00 Ea.	$54.99	$66.89	11.0000	11	11	$735.79	$735.79
Replace pipe insulation, fiberglass 3/4"	5	0.01 M.L.F.	$94.67	$114.91	11.0000	11	11	$1,264.02	$1,264.02
Replace pipe insulation, fiberglass 2"	5	0.01 M.L.F.	$114.07	$138.06	11.0000	11	11	$1,518.70	$1,518.70
Maintenance and repair explosionproof industrial heater	2	4.00 Ea.	$881.81	$1,030.57	27.5000	27	26	$27,825.27	$26,794.71
Replace heater explosionproof industrial heater	15	4.00 Ea.	$25,225.04	$28,826.28	3.6667	3	3	$86,478.83	$86,478.83
Repair multi-zone rooftop unit, 15 ton	10	1.00 Ea.	$36,634.04	$42,253.18	5.5000	5	4	$211,265.89	$169,012.71
Replace multi-zone rooftop unit, 15 ton	15	1.00 Ea.	$90,200.60	$103,926.70	3.6667	3	3	$311,780.10	$311,780.10
Repair central station A.H.U., 1300 CFM	10	1.00 Ea.	$601.37	$713.88	5.5000	5	4	$3,569.42	$2,855.54
Replace central station A.H.U., 1300 CFM	15	1.00 Ea.	$10,673.04	$12,341.31	3.6667	3	3	$37,023.92	$37,023.92
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	55.0000	55	55	$2,497.55	$2,497.55
Replace sprinkler head	20	48.00 Ea.	$4,401.15	$5,423.87	2.7500	2	2	$10,847.74	$10,847.74
Replace fuse	25	25.00 Ea.	$15,192.76	$17,405.77	2.2000	2	2	$34,811.55	$34,811.55
Repair switchgear, - (5% of total C.B.), indoor, less than 600 V	10	1.00 Ea.	$891.97	$1,029.49	5.5000	5	5	$5,147.47	$5,147.47
Maintenance and inspection switchgear, indoor, less than 600 V	3	1.00 Ea.	$43.82	$54.97	18.3333	18	18	$989.41	$989.41
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	5.5000	5	5	$7,769.55	$7,769.55
Maintenance and repair inverter	1	1.00 Ea.	$882.77	$1,054.91	55.0000	55	55	$58,020.05	$58,020.05
Maintenance and repair secondary transformer, dry	10	1.00 Ea.	$295.51	$351.26	5.5000	5	5	$1,756.32	$1,756.32
Maintenance and inspection secondary transformer, dry	0.5	1.00 Ea.	$87.02	$109.17	110.0000	110	110	$12,008.82	$12,008.82
Maintenance and inspection lighting panel, indoor	3	1.00 Ea.	$43.82	$54.97	18.3333	18	18	$989.41	$989.41
Repair failed breaker, enclosed, 600 V, 3 pole	4	1.00 Ea.	$1,204.74	$1,390.73	13.7500	13	13	$18,079.52	$18,079.52
Maintenance and inspection circuit breaker, enclosed, 600 V, 3 pole	0.33	1.00 Ea.	$34.69	$43.52	166.6667	166	166	$7,223.61	$7,223.61
Replace circuit breaker enclosed, 600 V, 3 pole circuit breaker	50	1.00 Ea.	$1,110.36	$1,308.65	1.1000	1	1	$1,308.65	$1,308.65
Maintenance and repair receptacles and plugs	20	44.00 Ea.	$2,013.40	$2,515.71	2.7500	2	2	$5,031.43	$5,031.43
Replace receptacle/plug receptacles and plugs	20	44.00 Ea.	$3,552.70	$4,370.13	2.7500	2	2	$8,740.25	$8,740.25
Maintenance and repair wiring devices, switches	10	22.00 Ea.	$1,006.70	$1,257.86	5.5000	5	5	$6,289.29	$6,289.29
Replace wiring devices, switches	15	22.00 Ea.	$1,529.76	$1,904.85	3.6667	3	3	$5,714.55	$5,714.55
Replace fluorescent light fixture ballast, 80 W	10	36.00 Ea.	$3,921.55	$4,835.78	5.5000	5	3	$24,178.92	$14,507.35
Replace lamps (2 lamps), 4', 34 W energy saver	10	36.00 Ea.	$977.46	$1,225.66	5.5000	5	5	$6,128.31	$6,128.31
Replace fluorescent fixture, lay-in, recess mtd, 2' x 4', two 40 W	20	36.00 Ea.	$9,741.64	$11,817.04	2.7500	2	2	$23,634.08	$23,634.08
Repair smoke detector	10	22.00 Ea.	$1,336.83	$1,654.51	5.5000	5	4	$8,272.57	$6,618.06
Check operation smoke detector	1	26.00 Ea.	$454.10	$569.67	55.0000	55	55	$31,332.09	$31,332.09
Replace smoke detector	15	26.00 Ea.	$8,772.96	$10,439.19	3.6667	3	3	$31,317.57	$31,317.57
Repair heat detector	10	16.00 Ea.	$1,060.06	$1,303.08	5.5000	5	5	$6,515.42	$6,515.42
Check operation heat detector	1	16.00 Ea.	$279.45	$350.57	55.0000	55	55	$19,281.29	$19,281.29
Check and repair manual pull station	10	4.00 Ea.	$379.95	$467.63	5.5000	5	4	$2,338.13	$1,870.51
Replace manual pull station	15	4.00 Ea.	$920.30	$1,106.02	3.6667	3	3	$3,318.05	$3,318.05
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.7500	2	2	$971.29	$971.29
Maintenance and repair of general wiring lightning protection system	1	1.20 M.L.F.	$133.59	$164.83	55.0000	55	55	$9,065.71	$9,065.71
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	55.0000	55	55	$26,253.24	$26,253.24
Replace lamp emergency lighting fixture	2	13.00 Ea.	$745.10	$899.32	27.5000	27	27	$24,281.77	$24,281.77
Replace emergency lighting fixture	20	13.00 Ea.	$8,109.16	$9,574.43	2.7500	2	2	$19,148.86	$19,148.86
Maintenance and repair exit light	20	8.00 Ea.	$319.32	$395.25	2.7500	2	2	$790.50	$790.50
Replace lamp exit light	5	8.00 Ea.	$146.39	$173.53	11.0000	11	11	$1,908.79	$1,908.79
Replace lighting fixture exit light	20	8.00 Ea.	$1,491.53	$1,806.28	2.7500	2	2	$3,612.56	$3,612.56
Maintenance and inspection battery, dry	0.08	1.00 Ea.	$43.82	$54.97	687.5000	687	687	$37,762.50	$37,762.50
Replace battery, dry	5	1.00 Ea.	$219.79	$253.81	11.0000	11	11	$2,791.90	$2,791.90
Maintenance and repair voice/data outlet	10	14.00 Ea.	$779.71	$974.61	5.5000	5	5	$4,873.04	$4,873.04
Replace voice/data outlet	20	14.00 Ea.	$396.44	$482.81	2.7500	2	2	$965.61	$965.61
Replace patch panel	15	4.00 Ea.	$3,788.72	$4,553.23	3.6667	3	3	$13,659.68	$13,659.68
			$600,174.10	$707,992.24				MR Subtotal:	$2,136,383.62
								MR Per Year:	$38,843.34
								PM Total:	$12,055.14
								Subtotal:	$50,898.48
								Total Per Unit:	$5.52

FAC 3191 Miscellaneous Item and Equipment RDT&E Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $5.52
UM: SF
Expected Service Life: 55
Model Size: 9217

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	2	0.52	$31.64	$23.47	$0.0000	55.11	65.32	77.10
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	2	8.14	$165.24	$368.03	$0.0000	533.27	660.20	795.40
Fire doors, swinging, annualized	2	0.78	$28.98	$32.15	$0.0000	61.13	73.67	87.66
Urinals, annualized	3	0.68	$20.52	$36.80	$0.0000	57.32	70.41	84.53
Toilet (vacuum breaker type), annualized	4	0.71	$36.74	$38.24	$0.0000	74.97	90.12	107.10
Lavatories, annualized	4	1.39	$30.87	$87.98	$0.0000	118.86	148.34	179.37
Air handling unit, 3 thru 24 tons, annualized	1	2.06	$163.16	$110.83	$0.0000	273.98	323.55	381.27
Air filter, electrostatic, annualized	2	15.20	$22.96	$820.62	$0.0000	843.58	1,092.06	1,341.69
VAV Boxes, annualized	9	8.41	$85.73	$536.79	$0.0000	622.52	792.13	966.02
Fire dampers, annualized	3	3.47	$25.21	$222.08	$0.0000	247.28	316.42	386.83
Fan, axial, up to 5,000 CFM, annualized	6	7.46	$82.65	$401.00	$0.0000	483.66	612.22	744.92
Hood and blower, annualized	1	2.32	$59.60	$124.36	$0.0000	183.96	227.23	273.48
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Controls, central system, electro/pneumatic, annually	4	7.68	$719.07	$490.68	$0.0000	1,209.75	1,428.86	1,683.93
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Extinguishing system, foam pump electric, annualized	1	17.72	$356.60	$951.75	$0.0000	1,308.36	1,629.54	1,968.56
Panelboard, 225 A and above, annualized	4	1.76	$103.79	$125.50	$0.0000	229.29	277.32	330.53
Light, emergency, hardwired system, annualized	12	3.00	$108.98	$189.44	$0.0000	298.42	366.15	439.33
Crane, electric bridge, up to 5 ton, annualized	1	2.92	$247.45	$113.21	$0.0000	360.66	419.37	490.45
						$8,086.50	$10,007.72	$12,055.14

FAC 3201 Underwater RDT&E Facility

FY25 SUC:	$11.05 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3211 RDT&E Technical Service Facility

FY25 SUC:	$6.77 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3711 RDT&E Range Building

FY25 SUC:	$6.21 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3712 RDT&E Range Facility

FY25 SUC:	$6,384.75 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3713 RDT&E Range Complex

FY25 SUC:	$36,817.72 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3901 Miscellaneous RDT&E Facility

FY25 SUC:	$1,905.87 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 3902 RDT&E Area

FY25 SUC: $0.00 / AC

Source:

FAC 3903 Aerodynamic wind tunnel

FY25 SUC:	$1,320,686.17 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Operations & Maintenance Cost Study for NASA Facilities; Final Report for Wind Tunnels. August 13, 2015

Contract GS-10F-0313N
Order DE-AD52-04NA99603
August 13, 2015

Operations & Maintenance Cost Study for NASA Facilities

Final Report for Wind Tunnels

August 13, 2015

Submitted to:

Pete Aitcheson
National Aeronautics and Space Administration

Submitted by:

CBRE | Whitestone
2050 Alameda Padre Serra, STE 200
Santa Barbara, CA 93103-1704

Contract NNC09BA14B

Operations & Maintenance Cost Study for NASA Facilities: Final Report for Wind Tunnels

Overview

National Aeronautics and Space Administration (NASA) requires a credible method for estimating the operations and maintenance (O&M) requirements of its facilities.[1] The failure to anticipate future costs can lead to under-funding and diminished service life.

NASA has over 1,100 buildings totaling 18.4 million GSFT distributed at 33 sites globally in the selected inventory for this project. It is not cost effective to inspect all facilities, yet NASA needs detailed sustainment and operations estimates to support its budget planning. This project developed cost models for a sample of NASA assets with inventory details collected through site surveys. Estimates were extrapolated by facility type and size and adjusted for location to generate requirements for the selected NASA inventory.

The project employed the MARS Facility Cost Forecast System to provide cost information. Now in its eighth version, MARS is a facility cost modeling tool developed by CBRE | Whitestone and used by many federal and commercial agencies.

Completed in March 2013, Phases 1 and 2 of this project estimated O&M costs for four facility types: Administration Buildings, Propulsion Buildings, Communications Buildings, and Space Science (R&D and Test) Buildings. Eight sample buildings were inspected at Goddard and Marshall Space Flight Centers. CBRE | Whitestone submitted formal reports for each facility type.

Phase 3 inspected a sample of two Wind Tunnel facilities at Glenn Research Center (GRC) in Cleveland, Ohio and generated detailed models in MARS. Site inspections were conducted by Jacobs Facilities, a long-time CBRE | Whitestone partner experienced in inspecting federal facilities and creating MARS component inventories. A team consisting of an architect, and electrical and mechanical engineers carried out the facility inspections.

O&M estimates from the sample were extrapolated to the remaining Wind Tunnels in the NASA inventory. The unique function of Wind Tunnels makes common extrapolation variables (per square foot or replacement value) ineffective. Key cost drivers identified by NASA and CBRE | Whitestone dictated how estimates for the sample assets were applied to the total inventory.

This report describes the project methodology and presents final estimates for the Wind Tunnels in the NASA inventory.

[1] Operations include custodial (cleaning, pest control, and trash collection), utilities (energy, water, and sewer), grounds (landscape care, mowing, and snow removal), security, telecommunications, and management. Maintenance (also known as sustainment) includes preventative maintenance, minor repair, unscheduled maintenance, and renewal and replacement.

Project Methodology

Parametric Estimates for Buildings

The project methodology entailed estimating O&M requirements for the selected NASA inventory based on the inspection and modeling of a sample of facilities. The project included five key steps:

1. Validate the existing NASA inventory and develop a sample
2. Perform on-site inspections of the sample buildings
3. Develop and calibrate MARS models
4. Develop a mapping and extrapolation methodology and variables for the unique function of Wind Tunnels
5. Generate estimates of sustainment and operations costs for the sample and extrapolate to the project inventory

Study Sample

NASA has over 1,100 buildings at 33 sites globally in the selected inventory. Complete inspection of each site to estimate O&M requirements is impractical and costly. This project generated sustainment and operations estimates for a sample of buildings and extrapolated the costs to a selected NASA inventory.

NASA selected 23 Wind Tunnel facilities distributed at four sites for this project. The project sample included the inspection of one small supersonic and one large subsonic Wind Tunnel. Staff at NASA HQ, the Aeronautics Test Program, and CBRE | Whitestone selected two Wind Tunnels at the GRC to minimize travel costs for the inspection. Component-level cost models were developed for the two tunnels using CBRE | Whitestone's MARS. The project inventory excluded other Classification types in the NASA inventory, such as Warehouses. Estimates for Administration, Propulsion, Communications, and Space Science (R&D and Test) Buildings were generated in Phases 1 and 2 of the project.

Table 1 shows the building detail for the inspected Wind Tunnels.

Table 1. Wind Tunnels Inspection Sample

Site	Classification	Property No.	Property Name	Year Built	Size[A]	CRV[B]
Glenn Research Center	Wind Tunnels	39/53/54/57/61	9'x15' Low Speed / 8'x6' Supersonic Wind Tunnel	1949	119,514	$106,691,109
	Wind Tunnels	37	1'x1' Supersonic Wind Tunnel	1942	7,479	$6,608,331
Total					**126,993**	**$113,299,440**

[A] Size is the approximate GSFT associated with the wind tunnel from site inspections. GSFT of entire property may exceed inspection sample.
[B] CRV is the Current Replacement Value of the entire property and may exceed the value of the inspected area.

The inspected sample was mapped to the remaining inventory. There are a number of variables that drive O&M costs. In Phase 1 and 2 of the project, building Classification type and size were the key inputs used to determine appropriate mapping of sample facilities to the total inventory. The unique systems and function of the Wind Tunnels prevent O&M costs from closely aligning with facility square footage. NASA and CBRE | Whitestone defined several variables and associated factors used to map the sample models and extrapolate total O&M costs to the remainder of the inventory. The Wind Tunnel mapping and extrapolation is described in detail in a later section of this report.

The 23 Wind Tunnels selected for this project represent 1.2 million GSFT with a $2.9 billion CRV. Table 2 shows the Wind Tunnels inventory by site.

Table 2. NASA Wind Tunnels by Site

Site	Property No.	Property Name	Size[A]	CRV[B]
AMES Research Center	N206/N206A	12' Pressure Tunnel	36,364	$253,246,932
AMES Research Center	N215	7' X 10' Subsonic Wind Tunnel #1	28,763	$36,488,779
AMES Research Center	N221/N221B	National Full Scale Aerodynamics Complex (NFAC) 40' X 80' & 80' X 120'	171,129	$529,305,708
AMES Research Center	N227A/N227B/N227C	11' X 11', 9' X 7', & 8' X 7' Unitary Plan Transonic Wind Tunnel	53,580	$322,857,273
Glenn Research Center	11/170	Icing Research Tunnel	32,501	$60,139,291
Glenn Research Center	37	1' X 1' Supersonic Wind Tunnel	7,479	$6,608,331
Glenn Research Center	39/53/54/57/61	9' X 15' Low Speed Wind Tunnel/8' X 6' Supersonic Wind Tunnel	119,514	$106,691,109
Glenn Research Center	85/87/88/90/113/114	10' X 10' Abe Silverstein Wind Tunnel	170,941	$297,274,694
Langley Research Center	1212C	14' X 22' Subsonic Wind Tunnel	51,354	$90,413,562
Langley Research Center	1236	National Transonic Facility (NTF)	79,745	$393,554,794
Langley Research Center	1242	0.3 Meter Cryogenic Tunnel	9,276	$13,304,480
Langley Research Center	1247D	20" Mach 6 Tunnel	100,360	$141,019,520
Langley Research Center	1251	Unitary Plan Wind Tunnel Test Section 1 & 2	134,535	$308,493,730
Langley Research Center	1251A	15" Mach 6 High Temperature Tunnel (Hyper. Flow App.)	24,312	$3,161,438
Langley Research Center	1251A	31" Mach 10 Tunnel	24,312	$3,161,438
Langley Research Center	1265	8' High Temperature Tunnel	25,517	$124,241,924
Langley Research Center	1275	20" Mach 6 CF4 Tunnel	17,428	$27,586,220
Langley Research Center	644	12' Low Speed Tunnel	3,767	$6,624,391
Langley Research Center	645	20' Vertical Spin Tunnel	14,461	$7,385,933
Langley Research Center	648	Transonic Dynamics Tunnel (TDT)	41,771	$134,476,694
Marshall Space Flight Center	4732	14" Trisonic Wind Tunnel	26,773	$15,864,288
Marshall Space Flight Center	4775	High Reynolds Number Wind Tunnel	3,521	$838,104
Plum Brook Station	3411	Hypersonic Test Facility	6,082	$40,988,331
Total			**1,183,485**	**$2,923,726,964**

[A] Size is the approximate GSFT associated with the wind tunnel from site inspections. GSFT of entire property may exceed inspection sample.
[B] CRV is the Current Replacement Value of the entire property and may exceed the value of the inspected area.

Detailed cost models were developed for the two Wind Tunnels using CBRE | Whitestone's MARS Facility Cost Forecast System.

Description of the MARS Model

CBRE | Whitestone used MARS to estimate preventative maintenance, unscheduled maintenance, repair, and renewal/replacement costs for this project. MARS is an asset management system that estimates both deferred maintenance and future requirements on the basis of asset components and their scheduled maintenance and repair. It also estimates costs for ten operations types in the typical commercial chart of accounts. MARS was originally developed in 1996, and is currently in its eighth version. It is used by many government agencies and commercial concerns.

Sustainment	Preventive Maintenance & Minor Repair Unscheduled Maintenance Renewal & Replacement
Operations	Custodial Energy Grounds Management Pest Control Refuse Road Clearance Security Telecom Water/Sewer

Note that the definition of future M&R requirements is the same as the “sustainment” requirements used for programming by DoD and an approach endorsed in a National Research Council (NRC) study of Department of Energy facility practices.[2] Among other agencies, the MARS Facility Cost Forecast System has been used to forecast budgets for the IRS, FAA, USDA, and CDC. It was recently used to benchmark costs for the Department of State Overseas Embassies. MARS is also the basis for the DoD Sustainment Model and a study for NNSA validating total life-cycle facility costs at eight nuclear weapons production and research sites.[3] The model is used continuously to simulate alternative facility costs for the U.S. nuclear complex.

The MARS process begins with a component inventory of a building or structure. Derived from building plans, equipment inventory data, and on-site inspections, these components are organized into UNIFORMAT category level three elements and are identified specifically in terms of product characteristics, quantity, and output level; e.g. “Single-Ply Modified

[2] National Research Council, *Intelligent Sustainment and Renewal of Department of Energy Facilities and Infrastructure, 2004*. P. 44.

[3] Jacobs Facilities and Whitestone Research, *Implementation of the Department of Defense Sustainment Model, Final Report*, May 2002.

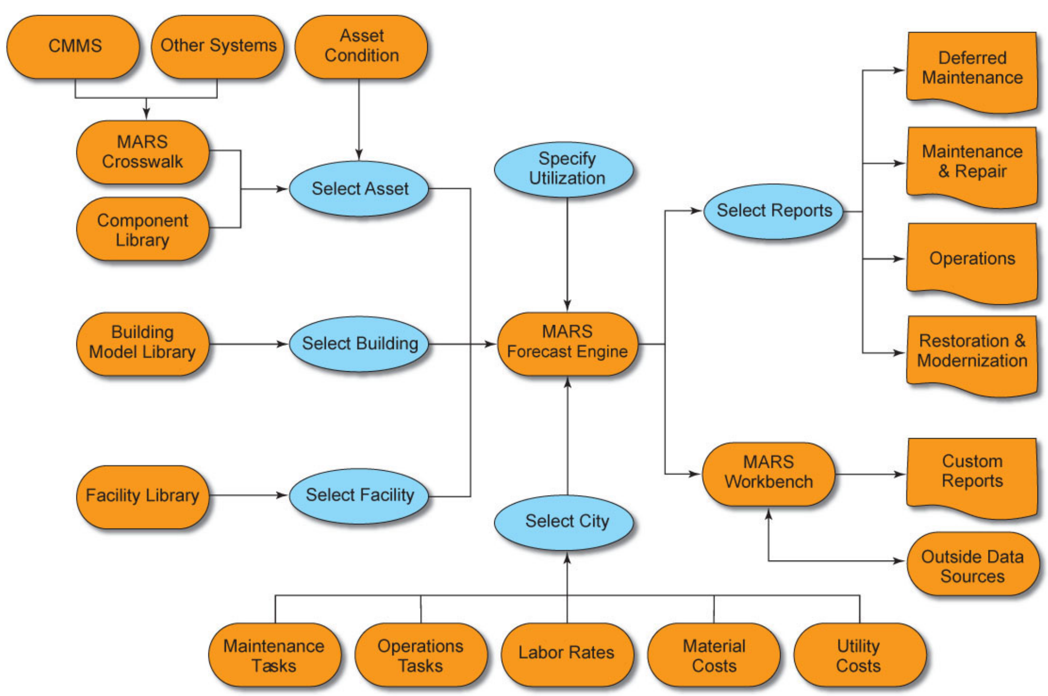
Bituminous/Thermoplastic Roof," "Condenser, Air-Cooled, 60 Ton," or "Pipe & Fittings, ¾" Copper."

Once the component inventory is completed, the MARS system relates maintenance tasks from a pre-defined task library to each selected component. New components and related tasks are defined as necessary. The frequency of each task determines the forecast of future required maintenance. MARS estimates four types of maintenance: preventative maintenance, unscheduled maintenance (service calls), repair, and renewal/replacement tasks. Tasks and their labor and material requirements are pre-defined by CBRE | Whitestone, but are also editable.

Other calibration steps include modifying default values for contract and in-house labor rates, specifying site-typical mark-up for contract expenditures, and identifying the utilization characteristics for each asset.

The sources for local wage rates and benefits are primarily the U.S. Department of Labor and Davis-Bacon Act labor agreements, and private sector employers. Both union and non-union wages are considered in determining prevailing rates by locality. State and local wage surveys are also used when available.

MARS Facility Cost Forecast System



MARS is also used to estimate operations costs other than maintenance and repair. These are based on the Facilities Operation Model developed jointly by the Department of Defense (DOD) and CBRE | Whitestone. This model provides costs for ten services, including those mentioned in the Federal Real Property Council (FRPC) guidance—utilities, cleaning and janitorial, and roads and grounds.[4] Each operation type for an asset can be calibrated for a level of service (low, medium, high) to reflect the level of demand or frequency at which certain operations task are performed.

The CBRE | Whitestone operations cost models provides estimates for the following services:

Custodial. The custodial function represents the expense of cleaning offices, work areas, restrooms and common areas. Costs include local wage rates and benefits, task productivity, mark-ups for equipment, materials, supervision, and assumptions concerning the level of service. Trash removal costs are not included. Custodial service levels are defined by altering the combination and frequency of common tasks.

Energy. Energy includes all expenses related to the purchase, generation, distribution, and conservation of energy and source fuels necessary to operate an asset. The main energy sources considered are electricity and natural gas. Not included are utilities maintenance and supervision, and utility tax rates. Service levels vary according to estimated commodity demand by asset use type.

Grounds. The grounds function includes any expense related to the maintenance of exterior landscaping. It does not include sweeping or the maintenance of signage, parking lots and roadways. Costs are estimated using local wage rates and benefits, task productivity, mark-ups for equipment, materials and supervision, and assumptions concerning the level of service. Service levels are defined by altering the combination and frequency of common tasks.

Management. The real property management function describes all costs associated with facility management, including: public works, contracts, material procurement, facility data, furnishings, real estate, and engineering services. Costs are expressed as a fixed percentage of Plant Replacement Value. Service levels are based on the distribution of costs found in institutional and commercial settings. For this project, the level of service for all NASA buildings was set to low to reflect economies of scale in a campus environment.

Pest Control. Pest control expenses cover indoor and outdoor pest control programs, separate from the grounds function. Costs are based on the frequency of common tasks for rodent and insect abatement and inspections. Costs include prevailing labor and material rates. Service levels are defined by altering the combination and frequency of common tasks.

Refuse. Refuse costs include all expenses related to trash collection and disposal, pick-up services, fees, recycling operations and administration, composting, etc. Costs exclude handling and disposal of HAZMAT materials. Service levels vary according to estimated demand by asset use type.

Road Clearance. The road clearance function includes all expenses related to sweeping paved areas including sidewalks, walkways, and parking lots. Costs include prevailing labor and material rates, and climatic variables. Service levels are defined by altering the combination and frequency of common tasks.

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[4] Federal Real Property Council. *Guidance for Real Property Inventory Reporting.* Washington, D.C. August, 2012.

Security. Security expenses relate to the physical security of assets and occupants, and include personnel, operating and monitoring security equipment. Costs include relevant prevailing labor and material rates. Service levels are defined by altering the combination and frequency of common tasks and services.

Telecommunications. Telecommunication expenses cover the purchase of all the services ordinarily associated with commercial activities, such as voice and data equipment and service subscription. The level of telecommunications is defined by the combination of services selected.

Water and Sewer. Water and Sewer expenses include all costs related to providing the asset with potable water, irrigation water, and sewage service. Estimates include local commodity costs. Service levels vary according to estimated commodity demand by asset use type.

Data Collection and Calibration

MARS Model Development

The technical work for this task involved the definition of the component inventory for the two sample Wind Tunnels. Glenn Research Center staff supplied existing equipment inventories and construction design documents before the inspection. Jacobs Facilities inspected the Wind Tunnels and created draft models in MARS. Due to the unique systems in the Wind Tunnels, Jacobs created 162 unique components in MARS. In total, 867 components were used in the models of the two facilities.

Jacobs submitted the MARS database to CBRE | Whitestone for a detailed component-by-component review. Three areas of focus included:

1) Check for completeness. Review the wall finishes (exterior and interior), roofing, plumbing, HVAC, fire protection, and electrical data to ensure the building model contains the appropriate components in each category.

2) Check for consistency. Review the building gross square feet for accuracy. Ensure the square footage of structural components (exterior walls, roofing system, interior finishes) are reasonable compared to building GSFT. Verify the capacity of the following is consistent with the building type and size:

- Heating, cooling, and air distribution
- Electrical service, distribution, and lighting
- Plumbing fixtures and water distribution
- Fire protection

3) Forecast review. Run the following building-level MARS reports and look for extraordinary costs (high or low) illustrating an error in the building model:

- Average M&R Costs
- Most Costly M&R Tasks

- Deferred Maintenance Detail
- Operation Cost Summary

The sample Wind Tunnel component lists and draft estimates were also provided to NASA staff for review. Any changes were incorporated into this report.

Attachment B and C provide detailed MARS component lists for the two inspected Wind Tunnels at GRC.

CBRE | Whitestone also collected information to calibrate the models for local site values.

Local Calibration of MARS

While the MARS system has pre-defined building models, labor and material costs, utility rates, and an extensive component library, all of these values can be changed or supplemented to reflect the actual site practices.

Calibration data was gathered to adjust MARS factors for maintenance & repair and operations costs of the Wind Tunnels. Data was gathered at both the site and the building level. Site-level information, such as labor and utility rates, was directly used to estimate O&M costs for the Wind Tunnels at GRC. Building-level calibration data was applied to the sample models and then extrapolated to the remaining NASA inventory.

The following data was collected to calibrate the building models:

Maintenance and Repair. A default assumption in MARS assigns in-house labor to preventative maintenance, minor repair, and unscheduled maintenance, while contract labor performs major repair and replacement tasks. NASA staff indicated all maintenance was performed by contract laborers. CBRE | Whitestone adjusted the MARS database accordingly.

NASA personnel specified laborers must be paid prevailing wages for the area. We used the default MARS wage rates for this study, and included a 30 percent mark-up for contract overhead.

Table 3 shows the source of the maintenance and repair factors for each site.

Table 3. Data Sources by Site, Maintenance & Repair

Site	In-house Shop Rates	In-house Markup Rates	Contract Labor Rates	Contract Overhead Rates	Utilization
Glenn Research Center	N/A	N/A	WST	WST	Site
WST=Whitestone, Site = Respective NASA Site					

MARS estimates also can be adjusted to reflect utilization factors that impact M&R. For example, many NASA facilities have special safety requirements which increase costs relative to conventional commercial practice. Other special requirements include high or low hours of operation and security. Glenn Research Center defined utilization factors for the two sample Wind Tunnels.

Table 4 displays the average utilization multipliers for the sample Wind Tunnels used to adjust for these requirements.

Table 4. Average Utilization Adjustment by Site[A]

Site	Hours of Operation[B]	Security[C]	Safety & Permitting[D]	Sum[E]
Goddard Space Flight Center	1.00	1.01	1.07	1.08

[A] Calculated from individual asset multipliers assigned by the sites.
[B] Hours of Operation rates building use on a weekly basis and is defined as follows: 0.80 = 40 hours, 1.00 = 41 to 80 hours, 1.37 = 80+ hours.
[C] Security is defined as follows: 1.00 = free access, 1.01 = contractor training & daily check-in, 1.15 = full contractor accompanyment.
[D] Safety & Permitting is defined as follows: 1.00 = typical commercial & service activity, 1.07 = non-specific laboratory, 1.75 = radiological or life science research, 3.00 = nuclear facility.
[E] In combination the multipliers are additive such that the total multiplier = $1 + \sum(\beta - 1)$ where β = the multiplier value.

Operations. MARS also estimates operations costs for ten services including: custodial, energy, grounds, management, pest control, refuse, road clearance, security, telecommunications, and water & sewer. Key drivers of operations estimates include utility rates, labor rates, and mark-ups, which were collected from GRC staff.

In addition, MARS is populated with default levels of service by operation and building type. The building types in MARS are typical to the commercial environment and do not include Wind Tunnels. CBRE | Whitestone worked with NASA staff to develop unique level of service ratings for the Wind Tunnel facilities. The ratings (low, medium, high, or none) reflect the level of utility demand or frequency of operations tasks in these specialized facilities. The sample Wind Tunnels at GRC were assigned a level of service by site staff.

The unique systems and function of the Wind Tunnels prevent utility consumption from closely aligning with facility size. Extrapolating energy and water & sewer costs based on square footage from the sample to the inventory would not generate accurate estimates. To avoid this type of extrapolation, NASA supplied utility rates for all four sites with Wind Tunnels in the inventory, and utility demand for each specific Wind Tunnel. In addition to the utilities estimated in MARS, NASA also provided utility rates and demand for several other types, including process cooling water, chilled water, high pressure air, service air, steam, and altitude exhaust. CBRE | Whitestone calculated total utility costs by multiplying the site rate by each Wind Tunnel's average consumption.

Other utility rates, such as refuse, provided in Phase 1 and 2 were significantly lower than the default MARS commercial rates. These discounts are often provided to large federal property holders like NASA. CBRE | Whitestone applied the average discounts for the previously calibrated sites to the remaining sites in the Wind Tunnel inventory.

As with M&R, CBRE | Whitestone used the default MARS wage rates and a 30 percent mark-up for contract overhead.

Table 5 shows the source of the operations calibration data.

Table 5. Data Sources by Site, Operations

Site	Source
Level of Service	GRC
Custodial Wage	CBRE | Whitestone
Groundskeeper Wage	CBRE | Whitestone
Property Management	GRC
Pest Control Wage	CBRE | Whitestone
Refuse Rates	CBRE | Whitestone
Road Clearance Wage	CBRE | Whitestone
Security Rates	CBRE | Whitestone
Telecom Rates	CBRE | Whitestone
Water/Sewer	ARC / GRC / LaRC / MSFC
Building Electricity	ARC / GRC / LaRC / MSFC
Tunnel Electricity	ARC / GRC / LaRC / MSFC
Natural Gas	ARC / GRC / LaRC
Steam	ARC / GRC / LaRC / MSFC
Process Cooling Water	ARC / GRC / LaRC
6,000 PSIG Air	LaRC
450 PSIG Air	GRC
Service Air	GRC
Building 64 Altitude Exhaust	GRC
Building 114 Altitude Exhaust	GRC
IRT Chiller Plant	GRC

Inventory Mapping and Extrapolation

There are a number of variables that drive O&M costs. In Phase 1 and 2 of the project, building Classification type and size were the key inputs used to determine appropriate mapping of sample facilities to the total inventory. Per square foot estimates were generated for the sample and extrapolated to the selected inventory by type (Administration, Propulsion, Communications, and Space Science (R&D and Test) Buildings) and size.

The unique systems and function of the Wind Tunnels prevent O&M costs from closely aligning with facility square footage. NASA and CBRE | Whitestone defined several variables and associated factors used to map the sample models and extrapolate total O&M costs to the remainder of the inventory.

Table 6 shows six variables that will be used to estimate the cost requirements of NASA Wind Tunnels.

Table 6. Inventory Mapping and Extrapolation Variables

Variable[A]	Description
Flow Velocity Category	Subsonic, Transonic, Supersonic, or Hypersonic. Used to determine mapping and extrapolation factor.
Mach Number	Used to determine mapping and extrapolation factor.
Operation Type	Continuous flow or blow-down. Used to determine mapping.
Closed or Open Tunnel	Closed-loop or open exhaust tunnel. Used to determine mapping.
Test Cell Cross Section Area	Used to determine extrapolation factor.
Auxiliary Equipment	Auxiliary cooling water, nozzle type, drying, and drive motor equipment. Used to determine extrapolation factor.

[A] Variables and extrapolation factors were defined by NASA through research, evaluating maintenance schedules, and historical knowledge of the Wind Tunnel facilities and their operating costs.

While all variables were considered in the mapping effort, air speed (flow velocity and mach number) and operation type (continuous flow or blow-down) were the key variables used to map the two inspected Wind Tunnels to the inventory. Continuous flow sub/trans/supersonic Tunnels were mapped to the 9'x15' Low Speed / 8'x6' Supersonic Wind Tunnel. These tunnels operate for an extended period of time and require special equipment, including large drive motors, to continuously supply air down the tunnel. All blow-down tunnels were mapped to the 1’x1’ Supersonic Wind Tunnel. These tunnels blow a single volume of air down the tunnel and do not operate continuously.

After the sample models were mapped to the inventory, the project team identified the key variables that were used to adjust the sample O&M costs to make them more appropriate for the remaining Wind Tunnels. These variables included air speed (flow velocity and mach number), test cell cross section area, and auxiliary equipment requirements (process cooling water, chiller water, drive motors, integral air dryers, compressors, electrolyte system, and flexwall system). Each variable included a factor to increase or decrease costs relative to the sample models. These factors were developed through research with NASA staff and provided by Pete Aitcheson.

The extrapolation factors were used to estimate O&M costs for each Wind Tunnel in the inventory to which they apply. The continuous flow Tunnels mapped to the 9'x15' Low Speed / 8'x6' Supersonic Wind Tunnel share similar features and all of the variables were applicable. However, only the test cell cross section area was used to determine the O&M costs of the Tunnels mapped to the 1’x1’ Supersonic Wind Tunnel.

Table 7 shows the selected Wind Tunnel inventory by site and the sample model mapping assignment and extrapolation factors.

Table 7. Inventory Mapping and Extrapolation Factors

Site	Property No.	Flow Velocity	Mach Number	Test Cell Area	Operation Type	Closed/Open	Sample Model	Extrapolation Factor
ARC	N206/N206A	Subsonic	0 to .55	11.25' X 11.25'	Continuous	Closed	9' X 15'	0.64
ARC	N215	Subsonic	0 to .33	7' X 10'	Continuous	Closed	9' X 15'	0.47
ARC	N221/N221B	Subsonic	0 to .45, 0 to .15	39' X 79', 79' X 118.3'	Continuous	Closed/Open	9' X 15'	4.61
ARC	N227A/N227B/N227C	Trans/Supersonic	0.4 to 1.4, 1.55 to 2.5, 2.45 to 3.5	11' X 11', 9' X 7', 8' X 7'	Continuous	Closed	9' X 15'	1.00
GRC	11/170	Subsonic	0.0 to .50	6' X 9'	Continuous	Closed	9' X 15'	0.52
GRC	37	Supersonic	1.6 to 5.0	1' X 1'	Continuous	Closed	N/A	1.00
GRC	39/53/54/57/61	Sub/Trans/Supersonic	0 to .2 & .4 to 2.0	9' X 15'/8' X 6'	Continuous	Closed/Open	N/A	1.00
GRC	85/87/88/90/113/114	Supersonic	2.0 to 3.5	10' X 10'	Continuous	Closed/Open	9' X 15'	1.99
LaRC	1212C	Subsonic	0 to .3	14.5' X 21.75'	Continuous	Closed/Open	9' X 15'	1.00
LaRC	1236	Transonic	.1 to 1.2	8.2' X 8.2'	Continuous	Closed	9' X 15'	0.48
LaRC	1242	Sub/Transonic	0.1 to .9	13" X 13"	Continuous	Closed	9' X 15'	0.06
LaRC	1247D	Hypersonic	6	20" X 20.5"	Blow down	Closed/Open	1' X 1"	1.69
LaRC	1251	Supersonic	1.46 to 2.86 & 2.3 to 4.63	4' X 4'	Continuous	Closed	9' X 15'	0.66
LaRC	1251A-15"	Hypersonic	6	14.5" Dia.	Blow down	Closed	1' X 1"	1.07
LaRC	1251A-31"	Hypersonic	10	31" X 31"	Blow down	Closed	1' X 1"	2.58
LaRC	1265	Hypersonic	3, 4, 5, & 7	8' Dia.	Blow down	Open	1' X 1"	7.07
LaRC	1275	Hypersonic	6	20" Dia.	Blow down	Closed	1' X 1"	1.48
LaRC	644	Subsonic	0 to 61 MPH	12' Octagon	Continuous	Open	9' X 15'	0.02
LaRC	645	Subsonic	0 to .08	20' Dia.	Continuous	Closed	9' X 15'	0.12
LaRC	648	Transonic	0 to 1.12	16' X 16'	Continuous	Closed	9' X 15'	0.94
MSFC	4732	Sub/Trans/Supersonic	.2 to 3.5	14" X 14"	Blow down	Closed	1' X 1"	1.17
MSFC	4775	Supersonic	.3 to 3.5	32" Dia.	Blow down	Closed	1' X 1"	2.36
PBS	3411	Hypersonic	5, 6, & 7	42" Dia.	Blow down	Closed	1' X 1"	3.10

A detailed summary of the methodology and calculations used to determine the Wind Tunnel utility costs, inventory mapping, and extrapolation factors was provided by Pete Aitcheson, NASA HQ Operations and Maintenance Program Manager. This summary can be found in Attachment A of this report.

Cost Estimates for Wind Tunnels

Sustainment Costs

The sustainment estimate for the 9'x15' Low Speed / 8'x6' Supersonic Wind Tunnel (Property No. 39/53/54/57/61) is an average of $1.2 million per year over a 50-year period. The 1’x1’ Supersonic Wind Tunnel (Property No. 37) is $167 thousand over the same period.

The sample estimates were extrapolated to the population. Table 8 shows sustainment costs by site for all Wind Tunnels. Sustainment estimates are expressed as 30, 40, and 50-year averages. While CBRE | Whitestone computes annual requirements, average costs are presented to smooth the annual oscillations. Overall, the sustainment requirements are an average of $20.9 million per year over 50 years. Expressed another way, this amounts to 0.7 percent of the $2.9 billion replacement value.

Table 8. Average Annual Estimates of Sustainment Requirements by Site, Wind Tunnels

				Sustainment[A]								
				30-Year Estimates			40-Year Estimates			50-Year Estimates		
Site	Property No.	GSFT[B]	CRV[C]	Avg. Annual Estimate	Per GSFT	Percent CRV	Avg. Annual Estimate	Per GSFT	Percent CRV	Avg. Annual Estimate	Per GSFT	Percent CRV
ARC	N206/N206A	36,364	$253,246,932	$980,441	$26.96	0.4%	$1,020,883	$28.07	0.4%	$975,942	$26.84	0.4%
ARC	N215	28,763	$36,488,779	$720,011	$25.03	2.0%	$749,711	$26.07	2.1%	$716,707	$24.92	2.0%
ARC	N221/N221B	171,129	$529,305,708	$7,062,237	$41.27	1.3%	$7,353,545	$42.97	1.4%	$7,029,829	$41.08	1.3%
ARC	N227A/N227B/N227C	53,580	$322,857,273	$1,531,939	$28.59	0.5%	$1,595,129	$29.77	0.5%	$1,524,909	$28.46	0.5%
GRC	11/170	32,501	$60,139,291	$627,642	$19.31	1.0%	$653,531	$20.11	1.1%	$624,761	$19.22	1.0%
GRC	37	7,479	$6,608,331	$169,293	$22.64	2.6%	$164,256	$21.96	2.5%	$167,314	$22.37	2.5%
GRC	39/53/54/57/61	119,514	$106,691,109	$1,207,003	$10.10	1.1%	$1,256,790	$10.52	1.2%	$1,201,464	$10.05	1.1%
GRC	85/87/88/90/113/114	170,941	$297,274,694	$2,401,936	$14.05	0.8%	$2,501,013	$14.63	0.8%	$2,390,914	$13.99	0.8%
LaRC	1212C	51,354	$90,413,562	$998,375	$19.44	1.1%	$1,039,557	$20.24	1.1%	$993,794	$19.35	1.1%
LaRC	1236	79,745	$393,554,794	$479,220	$6.01	0.1%	$498,987	$6.26	0.1%	$477,021	$5.98	0.1%
LaRC	1242	9,276	$13,304,480	$59,903	$6.46	0.5%	$62,373	$6.72	0.5%	$59,628	$6.43	0.4%
LaRC	1247D	100,360	$141,019,520	$236,653	$2.36	0.2%	$229,611	$2.29	0.2%	$233,886	$2.33	0.2%
LaRC	1251	134,535	$308,493,730	$658,928	$4.90	0.2%	$686,108	$5.10	0.2%	$655,904	$4.88	0.2%
LaRC	1251A-15"	24,312	$3,161,438	$149,834	$6.16	4.7%	$145,375	$5.98	4.6%	$148,082	$6.09	4.7%
LaRC	1251A-31"	24,312	$3,161,438	$361,281	$14.86	11.4%	$350,531	$14.42	11.1%	$357,057	$14.69	11.3%
LaRC	1265	25,517	$124,241,924	$990,022	$38.80	0.8%	$960,562	$37.64	0.8%	$978,447	$38.34	0.8%
LaRC	1275	17,428	$27,586,220	$207,246	$11.89	0.8%	$201,080	$11.54	0.7%	$204,823	$11.75	0.7%
LaRC	644	3,767	$6,624,391	$19,968	$5.30	0.3%	$20,791	$5.52	0.3%	$19,876	$5.28	0.3%
LaRC	645	14,461	$7,385,933	$119,805	$8.28	1.6%	$124,747	$8.63	1.7%	$119,255	$8.25	1.6%
LaRC	648	41,771	$134,476,694	$938,473	$22.47	0.7%	$977,184	$23.39	0.7%	$934,166	$22.36	0.7%
MSFC	4732	26,773	$15,864,288	$179,683	$6.71	1.1%	$174,337	$6.51	1.1%	$177,583	$6.63	1.1%
MSFC	4775	3,521	$838,104	$362,438	$102.94	43.2%	$351,654	$99.87	42.0%	$358,201	$101.73	42.7%
PBS	3411	6,082	$40,988,331	$524,809	$86.29	1.3%	$509,193	$83.72	1.2%	$518,674	$85.28	1.3%
Total[D]		**1,183,485**	**$2,923,726,964**	**$20,987,140**	**$17.73**	**0.7%**	**$21,626,946**	**$18.27**	**0.7%**	**$20,868,238**	**$17.63**	**0.7%**

[A] Sustainment is the average annual sum of preventative maintenance, unscheduled maintenance, and major repair and replacement tasks.
[B] Size is the approximate GSFT associated with the wind tunnel from site inspections. GSFT of entire property may exceed inspection sample.
[C] CRV is the Current Replacement Value of the entire property and may exceed the value of the inspected area.
[D] All costs expressed in $2012.

Operations Costs

Estimates of twenty operations costs are shown in Table 9 and 10. Costs were broken out into two tables, the typical MARS chart of accounts and the unique utilities associated with NASA Wind Tunnels. In total, the CBRE | Whitestone operations requirements for the selected Wind Tunnels are an annual average of $10.1 million, or 0.3 percent of replacement value. Note that in commercial accounting M&R (sustainment) is often included as an operating cost, but is reported separately above.

Table 9 shows costs for nine operations types included in MARS.

Table 9. Annual Estimates of CBRE | Whitestone Operations Costs by Site, Wind Tunnels

				CBRE | Whitestone Operations Types[A]											
Site	**Property No.**	**GSFT[B]**	**CRV[C]**	**Custodial**	**Grounds**	**Management**	**Pest Control**	**Refuse**	**Road Clearance**	**Security**	**Telecom**	**Water/ Sewer[D]**	**Total Costs**	**Per GSFT**	**Percent CRV**
ARC	N206/N206A	36,364	$253,246,932	$4,541	$12,533	$633,117	$5,407	$603	$0	$28,413	$27,670	$0	$712,284	$19.59	0.3%
ARC	N215	28,763	$36,488,779	$3,592	$9,913	$91,222	$4,277	$477	$0	$22,474	$21,886	$0	$153,841	$5.35	0.4%
ARC	N221/N221B	171,129	$529,305,708	$21,371	$58,981	$1,323,264	$25,444	$2,838	$0	$133,712	$130,215	$0	$1,695,824	$9.91	0.3%
ARC	N227A/N227B/N227C	53,580	$322,857,273	$6,691	$18,467	$807,143	$7,966	$889	$0	$41,865	$40,770	$0	$923,790	$17.24	0.3%
GRC	11/170	32,501	$60,139,291	$3,541	$6,817	$150,348	$2,555	$129	$2,603	$24,796	$24,730	$4,535	$220,054	$6.77	0.4%
GRC	37	7,479	$6,608,331	$713	$1,572	$16,521	$589	$30	$599	$12,761	$7,203	$17,106	$57,094	$7.63	0.9%
GRC	39/53/54/57/61	119,514	$106,691,109	$13,020	$25,066	$266,728	$9,396	$347	$9,548	$91,180	$90,940	$56,994	$563,219	$4.71	0.5%
GRC	85/87/88/90/113/114	170,941	$297,274,694	$18,623	$35,852	$743,187	$13,439	$680	$13,691	$130,415	$130,072	$82,592	$1,168,549	$6.84	0.4%
LaRC	1212C	51,354	$90,413,562	$4,888	$11,129	$226,034	$5,304	$732	$312	$38,609	$39,076	$0	$326,083	$6.35	0.4%
LaRC	1236	79,745	$393,554,794	$7,591	$17,282	$983,887	$8,236	$1,136	$484	$59,953	$60,679	$0	$1,139,248	$14.29	0.3%
LaRC	1242	9,276	$13,304,480	$883	$2,010	$33,261	$958	$132	$56	$6,974	$7,058	$0	$51,333	$5.53	0.4%
LaRC	1247D	100,360	$141,019,520	$8,360	$21,797	$352,549	$10,382	$1,430	$609	$168,745	$96,656	$0	$660,528	$6.58	0.5%
LaRC	1251	134,535	$308,493,730	$12,806	$29,156	$771,234	$13,894	$1,917	$817	$101,145	$102,370	$0	$1,033,338	$7.68	0.3%
LaRC	1251A-15"	24,312	$3,161,438	$2,025	$5,280	$7,904	$2,515	$346	$148	$40,878	$23,415	$0	$82,511	$3.39	2.6%
LaRC	1251A-31"	24,312	$3,161,438	$2,025	$5,280	$7,904	$2,515	$346	$148	$40,878	$23,415	$0	$82,511	$3.39	2.6%
LaRC	1265	25,517	$124,241,924	$2,125	$5,542	$310,605	$2,640	$364	$155	$42,904	$24,575	$0	$388,910	$15.24	0.3%
LaRC	1275	17,428	$27,586,220	$1,452	$3,785	$68,966	$1,803	$248	$106	$29,303	$16,785	$0	$122,448	$7.03	0.4%
LaRC	644	3,767	$6,624,391	$359	$816	$16,561	$389	$54	$23	$2,832	$2,866	$0	$23,900	$6.34	0.4%
LaRC	645	14,461	$7,385,933	$1,376	$3,134	$18,465	$1,493	$206	$88	$10,872	$11,004	$0	$46,638	$3.23	0.6%
LaRC	648	41,771	$134,476,694	$3,976	$9,052	$336,192	$4,314	$595	$254	$31,404	$31,784	$0	$417,571	$10.00	0.3%
MSFC	4732	26,773	$15,864,288	$2,224	$6,635	$39,661	$1,790	$406	$61	$46,335	$25,785	$0	$122,896	$4.59	0.8%
MSFC	4775	3,521	$838,104	$292	$873	$2,095	$235	$53	$8	$6,094	$3,391	$0	$13,042	$3.70	1.6%
PBS	3411	6,082	$40,988,331	$580	$1,278	$102,471	$479	$24	$487	$10,377	$5,858	$0	$121,554	$19.99	0.3%
Total[E]		**1,183,485**	**$2,923,726,964**	**$123,054**	**$292,250**	**$7,309,317**	**$126,020**	**$13,983**	**$30,196**	**$1,122,917**	**$948,203**	**$161,227**	**$10,127,166**	**$8.56**	**0.3%**

[A] CBRE | Whitestone operations include custodial, pest control, trash collection, utilities (w ater and sew er), grounds (landscape care, mow ing, and snow removal), security, telecommunications, and management.
[B] Size is the approximate GSFT associated w ith the w ind tunnel from site inspections. GSFT of entire property may exceed inspection sample.
[C] CRV is the Current Replacement Value of the entire property and may exceed the value of the inspected area.
[D] Water / Sew er use w as not available at the building level at ARC, LaRC, or MSFC.
[E] All costs expressed in $2012.

Operations requirements for the unique NASA Wind Tunnel utility types are displayed in Table 10. In total, the operations costs are an annual average of $21.2 million, or 0.7 percent of replacement value.

Table 10 shows costs for the 11 unique Wind Tunnels utilities.

Table 10. Annual Estimates of NASA Operations Costs by Site, Wind Tunnels

				NASA Operations Types[A]													
Site	**Property No.**	**GSFT[B]**	**CRV[C]**	**Building Electricity**	**Tunnel Electricity**	**Natural Gas**	**Steam**	**Process Cooling Water**	**6000 PSIG Air**	**450 PSIG Air**	**Service Air**	**Bldg. 64 Altitude Exh.**	**Bldg. 114 Altitude Exh.**	**IRT Chiller Plant**	**Total Costs**	**Per GSFT**	**Percent CRV**
ARC	N206/N206A	36,364	$253,246,932	$79,419	$118,977	$49,543	$0	$0	$0	$0	$0	$0	$0	$0	$247,939	$6.82	0.1%
ARC	N215	28,763	$36,488,779	$45,963	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$45,963	$1.60	0.1%
ARC	N221/N221B	171,129	$529,305,708	$150,008	$2,141,451	$50,830	$0	$0	$0	$0	$0	$0	$0	$0	$2,342,289	$13.69	0.4%
ARC	N227A/N227B/N227C	53,580	$322,857,273	$2,365,858	$0	$4,432	$0	$232,493	$0	$0	$0	$0	$0	$0	$2,602,783	$48.58	0.8%
GRC	11/170	32,501	$60,139,291	$27,240	$94,637	$0	$139,780	$0	$0	$0	$68,342	$0	$0	$26,789	$356,789	$10.98	0.6%
GRC	37	7,479	$6,608,331	$3,670	$0	$0	$28,265	$178	$0	$1,011,456	$0	$7,488	$0	$0	$1,051,058	$140.53	15.9%
GRC	39/53/54/57/61	119,514	$106,691,109	$26,526	$2,083,200	$146,830	$440,812	$684,370	$0	$1,137,888	$0	$179,712	$0	$0	$4,699,338	$39.32	4.4%
GRC	85/87/88/90/113/114	170,941	$297,274,694	$235,459	$1,438,400	$61,182	$606,300	$277,117	$0	$0	$28,476	$0	$572,688	$0	$3,219,622	$18.83	1.1%
LaRC	1212C	51,354	$90,413,562	$145,562	$204,868	$0	$117,802	$0	$36,724	$0	$0	$0	$0	$0	$504,956	$9.83	0.6%
LaRC	1236	79,745	$393,554,794	$456,373	$830,277	$0	$207,486	$37,047	$237,635	$0	$0	$0	$0	$0	$1,768,818	$22.18	0.4%
LaRC	1242	9,276	$13,304,480	$8,321	$14,221	$0	$21,274	$0	$0	$0	$0	$0	$0	$0	$43,816	$4.72	0.3%
LaRC	1247D	100,360	$141,019,520	$117,617	$0	$0	$296,854	$8,518	$4,505	$0	$0	$0	$0	$0	$427,496	$4.26	0.3%
LaRC	1251	134,535	$308,493,730	$292,491	$569,022	$0	$338,503	$89,442	$13,372	$0	$0	$0	$0	$0	$1,302,830	$9.68	0.4%
LaRC	1251A-15"	24,312	$3,161,438	$117,617	$0	$0	$296,854	$8,518	$7,299	$0	$0	$0	$0	$0	$430,290	$17.70	13.6%
LaRC	1251A-31"	24,312	$3,161,438	$117,617	$0	$0	$296,854	$8,518	$1,711	$0	$0	$0	$0	$0	$424,702	$17.47	13.4%
LaRC	1265	25,517	$124,241,924	$53,282	$0	$24,452	$84,638	$0	$112,771	$0	$0	$0	$0	$0	$275,142	$10.78	0.2%
LaRC	1275	17,428	$27,586,220	$11,861	$0	$13,332	$0	$0	$0	$0	$0	$0	$0	$0	$25,193	$1.45	0.1%
LaRC	644	3,767	$6,624,391	$13,103	$0	$5,855	$0	$0	$0	$0	$0	$0	$0	$0	$18,958	$5.03	0.3%
LaRC	645	14,461	$7,385,933	$13,103	$0	$22,485	$0	$0	$0	$0	$0	$0	$0	$0	$35,588	$2.46	0.5%
LaRC	648	41,771	$134,476,694	$218,965	$768,177	$71,224	$0	$36,300	$84,439	$0	$0	$0	$0	$0	$1,179,104	$28.23	0.9%
MSFC	4732	26,773	$15,864,288	$28,898	$0	$0	$9,122	$0	$1,711	$0	$0	$0	$0	$0	$39,731	$1.48	0.3%
MSFC	4775	3,521	$838,104	$2,331	$0	$0	$1,200	$0	$7,299	$0	$0	$0	$0	$0	$10,831	$3.08	1.3%
PBS	3411	6,082	$40,988,331	$75,888	$0	$8,692	$0	$0	$13,403	$0	$0	$0	$0	$0	$97,983	$16.11	0.2%
Total[D]		**1,183,485**	**$2,923,726,964**	**$4,607,174**	**$8,263,230**	**$458,856**	**$2,885,745**	**$1,382,503**	**$520,872**	**$2,149,344**	**$96,818**	**$187,200**	**$572,688**	**$26,789**	**$21,151,218**	**$17.87**	**0.7%**

[A] NASA Operations include utilities (electricity, natural gas, and steam), process cooling w ater, chiller w ater, high pressure air, service air, and altitude exhaust.
[B] Size is the approximate GSFT associated w ith the w ind tunnel from site inspections. GSFT of entire property may exceed inspection sample.
[C] CRV is the Current Replacement Value of the entire property and may exceed the value of the inspected area.
[D] All costs expressed in $2012.

Overall, the total operations requirements for the selected Wind Tunnels inventory are an average annual $31.3 million, or 1.1 percent of replacement value.

Total O&M Costs

Estimated total annual Wind Tunnels costs are shown in Table 11. A combination of maintenance and repair (sustainment) and operations, these costs represent an annual average for the next 50 years. Total costs are an estimated $52.1 million per year, or 1.8 percent of replacement value.

Table 11. Total Annual Costs by Site, Wind Tunnels

Site	Property No.	GSFT[A]	CRV[B]	O&M Estimates: 50-Year Avg. Sustainment[C]	O&M Estimates: Annual Operations[D]	Total Costs	Per GSFT	Percent CRV
ARC	N206/N206A	36,364	$253,246,932	$975,942	$960,223	$1,936,164	$53.24	0.8%
ARC	N215	28,763	$36,488,779	$716,707	$199,804	$916,511	$31.86	2.5%
ARC	N221/N221B	171,129	$529,305,708	$7,029,829	$4,038,113	$11,067,942	$64.68	2.1%
ARC	N227A/N227B/N227C	53,580	$322,857,273	$1,524,909	$3,526,574	$5,051,482	$94.28	1.6%
GRC	11/170	32,501	$60,139,291	$624,761	$576,843	$1,201,604	$36.97	2.0%
GRC	37	7,479	$6,608,331	$167,314	$1,108,152	$1,275,466	$170.54	19.3%
GRC	39/53/54/57/61	119,514	$106,691,109	$1,201,464	$5,262,556	$6,464,021	$54.09	6.1%
GRC	85/87/88/90/113/114	170,941	$297,274,694	$2,390,914	$4,388,171	$6,779,085	$39.66	2.3%
LaRC	1212C	51,354	$90,413,562	$993,794	$831,039	$1,824,833	$35.53	2.0%
LaRC	1236	79,745	$393,554,794	$477,021	$2,908,066	$3,385,087	$42.45	0.9%
LaRC	1242	9,276	$13,304,480	$59,628	$95,149	$154,777	$16.69	1.2%
LaRC	1247D	100,360	$141,019,520	$233,886	$1,088,023	$1,321,910	$13.17	0.9%
LaRC	1251	134,535	$308,493,730	$655,904	$2,336,169	$2,992,073	$22.24	1.0%
LaRC	1251A-15"	24,312	$3,161,438	$148,082	$512,800	$660,882	$27.18	20.9%
LaRC	1251A-31"	24,312	$3,161,438	$357,057	$507,212	$864,270	$35.55	27.3%
LaRC	1265	25,517	$124,241,924	$978,447	$664,052	$1,642,499	$64.37	1.3%
LaRC	1275	17,428	$27,586,220	$204,823	$147,640	$352,464	$20.22	1.3%
LaRC	644	3,767	$6,624,391	$19,876	$42,858	$62,734	$16.65	0.9%
LaRC	645	14,461	$7,385,933	$119,255	$82,226	$201,481	$13.93	2.7%
LaRC	648	41,771	$134,476,694	$934,166	$1,596,675	$2,530,841	$60.59	1.9%
MSFC	4732	26,773	$15,864,288	$177,583	$162,627	$340,210	$12.71	2.1%
MSFC	4775	3,521	$838,104	$358,201	$23,872	$382,073	$108.51	45.6%
PBS	3411	6,082	$40,988,331	$518,674	$219,537	$738,211	$121.38	1.8%
Total[E]		**1,183,485**	**$2,923,726,964**	**$20,868,238**	**$31,278,384**	**$52,146,622**	**$44.06**	**1.8%**

[A] Size is the approximate GSFT associated w ith the w ind tunnel from site inspections. GSFT of entire property may exceed inspection sample.

[B] CRV is the Current Replacement Value of the entire property and may exceed the value of the inspected area.

[C] Sustainment is the average annual sum of preventative maintenance, unscheduled maintenance, and major repair and replacement tasks.

[D] Operations include CBRE | Whitestone operations and NASA operations types.

[E] All costs expressed in $2012.

Included in Attachment B and C are detailed MARS reports for the two sample Glenn Research Center Wind Tunnels.

Attachment A: Detailed Wind Tunnels Research Summary

Wind Tunnel O & M Cost Analysis for Model Input

Provided by
Pete Aitcheson, NASA HQ Operations and Maintenance Program Manager

Wind Tunnel Data

As expected with any large organization, there are a number of data sources for wind tunnels and not all the data matches. Outside of visiting and analyzing every wind tunnel in the agency, which was cost prohibitive, a variety of other sources were used to determine which wind tunnels would be modeled in this project. These include:

1. The Aeronautics Test Program (ATP) was most helpful, particularly in determining which tunnels should be modeled and for providing an updated list of demolished wind tunnels. Their website was also useful to verify the wind tunnel characteristics which were used to help develop the extrapolation factors for the maintenance costs.
2. The SCAP program provided valuable information.
3. A table from Mr. Lee's manuscript on NASA Wind Tunnels.
4. The NASA Technical Facilities Catalog and the Aeronautical Facilities Catalog were also used to understand characteristics and configurations.
5. Real Property Management System (RPMS) was used for building level data.
6. Several NASA Wind Tunnel technical reports were used when more detailed information was required.
7. Discussions with on-site personnel to confirm various on-site conditions.

All the information gathered was summarized in a spreadsheet which listed:

1. Facility Number
2. Facility Size (in gross square feet)
3. Status (Active or inactive)
4. Mach Number
5. Reynolds Number
6. Flow Velocity Category (subsonic, transonic, supersonic or hypersonic)
7. Test Cell Cross Sectional Area
8. Operation (continuous or blow-down, open or closed loop)
9. Use Activity (high, medium or low)
10. Detailed Model (no for all except the 1 X 1 and the 8 X 6/9 X 15)
11. Extrapolate to 1 X 1 or the 8 X 6/9 X 15
12. Extrapolation Factor (based on test cell size flow velocity in the tunnel and configuration)
13. Notes – The notes section provides characteristics specific to each tunnel.

The spreadsheet is divided into 3 blocks:

1. Active Wind Tunnels – these are currently being used for testing at some level.
2. Inactive Wind Tunnels – these are mothballed, but could be reopened and used if a program desired to test at these conditions. For purposes of the cost study, these tunnels were modeled and medium use was assumed.

3. Propulsion Tunnels – these were not modeled, because the type of equipment and configuration appeared to deviate too far from the typical wind tunnel configuration. Arc heated, ballistic and shock facilities were also not modeled in this study.

Tunnels with multiple test cells were modeled as one tunnel since they shared common equipment.

Extrapolation of Maintenance Costs

Maintenance costs for more common types of facilities such as office buildings or warehouses can be extrapolated to different size facilities of the same type fairly accurately on a square foot basis. The floor area of a wind tunnel has very little relevance when it comes to determining maintenance costs. Instead, the maintenance cost for a wind tunnel are more closely related to the to the power requirements of the tunnel which are in part determined by the wind speed (velocity) in the tunnel, test cell size (volume). The configuration also impacts maintenance costs such as blow down verses continuous operation (time). The following criteria were used for the initial extrapolation:

1. For subsonic and transonic continuous operation type tunnels the extrapolation was based on the 9 X 15 test section.
2. For supersonic continuous operation type tunnels the extrapolation was based on the 8 X 6 test section.
3. All blow down tunnels were extrapolated to the 1 X 1 (1NW) Wind Tunnel.

In addition, LaRC has two vertically configured tunnels; the 20 foot Vertical Spin Tunnel (VST) and the 12 Foot Low Speed Tunnel (LST). Because of their vertical configuration, they have a much smaller footprint, so the extrapolation factor was adjusted by the ratio of the area vertical tunnel to the area of the 9 X 15.

Additional features of the continuous operation type wind tunnels also impact O & M costs. The following features were also taken into account to modify the extrapolation factor in addition to 1 through 3 listed above:

1. Process cooling water requirements
2. Number of drive motors
3. Auxiliary chiller plant (IRT only)
4. Integral air dryers
5. Compressors
6. Electrolyte systems
7. Flex wall or sliding block nozzle (continuously variable)

There are other features that could be taken into account, but it was determined the remaining features either had a lower impact on overall O & M costs for most of the wind tunnels in the agency, the feature was unique to one or two facilities or modeling was more appropriate for another type of facility other than a wind tunnel. Note that most wind tunnels used an outside source of air (ie. from a plant located outside of the tunnel complex), in those cases the air was treated as a utility which is why it is not factored in at this point. The factors for each of the features used to adjust the extrapolation factor were derived from the 8 X 6/9 X 15 annual maintenance labor hours. For example, process cooling in the 8 X 6/9 X 15 consumed 6% of the total annual maintenance hours so the process cooling maintenance factor was determined to be 1.06. Below provides more detail about the maintenance factors:

1. Process cooling water requirements – If the tunnel did not use process cooling the extrapolation factor was divided by 1.06, since 6% of the total annual labor hours on the 8 X 6/9 X 15 were used to service the process cooling related components.
2. Number of drive motors – since the 8 X 6/9 X 15 has three drive motors, two motor maintenance factors were used; one factor for one drive motor and one factor for 6 or more drive motors (it was assumed having 2-4 motors was considered minimally different from 3 motors). None of the wind tunnels examined had 5 drive motors. The one motor maintenance factor is a 9% decrease in overall wind tunnel maintenance costs and the 6 plus motor maintenance factor increases overall maintenance costs by 38%.
3. Auxiliary chiller plant (IRT only) – Because the IRT relies exclusively on the IRT Chiller Plant for testing, the chiller plant maintenance was included in the IRT Extrapolation Factor. This factor was derived by dividing the Building 170 maintenance costs by an hourly rate to arrive at the annual labor hours. The percentage increase was calculated like all the other factors by dividing the chiller plant maintenance hours by the total annual maintenance hours of the 8 X 6/9 X 15 since this wind tunnel was used as the baseline. Note the energy use by the IRT Chiller Plant is taken into account in the cost of chilled water, not in the maintenance factor.
4. Air dryer - If the tunnel did not use an air dryer integral to the tunnel, the extrapolation factor was divided by 1.15, since 15% of the total annual labor hours on the 8 X 6/9 X 15 were used to service the dryer building components (Building 57).
5. Compressors - Compressors tend to be more maintenance intensive than fans. If a tunnel was equipped with a fan, the maintenance requirements were reduced by 8% (the extrapolation factor was divided by 1.08).
6. Electrolyte system - The 8 X 6/9 X 15 and the 10 X 10 use a large variable resistor system that is submerged in an electrolyte that is more maintenance intensive than an electronic variable speed drive or viable pitch fans. If a tunnel did not have this type of variable speed control, the maintenance requirements were reduced by 9% (the extrapolation factor was divided by 1.09).
7. Flex Wall or Sliding Block Nozzle – Wind tunnels equipped with continuously variable flex wall nozzles or sliding block nozzles are more maintenance intensive than those equipped with a fixed nozzle. Maintenance requirements for fixed nozzle tunnels where reduced by 5% (the extrapolation factor was divided by 1.05).

The formula used for extrapolating the *subsonic and transonic* wind tunnel maintenance costs to the 9 X 15 is as follows:

$$EF \quad = \frac{\left(\frac{T}{T_{9x15}}\right)^{1/2} \times [1 + (C_1 + C_5)]}{[1 + (C_2 + C_3 + C_4 + C_6 + C_7 + C_8)]}$$

The formula used for extrapolating the *supersonic* wind tunnel maintenance costs to the 8 X 6 is as follows:

$$EF = \frac{\left(\frac{T}{T_{8x6}}\right)^{1/2} \times (1 + C_5)}{[1 + (C_2 + C_3 + C_4 + C_6 + C_7 + C_8)]}$$

The formula used for extrapolating the *vertically configured subsonic* wind tunnel maintenance costs to the 9 X 15 is as follows:

$$EF = \left\{ \frac{\left(\frac{T}{T_{9x15}}\right)^{1/2}}{[1 + (C_2 + C_3 + C_4 + C_6 + C_7 + C_8)]} \right\} X \left(\frac{A}{A_{9x15}}\right)$$

The formula used for extrapolating the blow down wind tunnel maintenance costs to the 1 X 1 is as follows:

$$EF = \left(\frac{T}{T_{1x1}}\right)^{1/2}$$

Where:

EF = the extrapolation factor or maintenance cost multiplier for the wind tunnel being analyzed
T = the test cell cross sectional area for the wind tunnel being analyzed
T_{9x15} = the test cell cross sectional area of the 9 X 15
T_{8x6} = the test cell cross sectional area of the 8 X 6
T_{1x1} = the test cell cross sectional area of the 1 X 1
A = facility size (gross square feet) of the wind tunnel being analyzed
A_{9x15} = facility size (gross square feet) of the 9 X 15
C_1 = maintenance factor if the wind tunnel is equipped with an auxiliary chiller plant. The value used is 0.25, but is adjustable (see prior detailed explanation).
C_2 = maintenance factor if the wind tunnel does not use process cooling water. The value used is 0.06, but is adjustable (see prior detailed explanation).
C_3 = maintenance factor if the wind tunnel is not equipped with a dryer. The value used is 0.15, but is adjustable (see prior detailed explanation).
C_4 = maintenance factor if the wind tunnel has one drive motor. The value used is 0.09, but is adjustable (see prior detailed explanation).
C_5 = maintenance factor if the wind tunnel has 6 or more drive motors. The value used is 0.38, but is adjustable (see prior detailed explanation).
C_6 = maintenance factor if the wind tunnel is equipped with a fan instead of a compressor. The value used is 0.08, but is adjustable (see prior detailed explanation).
C_7 = maintenance factor if the wind tunnel is equipped with a solid state variable speed drive or a variable pitched fan. The value used is 0.09, but is adjustable (see prior detailed explanation).
C_8 = maintenance factor if the wind tunnel has a fixed nozzle. The value used is 0.05, but is adjustable (see prior detailed explanation).

Note: C_1 & C_5 were used to increase the value of the extrapolation factor, while $C_{2,\ 3,\ 4,\ 6,\ 7\ \&\ 8}$ reduced the value of the extrapolation factor.

Extrapolation of custodial, refuse, grounds, pest control, road clearance, security, management, and telecommunications costs were based on facility size (gross square feet) and came from CBRE | Whitestone's MARS Facility Cost Forecast System.

Utility Costs

Glenn Research Center (GRC)

Commercially provided utilities - for electricity, natural gas and water, the average of the combined annual rates for FY 2011 and FY 2012 from the NASA Energy Tracking System (NETS) were used. For some of the buildings, low voltage electricity, natural gas and steam was not metered, for these cases the utilities were estimated based on square feet and utility use of similar facilities.

Central Process System (CPS) – Compressed Air/Altitude Exhaust/Chilled Water.
Since most of the Wind Tunnels at Lewis Field use either compressed air or altitude exhaust (in most cases both) from the Central Process Systems, these commodities were treated like any other utility and unit costs were estimated. This was done using the following methods:

1. First, the full load output of all high horsepower test equipment was converted from horse power to Mega Watts (MW).
2. Since NETS does not list the high voltage equipment power consumption, it had to be calculated. The operational times for each piece of equipment was used along with the peak load multiplied a diversity value (adjustable) to arrive at the high voltage electricity consumption.
3. The building utility costs for Building 64 and Building 5 (low voltage electricity, water, sewer and natural gas) plus the operations, maintenance, janitorial, and management costs were distributed to each piece of equipment based on a combination of horsepower and average annual runtime.
4. The estimated high voltage electricity costs for each piece of equipment were added to the costs calculated in Number 3 (above).
5. The cost for 450 PSIG air, also included the cost for 40 PSIG air and 150 PSIG air and likewise, the cost for 150 PSIG air included the cost of 40 PSIG air since the low pressure systems feed into the higher pressure systems.

It is important to note that the cost of these commodities can vary significantly based on annual runtimes. The more the equipment runs, the lower the unit cost since the fixed costs of running the plant can be spread over more run hours.

Process Cooling Water – The wind tunnels at GRC use process cooling primarily to keep the equipment cool and to remove heat from the wind tunnel air stream. The process cooling is provided by 5 cooling towers in various locations around Lewis Field. The cost for process cooling water was calculated as follows:

1. The average amount of make-up water used in FY 2011 and FY 2012, assuming 3 cycles of concentration and a typical temperature difference across the towers provided a total annual flow of process cooling water.

2. The management, operations, maintenance and utility costs (including make-up water and water treatment) for all towers and pumping stations were divided by the total production of process cooling water to arrive at a unit cost.

Steam costs were also estimated at Lewis Field since it is generated on site. The steam costs accounted for the following:

1. Cost of natural gas
2. Efficiency of the plant
3. Efficiency of the distribution system
4. Operations and maintenance costs for Building 12

Ames Research Center (ARC), Langley Research Center (LaRC) & Marshall Space Flight Center (MSFC) Utility Costs

Like GRC, the commercially supplied costs were taken from the FY 2011 and FY 2012 NETS Data. LaRC and ARC both have process cooling. 75% of the cost of process cooling is the cost of the make-up water, so the process cooling water costs were scaled by the ratio of the ARC costs to the GRC costs and the same for the LaRC costs. Central station compressed air costs for LaRC were obtained from Operational-Phase Life Cycle Assessment of Select NASA Ground Test Facilities. Actual utility rates in NETS were used for the MSFC Tunnels except for the high pressure air for which the LaRC rate was used.

Operational Times

Facility Operational Times: 41 – 80 hours hours/week was the range selected in the calibration sheet, which is the medium use selection in the MARS Calibration Sheet.
Wind Tunnel Run Times: these were established based on a combination of testing hours supplied by test personnel at GRC and the CPS scheduled utilities for each wind tunnel. One of three levels of operation were applied to each wind tunnel across the agency:

1. High – 600 hours of run time per year
2. Medium – 400 hours of run time per year
3. Low – 200 hours of run time per year

For the purpose of the model, all inactive facilities were assigned a default value of medium use so that ATP would be able to use these values to appropriately budget for maintenance costs should a wind tunnel become active again.

Annual Utility Usage by Wind Tunnel

Glenn Research Center (GRC)

The next step to determine the annual utility costs was to break out the utility use by wind tunnel. To do this, it was necessary to establish the “typical” operational characteristics of each wind tunnel at Lewis Field. It is understood that the type CPS utilities used and drive motor loads would vary based on the type and amount of testing, it was important for estimating utility usage for each tunnel to establish a “typical” or “average” operation. This was done through discussions with the CPS dispatch personnel. This information was needed coupled with the tunnel operational times to determine the wind tunnel drive motor electricity consumption, high pressure air consumption, service air consumption and altitude exhaust consumption for the 1X1, IRT, 8X6/9X15 and 10X10.

The next step was to estimate the process cooling water consumption for each tunnel. All the wind tunnels modeled at Lewis Field except the IRT used process cooling water in the operation. The 1X1 used process cooling water for cooling the hydraulic oil and for the spray cooler. The 8X6/9X15 and 10X10 used process cooling water for electrolyte cooling, motor cooling, oil cooling, dryer cooling and wind tunnel air stream cooling. While on site, pipe sizes were recorded, pipe flow velocities were assumed based on pipe size and standard design practice, then, flow rates were calculated. The flow rates were multiplied by a diversity factor (adjustable) and wind tunnel operational time to get total process water consumed annually per wind tunnel.

Finally, the building utilities, drive motor electricity consumption, CPS utilities and process cooling water consumption was summed up to determine the total annual utility usage for each wind tunnel by utility.

As mentioned in the beginning of this section, where there were gaps in building utility information (low voltage electricity, steam and natural gas), those annual consumption numbers were estimated. Building utilities for the 1X1 had to be estimated by square foot since it only occupies a portion of Building 37. Utilities were also estimated for Buildings 61 and 113 (8X6/9X15 and 10X10 Model Shops) since they were not individually metered. Steam was not metered in any of the facilities, so all those values were estimated using the steam consumption values per square foot from another facility at Lewis Field.

The utilities for the Hypersonic Test Facility (HTF) at Plum Brook Station (PBS) included estimates for the high pressure air (based on the amount of air moved and runtime) and the 3 MW heaters as well as the building utilities. The LaRC cost for the high pressure air was used for the HTF. The building utilities are actuals and are a little low since the facility is currently inactive.

Ames Research Center (ARC)

The utilities estimated for the Unitary Wind Tunnel at ARC were from an accompanying appendix to this original report. The utilities for the National Full Scale (NFS) – 40X80/80X120, 7X10 and 12 Foot Pressure wind tunnels were estimated by calculating the drive motor power consumption and combining the values with the rest of the building utilities which were taken from NETS.

Langley Research Center (LaRC)

The utilities for the 14X22 Wind Tunnel were estimated by calculating the drive motor power consumption and combining the values with the rest of the building utilities from NETS.

The 20 foot Vertical Spin Tunnel (VST), 12 foot Low Speed Tunnel (LST) and the 20” CF_4 Wind Tunnels used the actual metered data from NETS for annual utility usage.

The National Transonic Facility (NTF) has an LN2 plant associated with the operation and those utilities and maintenance costs are not included in this study. It was assumed the annual electricity consumption listed in NETS was for low voltage power only. The drive motor power was calculated separately. Steam and compressed air use was pulled from an accompanying appendix to this original report. Process cooling water use was calculated from the annual make-up water requirements, cycles of concentration and the average temperature difference across the tower. The utilities for the Transonic Dynamics Tunnel (TDT) were calculated in the same manner. The Unitary Plan Wind Tunnel (UPWT) utilities were also estimated in the same manner except the building utilities were split in half since the UPWT shares Building 1251 with the 31” Mach 10 and the 15” Mach 6 Wind Tunnels.

The 8 foot High Temperature Tunnel (HTT) utilities were estimated using actual utility data from NETS for natural gas and electricity. Steam and compressed air quantities were taken from an accompanying appendix to this original report.

The 0.3 Meter Cryogenic Wind Tunnel building utilities were estimated using the data out of NETS. The drive motor electricity use was calculated separately and the steam use was scaled proportionally by square foot off the actual steam usage in Building 1212C.

The 31” Mach 10 and the 15” Mach 6 Wind Tunnels share approximately one half of Building 1251 with the UPWT. The remaining utilities not applied to the UPWT were split evenly between the two tunnels except for compressed air which was scaled based on test cell area. The values used to scale the compressed air were from an accompanying appendix to this original report.

Building 1247D houses the 20” Mach 6 Wind Tunnel along with a number of other test cells. Since there was no way to separate the utilities for the 20” Mach 6 from the rest of the building it was assumed the 20” Mach 6 Tunnel used the same building utilities as the 31” Mach 10 and the 15” Mach 6 Tunnels in Building 1251. The high pressure air consumption was scaled based on test cell size.

Marshall Space Flight Center (MSFC)

MSFC has two inactive wind tunnels; the High Reynolds Number Wind Tunnel in Building 4775 and the Trisonic Wind Tunnel in Building 4732. For both tunnels the electricity use was taken from NETS. The steam at MSFC is supplied by the Army and not generally metered at the building level, so steam was scaled by square foot from the usage in another facility. Since these are both blow-down tunnels, the compressed air use was scaled off the LaRC 31” Mach 10 and the 15” Mach 6 Wind Tunnels compressed air use by test cell cross sectional area. As mentioned earlier, the LaRC high pressure compressed air rates were used.

Size and Current Replacement Value (CRV)

The size and Current Replacement Value (CRV) values came from NASA’s Real Property Management System (RPMS). There were several assumptions used which are listed below:

1. The 8X6/9X15 is made up of Buildings 39, 53, 54, 57, & 61. The control room is in Building 54 and only the control room portion of Building 54 was included in the model since the rest of Building 54 is office space. The size of the control room was measured on site and is about 2900 square feet. The CRV was estimated from RS Means for computer rooms and adjusted for the Cleveland area.

2. The IRT includes the IRT refrigeration plant size and CRV since it is used exclusively for the operation of the IRT.
3. The 1X1 in housed in Building 37, but does not take up the entire building. The size was measured on site and the CRV was prorated based on the gross square feet and CRV of Building 37.
4. The 20” Mach 6 Wind Tunnel at LaRC is housed in Building 1247D with other test cells. The CRV and size listed is for the entire building.
5. The 31” Mach 10 Wind tunnel and the 15” Mach 6 HTT are both located in Building 1251A. The size and CRV listed is for the entire building.
6. FY 2012 data was used to be consistent with the previously modeled facilities.

All the other sizes and CRV’s are right out of the RPMS with no further explanation required.

Some Final Comments

It is important to understand the limitations of a study like this; first, we performed a detailed analysis on two very different wind tunnel facilities to come up with an accurate estimate of operations and maintenance costs over the life cycle of those facilities. This is not to be confused with what NASA is spending, but rather what NASA should be spending on those facilities. This information was used to extrapolate O & M costs to 21 other wind tunnel facilities. There are vast differences between wind tunnels based on their testing capabilities and we tried to take care of these differences as best as possible with the extrapolation factors. While using test cell size and air velocity as a basis for the extrapolation may not be perfect, it turned out to be a much better fit than facility size. As mentioned earlier in the report, technical facilities are not like office space or warehouses where extrapolation by size is a pretty good fit.

Because we only had the resources to look at two facilities, the sample size and therefore the accuracy is at the lower end of the scale. Estimating O & M cost is not an accurate science and predicting failure or equipment life span is not easy. Things like environmental conditions, manufacturing processes and tolerances, quality of components, materials, workmanship, weather, installation, commissioning, quality assurance, level of preventative maintenance and predictive testing and inspection all play a part in determining how long a building system or component might last.

Finally, the costs are presented as total annual costs, cost per Gross Square Foot (GSF) and cost as a percentage of Current Replacement Value (CRV) of the facility. The focus should be on the total cost, not percent of CRV or cost per GSF, these numbers are for comparison purposes only. Percent of CRV or cost per GSF for wind tunnels has very little meaning since size was not used to extrapolate costs and the NASA CRV’s tend to be less accurate for technical facilities.

FY17 SUC Calculation as Follows:

Average Sustainment Cost for 23 NASA Wind Tunnels, August 2015	$907,314.65	EA
ENR Inflation August 2015 to October, 2016	1.0257	
FY17 SUC	$930,632.64	EA

FAC 3904 Propulsion engine test cell

FY25 SUC:	$68,729.80 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Based on mulple FAC S and R.S. Means Cost Works 2010 Quarter 1 Component list provided by AEDC/TSDC D, Arnold Air Force Base

FAC 3904 Propulsion Engine Test Cell V13 Sustainment Unit Cost

References:
Real Property Classification System Version 2010-2
FSM Version 12 Database
RS Means CostWorks, 2010

UM= EA

SUSTAINMENT UNIT COST = $41,763.96

Cost Methodology

The SUC for this FAC was determined using a combination of SUCs for other FACs and RS Means CostWorks for specified facility components. The list of components for each facility was provided by Bill Wendle, Program Section Chief, AEDC/TSDCD, Arnold AFB.

NOTE: At least three of the fifteen in the FAD are inactive. Of the others, 4 should be classified as a different type of facility. They are an electronics building, steam accumulator, exhaust duct, and a dehumidification chamber.

FAC 3904 SUC Calculation

FAC	Desciption	Quantity	UM	Unit Cost	Total
N/A	CostWorks Components	1	N/A	N/A	$15,705.56
N/A	Cathodic Protection System	1	EA	$2,000.00	$2,000.00
8111	Elecrical Power Gen Plant	60	KW	$15.14	$908.40
8313	Industrial Waste Water Collection	10	KG	$0.54	$5.40
8526	Misc. Paved Surfaces	2500	SY	$1.49	$3,725.00
8261	A/C Plant 5 to 25 TN	30	TR	$74.32	$2,229.60
8131	Electric Substation	1000	KV	$17.19	$17,190.00
	Total Cost				$41,763.96

FAC 3904

CostWorks 2010 Quarter 1 - FAC3904

Design Life= 55

UM = EA 1

Sq=100 S.F; M.L.F=1000 l

This spreadsheet was exported from R.S Means CostWorks

Terminal Cutoff is the removal of a single task occurrence if that task occurs within 10% of the end of the design life and if the frequency of the task exceeds 20% of the design life. This prevents scheduling major work near the end of the design life

Description	Frequency	Crew	Qty	Unit	Total In-House	Total Incl. O&P	Type	Release	Occurances in Design	Adjusted Occurrence	Terminal Cutoff
Rebuild 10" diameter reduced pressure backflow p	10	1 Plum	1.000	Ea.	873.00	1,038.40	FMR	2010 Qtr 1	5	5	$ 5,192.00
Inspect sprinkler system	1	1 Plum	1.000	Ea.	30.20	37.80	FMR	2010 Qtr 1	55	55	$ 2,079.00
Replace sprinkler head	20	1 Plum	49.000	Ea.	3,479.00	4,263.00	FMR	2010 Qtr 1	2	2	$ 8,526.00
Check and repair manual pull station	10	1 Elec	5.000	Ea.	357.50	435.25	FMR	2010 Qtr 1	5	5	$ 2,176.25
Replace manual pull station	15	1 Elec	5.000	Ea.	884.40	1,053.25	FMR	2010 Qtr 1	3	3	$ 3,159.75
Maintenance and inspection generator, gasoline, 1	0.08	1 Elec	1.000	Ea.	48.00	60.00	FMR	2010 Qtr 1	687	687	$ 41,220.00
Replace generator component gasoline, 175 KW	25	2 Elec	1.000	Ea.	92,675.00	106,250.00	FMR	2010 Qtr 1	2	1	$ 106,250.00
Maintenance and repair transfer switch	5	1 Elec	1.000	Ea.	242.00	294.00	FMR	2010 Qtr 1	11	11	$ 3,234.00
Maintenance and inspection transfer switch	0.5	1 Elec	1.000	Ea.	30.00	37.50	FMR	2010 Qtr 1	110	110	$ 4,125.00
Replace transfer switch	18	1 Elec	1.000	Ea.	3,625.15	4,137.73	FMR	2010 Qtr 1	3	2	$ 8,275.46
Maintenance and repair of general wiring lightning	1	1 Elec	1.000	M.L.F.	73.50	91.00	FMR	2010 Qtr 1	55	55	$ 5,005.00
Replace lightning protection general wiring system	25	2 Elec	1.000	M.L.F.	7,597.50	9,099.50	FMR	2010 Qtr 1	2	1	$ 9,099.50
Maintenance and repair special ground system	4	1 Elec	1.000	Ea.	16.05	20.00	FMR	2010 Qtr 1	13	13	$ 260.00
Replace special ground system	50	2 Elec	1.000	M.L.F.	1,675.00	2,003.00	FMR	2010 Qtr 1	1	0	$ -
Minor repairs to fire alarm control panel	5	1 Elec	1.000	Ea.	118.85	143.75	FMR	2010 Qtr 1	11	11	$ 1,581.25
Maintenance and inspection fire alarm control pan	0.5	1 Elec	1.000	Ea.	32.00	40.00	FMR	2010 Qtr 1	110	110	$ 4,400.00
Replace fire alarm control panel	15	1 Elec	1.000	Ea.	1,930.37	2,314.05	FMR	2010 Qtr 1	3	3	$ 6,942.15
Minor repairs to annunciation panel	5	1 Elec	1.000	Ea.	118.85	143.75	FMR	2010 Qtr 1	11	11	$ 1,581.25
Maintenance and inspection annunciation panel	0.5	1 Elec	1.000	Ea.	32.00	40.00	FMR	2010 Qtr 1	110	110	$ 4,400.00
Replace annunciation panel	15	1 Elec	1.000	Ea.	856.37	1,028.05	FMR	2010 Qtr 1	3	3	$ 3,084.15
Replace fire alarm bell, 6"	20	1 Elec	25.000	Ea.	4,147.00	4,966.25	FMR	2010 Qtr 1	2	2	$ 9,932.50
Repair heat detector	10	1 Elec	50.000	Ea.	2,252.50	2,767.50	FMR	2010 Qtr 1	5	5	$ 13,837.50
Check operation heat detector	1	1 Elec	50.000	Ea.	600.00	752.50	FMR	2010 Qtr 1	55	55	$ 41,387.50
Replace heat detector	15	1 Elec	50.000	Ea.	7,094.00	8,582.50	FMR	2010 Qtr 1	3	3	$ 25,747.50
					$128,788.24	**$149,598.78**					

MR Subtotal	$311,495.76
MR Per Year	$ 5,663.56
PM Per Year	$ 10,042.00
Subtotal	$ 15,705.56
Total Per Unit	$ 15,705.56

FAC 3904

CostWorks 2010 Quarter 1 - FAC3904

Description	Qty	Labor Hours	Bare Mat.	Bare Labor	Bare Equip.	Bare Total	Total In-House	Total Incl. O&P	Zip Code Prefix	Type	Release
Backflow prevention device, up to 4", annualized	1.000	0.33	0.00	17.35	0.00	17.35	21.50	27.00		FMR	2010 Qtr 1
Backflow prevention device, over 4", annualized	1.000	0.49	0.00	25.50	0.00	25.50	32.00	40.00		FMR	2010 Qtr 1
Extinguishing system, wet pipe, annualized	1.000	11.34	147.00	570.00	0.00	717.00	870.00	1,075.00		FMR	2010 Qtr 1
Extinguishing system, deluge / preaction, annualized	1.000	11.57	147.00	585.00	0.00	732.00	885.00	1,075.00		FMR	2010 Qtr 1
Fire pump, electric motor driven, annualized	1.000	47.74	116.00	2,400.00	0.00	2,516.00	3,100.00	3,875.00		FMR	2010 Qtr 1
Extinguishing system, CO2, annualized	1.000	9.47	187.00	475.00	0.00	662.00	795.00	975.00		FMR	2010 Qtr 1
Extinguishing system, dry chemical, annualized	1.000	5.61	187.00	283.00	0.00	470.00	555.00	670.00		FMR	2010 Qtr 1
Fire alarm annuciator system, annualized	1.000	11.05	137.00	555.00	0.00	692.00	840.00	1,025.00		FMR	2010 Qtr 1
Crane, electric bridge, over 15 tons, annualized	2.000	16.66	124.00	720.00	0.00	844.00	1,030.00	1,280.00		FMR	2010 Qtr 1
			$1,045.00	**$5,630.85**	**$0.00**	**$6,675.85**	**$8,128.50**	**$10,042.00**			

FAC 4111 Bulk Liquid Fuel Storage

FY25 SUC:	$4.11 / BL
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Study of Fuel Facilities

FAC 4111 Bulk Liquid Fuel Storage

SUC Model for Tanks ≤ 1,190.5 Barrels

Component	Frequency	Estimated Cost per Occurrence	Occurrences in Design Life	Occurrences Rounded	Design Life Cost
Design Life	**40**	**Years**			
Representative Size	**395.24**	**BL**			
Inspection Cost Total	10	$ 27,236.23	4.0	4.0	$ 108,944.92
Repair Cost Total	20	$ 132,855.88	2.0	2.0	$ 265,711.76
Pre-Post Cost Total	20	$ 3,975.72	2.0	2.0	$ 7,951.44
RMMR	1	$ 106.00	40.0	40.0	$ 4,240.00
SIOH	1	$ 83.00	40.0	40.0	$ 3,320.00
Cathodic Protection	1	$ 1.26	40.0	40.0	$ 50.40
Operator Maintenance	1	$ 7,908.29	40.0	40.0	$ 316,331.60
Total					$ 706,550.12
Per Year					$ 17,663.75
Annual SUC Per UM					$ 44.82

FAC 4111 Bulk Liquid Fuel Storage

SUC Model for Tanks > 1,190.5 Barrels

Component	Frequency	Estimated Cost per Occurrence	Occurrences in Design Life	Occurrences Rounded	Design Life Cost
Design Life	**40**	**Years**			
Representative Size	**35,714**	**BL**			
Exterior Inspection Cost Total	5	$ 15,192.19	8.0	8.0	$ 121,537.55
Internal Inspection Cost Total	10	$ 87,987.54	4.0	4.0	$ 351,950.17
Internal Tank Repair Totals	10	$ 442,998.40	4.0	4.0	$ 1,771,993.60
External Tank Repair Totals	5	$ 127,183.62	8.0	8.0	$ 1,017,468.95
Pre-Post Cost Total	10	$ 65,578.80	4.0	4.0	$ 262,315.21
RMMR	1	$ 9,615.00	40.0	40.0	$ 384,600.00
SIOH	1	$ 178.57	40.0	40.0	$ 7,142.86
Cathodic Protection	1	$ 113.85	40.0	40.0	$ 4,554.00
Operator Maintenance	1	$ 7,908.29	40.0	40.0	$ 316,331.60
Total					$ 4,237,893.94
Per Year					$ 105,947.35
Annual SUC Per UM					$ 3.10

FAC 4112 Large Bulk Liquid Fuel Storage

FY25 SUC:	$1.57 / BL
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Study of Fuel Facilities

FAC 4112 Large Bulk Liquid Fuel Storage

Design Life	**65**	**Years**			
Representative Size	**214,286**	**BL**			
Component	**Frequency**	**Estimated Cost per Occurrence**	**Occurrences in Design Life**	**Occurrences Rounded**	**Design Life Cost**
Exterior Inspection Cost Total	5	$ 25,578.21	13.0	13.0	$ 332,516.78
Internal Inspection Cost Total	10	$ 178,812.22	6.5	6.0	$ 1,072,873.31
Internal Tank Repair Totals	10	$ 764,835.70	6.5	6.0	$ 4,589,014.19
External Tank Repair Totals	5	$ 191,184.69	13.0	13.0	$ 2,485,400.99
Pre-Post Cost Total	10	$ 292,276.31	6.5	6.0	$ 1,753,657.88
RMMR	1	$ 57,687.00	65.0	65.0	$ 3,749,655.00
SIOH	1	$ 1,071.43	65.0	65.0	$ 69,642.86
Cathodic Protection	1	$ 28,690.18	65.0	65.0	$ 1,864,861.82
Operator Maintenance	1	$ 7,908.29	65.0	65.0	$ 514,038.53
Total					$ 16,431,661.34
Per Year					$ 252,794.79
Annual SUC Per UM					$ 1.18

FAC 4113 Cut-and-Cover Bulk Liquid Fuel Storage

FY25 SUC:	$2.12 / BL
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	2018 DLA Study of Fuel Facilities

FAC 4113 Cut and Cover Bulk Liquid Fuel Storage

Design Life	40	Years			
Representative Size	80,801	BL			
Component	**Frequency**	**Estimated Cost per Occurrence**	**Occurrences in Design Life**	**Occurrences Rounded**	**Design Life Cost**
Exterior Inspection Cost Total	5	$ 17,199.00	8.0	8.0	$ 137,592.00
Internal Inspection Cost Total	10	$ 381,672.05	4.0	4.0	$ 1,526,688.22
Internal Tank Repair Totals	10	$ 273,873.00	4.0	4.0	$ 1,095,492.00
External Tank Repair Totals	5	$ 89,490.00	8.0	8.0	$ 715,920.00
Pre-Post Cost Total	10	$ 10,974.32	4.0	4.0	$ 43,897.29
RMMR	1	$ 21,752.00	40.0	40.0	$ 870,080.00
SIOH	1	$ 404.00	40.0	40.0	$ 16,160.19
Cathodic Protection	1	$ 10,818.24	40.0	40.0	$ 432,729.42
Operator Maintenance	1	$ 7,908.29	40.0	40.0	$ 316,331.40
Total					$ 5,154,890.51
Per Year					$ 128,872.26
Annual SUC Per UM					$ 1.60

FAC 4114 Small Bulk Storage

FY25 SUC:	$0.09 / GA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4121 Bulk Liquid Storage, Other Than Fuel

FY25 SUC:	$0.11 / GA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4122 Liquid Oxygen Storage

FY25 SUC:	$0.93 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4211 Ammunition Storage, Depot and Arsenal

FY25 SUC:	$3.28 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4221 Ammunition Storage, Installation

FY25 SUC:	$3.33 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4222 Ammunition Storage Shed, Installation

FY25 SUC:	$0.52 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4231 Liquid Propellant Storage, Ammunition Related

FY25 SUC:	$0.11 / GA
Source:	Set to FAC 4121 CostWorks Model

FAC 4241 Battery Storage, Weapon Related

FY25 SUC:	$8.19 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4311 Cold Storage, Depot

FY25 SUC:	$3.92 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4321 Cold Storage, Installation

FY25 SUC:	$4.67 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4411 Covered Storage Building, Depot

FY25 SUC:	$2.32 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4412 Covered Storage Shed, Depot

FY25 SUC:	$1.04 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4413 Hazardous Materials Storage, Depot

FY25 SUC:	$4.97 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 4413 Hazardous Materials Storage, Depot

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.97
UM: SF
Expected Service Life: 45
Model Size: 5627

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	120.00 S.F.	$4,882.12	$5,946.04	3.0000	3	3	$17,838.12	$17,838.12
Replace metal hand rail	30	140.00 L.F.	$8,628.74	$10,032.87	1.5000	1	1	$10,032.87	$10,032.87
Refinish metal hand rail	7	140.00 L.F.	$293.44	$362.14	6.4286	6	6	$2,172.82	$2,172.82
Replace steel decking	30	360.00 S.F.	$2,161.31	$2,511.75	1.5000	1	1	$2,511.75	$2,511.75
Metal floor grating repairs - (2% of grating)	10	460.00 S.F.	$15,904.45	$19,152.86	4.5000	4	4	$76,611.44	$76,611.44
Replace metal floor grating	30	460.00 S.F.	$13,234.31	$15,269.80	1.5000	1	1	$15,269.80	$15,269.80
Point and refinish painted concrete block wall, 1st floor	25	35.10 C.S.F.	$19,242.69	$23,649.29	1.8000	1	1	$23,649.29	$23,649.29
Replace steel siding - 1st floor	35	14.80 C.S.F.	$9,144.25	$11,024.76	1.2857	1	1	$11,024.76	$11,024.76
Refinish steel siding - 1st floor	20	14.80 C.S.F.	$3,140.88	$3,856.36	2.2500	2	2	$7,712.71	$7,712.71
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	0.20 S.F.	$2.73	$3.21	45.0000	45	45	$144.26	$144.26
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	14.00 Ea.	$2,260.97	$2,694.38	2.2500	2	2	$5,388.77	$5,388.77
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	14.00 Ea.	$11,504.69	$13,441.59	0.9000	0	0	$0.00	$0.00
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	3.2143	3	3	$8,286.91	$8,286.91
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	11.2500	11	11	$1,938.83	$1,938.83
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	1.0000	1	1	$2,569.71	$2,569.71
Repair 12' x 12' steel roll-up door	10	3.00 Ea.	$2,706.51	$3,189.37	4.5000	4	4	$12,757.47	$12,757.47
Refinish 12' x 12' steel roll-up door	5	3.00 Ea.	$768.15	$931.93	9.0000	9	9	$8,387.37	$8,387.37
Replace 12' x 12' steel roll-up door	35	3.00 Ea.	$10,826.02	$12,757.47	1.2857	1	1	$12,757.47	$12,757.47
Debris removal, by hand and visual inspection, metal panel roofing	1	5.60 M.S.F.	$137.62	$168.07	45.0000	45	45	$7,563.36	$7,563.36
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	1.40 S.F.	$39.56	$47.08	45.0000	45	45	$2,118.58	$2,118.58
Minor metal roof panel replacement, 2.5% of roof area	20	140.00 S.F.	$1,936.31	$2,290.41	2.2500	2	2	$4,580.82	$4,580.82
Total metal roof panel replacement	30	56.30 Sq.	$54,116.41	$63,994.14	1.5000	1	1	$63,994.14	$63,994.14
Repair 8" concrete block wall - (2% of walls) painted	25	1.60 C.S.F.	$1,945.50	$2,336.84	1.8000	1	1	$2,336.84	$2,336.84
Refinish concrete block wall painted	4	31.00 C.S.F.	$4,251.74	$5,111.49	11.2500	11	11	$56,226.44	$56,226.44
Replace 8" concrete block wall painted	75	31.00 C.S.F.	$40,023.15	$48,167.59	0.6000	0	0	$0.00	$0.00
Repair steel painted interior door	14	3.00 Ea.	$890.55	$1,038.97	3.2143	3	3	$3,116.90	$3,116.90
Refinish 3'-0" x 7'-0" steel painted interior door	4	12.00 Ea.	$722.44	$888.29	11.2500	11	11	$9,771.23	$9,771.23
Replace 3'-0" x 7'-0" steel painted interior door	60	12.00 Ea.	$16,914.21	$19,593.61	0.7500	0	0	$0.00	$0.00
Replace 5/8" drywall	75	656.00 S.F.	$1,691.83	$2,070.71	0.6000	0	0	$0.00	$0.00
Refinish concrete floor finished	25	23.00 C.S.F.	$10,545.79	$12,670.10	1.8000	1	1	$12,670.10	$12,670.10
Replace vinyl tile flooring	18	22.30 S.Y.	$1,261.25	$1,543.81	2.5000	2	2	$3,087.62	$3,087.62
Repair gypsum board ceiling - (2% of ceilings)	20	0.04 C.S.F.	$16.35	$20.04	2.2500	2	2	$40.09	$40.09
Refinish gypsum board ceiling, up to 12' high	20	2.00 C.S.F.	$304.27	$374.09	2.2500	2	1	$748.18	$374.09
Replace gypsum board ceiling, up to 12' high	40	2.00 C.S.F.	$837.74	$1,027.56	1.1250	1	1	$1,027.56	$1,027.56
Acoustic tile repairs - (2% of ceilings)	9	0.08 C.S.F.	$92.06	$106.69	5.0000	5	5	$533.47	$533.47
Replace acoustic tile ceiling, fire-rated	20	4.20 C.S.F.	$2,623.71	$3,085.47	2.2500	2	2	$6,170.94	$6,170.94
Replace flush valve diaphragm tankless water closet	10	4.00 Ea.	$110.36	$137.10	4.5000	4	4	$548.42	$548.42
Rebuild flush valve tankless water closet	20	4.00 Ea.	$773.08	$931.82	2.2500	2	2	$1,863.63	$1,863.63
Replace tankless water closet	35	4.00 Ea.	$5,506.63	$6,372.78	1.2857	1	1	$6,372.78	$6,372.78
Replace tankless flush valve	25	4.00 Ea.	$1,090.62	$1,280.11	1.8000	1	1	$1,280.11	$1,280.11
Replace wax ring gasket for tankless water closet	5	4.00 Ea.	$599.02	$749.53	9.0000	9	9	$6,745.75	$6,745.75
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	6.4286	6	6	$411.31	$411.31
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.2500	2	2	$931.82	$931.82
Replace wall-hung urinal	35	2.00 Ea.	$2,184.58	$2,628.78	1.2857	1	1	$2,628.78	$2,628.78
Replace washer in spud connection lavatory, vitreous china	7	4.00 Ea.	$69.57	$84.93	6.4286	6	6	$509.61	$509.61
Replace washer in faucet lavatory, vitreous china	2	4.00 Ea.	$54.39	$67.85	22.5000	22	22	$1,492.73	$1,492.73
Replace faucets lavatory, vitreous china	10	4.00 Ea.	$794.49	$955.13	4.5000	4	4	$3,820.54	$3,820.54
Clean out strainer and P trap lavatory, vitreous china	2	4.00 Ea.	$148.35	$185.80	22.5000	22	22	$4,087.69	$4,087.69
Replace lavatory, vitreous china	35	4.00 Ea.	$3,005.50	$3,603.54	1.2857	1	1	$3,603.54	$3,603.54
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	22.5000	22	22	$370.61	$370.61
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	15.0000	15	15	$169.41	$169.41
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	4.5000	4	4	$955.13	$955.13
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	22.5000	22	22	$1,216.57	$1,216.57
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	1.00 Ea.	$910.17	$1,070.70	4.5000	4	4	$4,282.81	$4,282.81
Inspect and clean shower head emergency shower station	3	2.00 Ea.	$104.12	$130.40	15.0000	15	15	$1,956.02	$1,956.02
Replace shower emergency shower station	25	2.00 Ea.	$2,111.80	$2,526.39	1.8000	1	1	$2,526.39	$2,526.39
Inspect and clean spray heads, emergency eye wash	3	2.00 Ea.	$104.12	$130.40	15.0000	15	15	$1,956.02	$1,956.02
Replace eye wash station, emergency eye wash	25	2.00 Ea.	$1,580.90	$1,923.10	1.8000	1	1	$1,923.10	$1,923.10
Replace pipe and fittings, copper 3/4"	20	32.00 L.F.	$771.15	$937.28	2.2500	2	2	$1,874.56	$1,874.56
Replace pipe and fittings, copper 2"	25	16.00 L.F.	$904.99	$1,084.54	1.8000	1	1	$1,084.54	$1,084.54
Drain and flush water heater, electric, 120 gallon	7	1.00 Ea.	$310.63	$389.04	6.4286	6	6	$2,334.26	$2,334.26
Check operation water heater, electric, 120 gallon	3	1.00 Ea.	$2.72	$3.41	15.0000	15	15	$51.14	$51.14
Replace water heater, electric, 120 gallon	15	1.00 Ea.	$15,946.05	$18,237.49	3.0000	3	3	$54,712.47	$54,712.47
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.2500	2	2	$126.21	$126.21
Repair joint pipe and fittings, PVC	10	2.00 Ea.	$314.41	$391.82	4.5000	4	4	$1,567.29	$1,567.29
Replace pipe, 4" pipe and fittings, PVC	30	150.00 L.F.	$14,054.77	$17,200.48	1.5000	1	1	$17,200.48	$17,200.48
General maintenance & repair drain: roof, scupper, area	1	2.00 Ea.	$78.44	$98.24	45.0000	45	45	$4,420.65	$4,420.65
Replace drain: roof, scupper, area	40	2.00 Ea.	$2,192.71	$2,530.43	1.1250	1	1	$2,530.43	$2,530.43
Replace fan & motor, propeller exhaust, 1000 CFM exhaust fan	15	4.00 Ea.	$3,723.90	$4,386.19	3.0000	3	3	$13,158.58	$13,158.58
Replace roof mounted exhaust fan, 800 CFM exhaust fan	20	2.00 Ea.	$3,451.15	$4,045.26	2.2500	2	2	$8,090.51	$8,090.51
Repair circulator pump, 1/12 - 3/4 H.P.	5	1.00 Ea.	$104.83	$123.65	9.0000	9	6	$1,112.82	$741.88
Replace circulator pump, 1/12 - 3/4 H.P.	15	1.00 Ea.	$3,687.87	$4,253.96	3.0000	3	3	$12,761.87	$12,761.87
Repair damaged pipe insulation, fiberglass 3/4"	5	4.00 Ea.	$91.82	$111.96	9.0000	9	9	$1,007.60	$1,007.60
Repair damaged pipe insulation, fiberglass 2"	5	2.00 Ea.	$54.99	$66.89	9.0000	9	9	$602.01	$602.01
Replace pipe insulation, fiberglass 3/4"	5	0.03 M.L.F.	$284.00	$344.73	9.0000	9	9	$3,102.59	$3,102.59
Replace pipe insulation, fiberglass 2"	5	0.01 M.L.F.	$114.07	$138.06	9.0000	9	9	$1,242.57	$1,242.57
Maintenance and repair explosionproof industrial heater	2	4.00 Ea.	$881.81	$1,030.57	22.5000	22	22	$22,672.44	$22,672.44
Maintenance and inspection explosionproof industrial heater	0.5	4.00 Ea.	$339.09	$425.39	90.0000	90	90	$38,285.02	$38,285.02
Repair single zone rooftop unit, 5 ton	10	1.00 Ea.	$2,912.53	$3,474.76	4.5000	4	4	$13,899.02	$13,899.02
Replace single zone rooftop unit, 5 ton	15	1.00 Ea.	$8,648.69	$10,289.33	3.0000	3	3	$30,867.99	$30,867.99
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	45.0000	45	45	$2,043.45	$2,043.45
Replace sprinkler head	20	56.00 Ea.	$5,134.68	$6,327.85	2.2500	2	2	$12,655.69	$12,655.69
Replace fire pump / electric motor assembly 100 H.P.	25	1.00 Ea.	$46,050.08	$53,152.38	1.8000	1	1	$53,152.38	$53,152.38
Replace fuse	25	24.00 Ea.	$14,585.05	$16,709.54	1.8000	1	1	$16,709.54	$16,709.54
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	4.5000	4	4	$6,215.64	$6,215.64
Maintenance and repair motor starter, up to 600 V	5	2.00 Ea.	$699.10	$837.86	9.0000	9	9	$7,540.73	$7,540.73
Maintenance and inspection motor starter, up to 600 V	0.5	2.00 Ea.	$116.84	$146.58	90.0000	90	90	$13,192.14	$13,192.14
Replace starter motor starter, up to 600 V	18	2.00 Ea.	$1,637.91	$1,954.90	2.5000	2	2	$3,909.80	$3,909.80
Replace circuit breaker enclosed, 240 V, 1 pole circuit breaker	50	4.00 Ea.	$2,097.90	$2,498.49	0.9000	0	0	$0.00	$0.00
Maintenance and repair breaker, enclosed, 240 V, 3 pole	25	8.00 Ea.	$618.29	$775.65	1.8000	1	1	$775.65	$775.65
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	1.00 Ea.	$43.82	$54.97	5.6250	5	5	$274.84	$274.84
Maintenance and inspection safety switch, 3 pole, heavy duty	1	1.00 Ea.	$43.82	$54.97	45.0000	45	45	$2,473.53	$2,473.53
Replace safety switch, heavy duty 30 A	25	1.00 Ea.	$767.57	$911.04	1.8000	1	1	$911.04	$911.04
Maintenance and repair receptacles and plugs	20	35.00 Ea.	$1,601.57	$2,001.14	2.2500	2	2	$4,002.27	$4,002.27
Replace receptacle/plug receptacles and plugs	20	35.00 Ea.	$2,826.01	$3,476.24	2.2500	2	2	$6,952.47	$6,952.47
Maintenance and repair wiring devices, switches	10	16.00 Ea.	$732.15	$914.81	4.5000	4	4	$3,659.22	$3,659.22
Replace wiring devices, switches	15	16.00 Ea.	$1,112.55	$1,385.35	3.0000	3	3	$4,156.04	$4,156.04
Replace incandescent lighting fixture lamp for explosion proof fixture	5	46.00 Ea.	$1,204.83	$1,451.80	9.0000	9	9	$13,066.19	$13,066.19
Replace fluorescent light fixture ballast, 80 W	10	14.00 Ea.	$1,525.05	$1,880.58	4.5000	4	4	$7,522.33	$7,522.33
Replace lamps (2 lamps), 4', 34 W energy saver	10	40.00 Ea.	$1,086.06	$1,361.85	4.5000	4	4	$5,447.39	$5,447.39
Repair smoke detector	10	11.00 Ea.	$668.42	$827.26	4.5000	4	3	$3,309.03	$2,481.77
Check operation smoke detector	1	11.00 Ea.	$192.12	$241.02	45.0000	45	45	$10,845.73	$10,845.73
Replace smoke detector	15	11.00 Ea.	$3,711.64	$4,416.58	3.0000	3	3	$13,249.74	$13,249.74
Repair heat detector	10	14.00 Ea.	$927.56	$1,140.20	4.5000	4	4	$4,560.79	$4,560.79
Check operation heat detector	1	14.00 Ea.	$244.52	$306.75	45.0000	45	45	$13,803.65	$13,803.65
Replace heat detector	15	14.00 Ea.	$2,657.25	$3,245.46	3.0000	3	3	$9,736.37	$9,736.37
Check and repair manual pull station	10	3.00 Ea.	$284.97	$350.72	4.5000	4	3	$1,402.88	$1,052.16
Replace manual pull station	15	3.00 Ea.	$690.23	$829.51	3.0000	3	3	$2,488.54	$2,488.54
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	9.0000	9	9	$1,758.83	$1,758.83
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	90.0000	90	90	$5,221.89	$5,221.89
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.0000	3	3	$8,524.19	$8,524.19
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	9.0000	9	9	$1,758.83	$1,758.83
Replace fire alarm bell, 6"	20	3.00 Ea.	$601.31	$728.47	2.2500	2	2	$1,456.93	$1,456.93
Maintenance and repair electrical service ground	25	1.20 M.L.F.	$114.55	$143.20	1.8000	1	1	$143.20	$143.20
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	45.0000	45	44	$21,479.92	$21,002.59
Replace lightning ground rod	25	4.00 Ea.	$1,031.13	$1,274.23	1.8000	1	1	$1,274.23	$1,274.23
Maintenance and repair voice/data outlet	10	6.00 Ea.	$334.16	$417.69	4.5000	4	4	$1,670.76	$1,670.76
Replace voice/data outlet	20	6.00 Ea.	$169.90	$206.92	2.2500	2	2	$413.83	$413.83
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	90.0000	90	90	$10,443.78	$10,443.78
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	3.0000	3	3	$3,414.92	$3,414.92
			$425,504.49	$504,773.97				MR Subtotal:	$954,616.48
								MR Per Year:	$21,213.70
								PM Total:	$6,779.65
								Subtotal:	$27,993.35
								Total Per Unit:	$4.97

FAC 4413 Hazardous Materials Storage, Depot

Release:	2024 Qtr 3	FY25 SUC:	$4.97
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	45
		Model Size:	5627

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	2	0.52	$31.64	$23.47	$0.0000	55.11	65.32	77.10
Door, overhead, manual, up to 24' high x 25' wide, annualized	3	6.59	$45.68	$297.26	$0.0000	342.94	436.68	532.71
Fire doors, swinging, annualized	4	1.57	$57.96	$64.30	$0.0000	122.26	147.34	175.32
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (vacuum breaker type), annualized	4	0.71	$36.74	$38.24	$0.0000	74.97	90.12	107.10
Lavatories, annualized	4	1.39	$30.87	$87.98	$0.0000	118.86	148.34	179.37
VAV Boxes, annualized	4	3.74	$38.10	$238.57	$0.0000	276.68	352.06	429.34
Fan, axial, up to 5,000 CFM, annualized	6	7.46	$82.65	$401.00	$0.0000	483.66	612.22	744.92
Controls, central system, electro/pneumatic, annualized	1	1.92	$179.77	$122.67	$0.0000	302.44	357.22	420.98
Air compressor, centrifugal, to 40 H.P., annualized	2	6.82	$136.78	$436.54	$0.0000	573.32	717.95	869.43
Extinguishing system, foam bottle, annualized	1	3.71	$21.49	$199.66	$0.0000	221.15	283.20	346.32
Circuit breaker, high voltage air, annualized	8	3.76	$132.14	$266.93	$0.0000	399.06	492.36	592.25
Transformer, dry type 500 KVA and over, annualized	2	1.54	$33.03	$109.56	$0.0000	142.59	178.77	216.59
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Fire alarm annuciator system, annually	1	2.73	$185.63	$173.30	$0.0000	358.93	429.49	509.32
Security, intrusion alarm system, annualized	1	3.83	$178.64	$242.03	$0.0000	420.67	511.14	610.55
Light, emergency, hardwired system, annualized	7	1.75	$63.57	$110.51	$0.0000	174.08	213.59	256.28
Crane, electric bridge, up to 5 ton, annualized	1	2.92	$247.45	$113.21	$0.0000	360.66	419.37	490.45
						$4,580.23	$5,640.77	$6,779.65

FAC 4414 Controlled Humidity Storage, Depot

FY25 SUC:	$2.64 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4421 Covered Storage Building, Installation

FY25 SUC:	$3.41 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4422 Covered Storage Shed, Installation

FY25 SUC:	$1.53 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4423 Hazardous Materials Storage, Installation

FY25 SUC:	$6.22 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4424 Controlled Humidity Storage, Installation

FY25 SUC:	$2.20 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4425 Vehicle Storage, Covered

FY25 SUC:	$1.30 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 4425 Vehicle Storage, Covered

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $1.30
UM: SF
Expected Service Life: 40
Model Size: 8614

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	268.00 S.F.	$10,903.41	$13,279.49	2.6667	2	2	$26,558.98	$26,558.98
Replace aluminum siding, 1st floor	35	25.00 C.S.F.	$15,915.10	$19,170.83	1.1429	1	1	$19,170.83	$19,170.83
Replace aluminum siding, 2nd floor	35	25.00 C.S.F.	$19,480.16	$23,605.41	1.1429	1	1	$23,605.41	$23,605.41
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	0.01 S.F.	$0.14	$0.16	40.0000	40	40	$6.41	$6.41
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	2.00 Ea.	$323.00	$384.91	2.0000	2	2	$769.82	$769.82
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	2.00 Ea.	$1,643.53	$1,920.23	0.8000	0	0	$0.00	$0.00
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	2.8571	2	2	$5,524.61	$5,524.61
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	10.0000	10	10	$1,762.58	$1,762.58
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	0.8889	0	0	$0.00	$0.00
Replace 12' x 24' aluminum double roll-up door	35	4.00 Ea.	$35,360.51	$41,123.29	1.1429	1	1	$41,123.29	$41,123.29
Debris removal, by hand and visual inspection, metal panel roofing	1	7.72 M.S.F.	$189.72	$231.70	40.0000	40	40	$9,268.12	$9,268.12
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	154.00 S.F.	$746.63	$886.05	8.0000	8	8	$7,088.41	$7,088.41
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	3.00 S.F.	$84.78	$100.88	40.0000	40	40	$4,035.40	$4,035.40
Minor metal roof panel replacement, 2.5% of roof area	20	193.00 S.F.	$2,669.34	$3,157.49	2.0000	2	2	$6,314.99	$6,314.99
Total metal roof panel replacement	30	77.20 Sq.	$74,205.81	$87,750.40	1.3333	1	1	$87,750.40	$87,750.40
Refinish concrete floor finished	25	8.10 C.S.F.	$3,713.95	$4,462.08	1.6000	1	1	$4,462.08	$4,462.08
Replace fan & motor, propeller exhaust, 4700 CFM exhaust fan	15	4.00 Ea.	$9,051.69	$10,533.01	2.6667	2	2	$21,066.03	$21,066.03
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	4.00 Ea.	$17,377.45	$20,158.61	2.0000	2	2	$40,317.22	$40,317.22
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	4.0000	4	4	$4,698.57	$4,698.57
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	40.0000	40	40	$1,816.40	$1,816.40
Replace sprinkler head	20	20.00 Ea.	$1,833.81	$2,259.94	2.0000	2	2	$4,519.89	$4,519.89
Replace metal halide ballast, 175 W	10	24.00 Ea.	$4,117.48	$4,931.93	4.0000	4	4	$19,727.73	$19,727.73
Replace metal halide fixture lamp, 175 W	5	24.00 Ea.	$1,460.14	$1,774.16	8.0000	8	8	$14,193.30	$14,193.30
Repair smoke detector	10	4.00 Ea.	$243.06	$300.82	4.0000	4	3	$1,203.28	$902.46
Check operation smoke detector	1	4.00 Ea.	$69.86	$87.64	40.0000	40	40	$3,505.69	$3,505.69
Replace smoke detector	15	4.00 Ea.	$1,349.69	$1,606.03	2.6667	2	2	$3,212.06	$3,212.06
Repair heat detector	10	7.00 Ea.	$463.78	$570.10	4.0000	4	4	$2,280.40	$2,280.40
Replace heat detector	15	7.00 Ea.	$1,328.62	$1,622.73	2.6667	2	2	$3,245.46	$3,245.46
Check and repair manual pull station	10	4.00 Ea.	$379.95	$467.63	4.0000	4	3	$1,870.51	$1,402.88
Replace manual pull station	15	4.00 Ea.	$920.30	$1,106.02	2.6667	2	2	$2,212.03	$2,212.03
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	8.0000	8	8	$1,563.40	$1,563.40
Replace annunciation panel	15	1.00 Ea.	$1,250.41	$1,502.49	2.6667	2	2	$3,004.99	$3,004.99
Maintenance and repair of general wiring lightning protection system	1	1.20 M.L.F.	$133.59	$164.83	40.0000	40	40	$6,593.25	$6,593.25
Replace lightning protection general wiring system	25	1.20 M.L.F.	$16,109.13	$19,074.77	1.6000	1	1	$19,074.77	$19,074.77
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	40.0000	40	39	$9,546.63	$9,307.97
Replace lightning ground rod	25	2.00 Ea.	$515.56	$637.11	1.6000	1	1	$637.11	$637.11
			$227,922.89	$270,033.16				MR Subtotal:	$400,722.94
								MR Per Year:	$10,018.07
								PM Total:	$1,212.43
								Subtotal:	$11,230.50
								Total Per Unit:	$1.30

FAC 4425 Vehicle Storage, Covered

Release:	2024 Qtr 3	FY25 SUC:	$1.30
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	40
		Model Size:	8614

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	3	0.78	$47.47	$35.20	$0.0000	82.67	97.97	115.65
Door, overhead, electric, roll up, to 24' high x 25' wide, annually	4	8.16	$164.16	$369.52	$0.0000	533.68	660.95	796.43
Fan, axial, up to 5,000 CFM, annualized	2	2.49	$27.55	$133.67	$0.0000	161.22	204.07	248.31
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
						$813.28	$1,006.50	$1,212.43

FAC 4426 Storage Silo, Loose Material

FY25 SUC:	$1.17 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4427 Small Arms Storage, Installation

FY25 SUC:	$3.92 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4428 Storage and Customer Issue

FY25 SUC:	\$2.49 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4511 Open Storage, Depot

FY25 SUC:	$0.19 / SY
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 4521 Open Storage, Installation

FY25 SUC:	$0.19 / SY
Source:	Set to FAC 4511 CostWorks Model

FAC 5100 Hospital

FY25 SUC:	$9.68 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 5100 Hospital

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $9.68
UM: SF
Expected Service Life: 30
Model Size: 402128

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair metal stairs	15	660.00 S.F.	$55,041.03	$63,520.25	2.0000	2	2	$127,040.51	$127,040.51
Replace metal hand rail	30	82.00 L.F.	$5,053.98	$5,876.39	1.0000	1	1	$5,876.39	$5,876.39
Refinish metal hand rail	7	580.00 L.F.	$1,215.69	$1,500.28	4.2857	4	4	$6,001.12	$6,001.12
Refinish fire escape stair and platform	7	4.00 Flight	$2,298.93	$2,777.35	4.2857	4	4	$11,109.42	$11,109.42
Replace fire escape stair and platform	25	4.00 Flight	$26,498.81	$32,294.13	1.2000	1	1	$32,294.13	$32,294.13
Metal floor grating repairs - (2% of grating)	10	46.00 S.F.	$1,590.44	$1,915.29	3.0000	3	3	$5,745.86	$5,745.86
Replace metal floor grating	30	890.00 S.F.	$25,605.52	$29,543.75	1.0000	1	1	$29,543.75	$29,543.75
Repair 8" concrete block wall, 1st floor	25	44,262.00 S.F.	$1,185,044.17	$1,449,716.39	1.2000	1	1	$1,449,716.39	$1,449,716.39
Waterproof concrete block wall, 1st floor	10	5,442.00 C.S.F.	$1,055,981.71	$1,272,480.52	3.0000	3	3	$3,817,441.56	$3,817,441.56
Repair clay brick wall, 1st floor	25	38,426.00 S.F.	$1,830,256.59	$2,245,520.80	1.2000	1	1	$2,245,520.80	$2,245,520.80
Refinish steel louver, 1st floor	5	26.00 Ea.	$2,872.62	$3,554.63	6.0000	6	6	$21,327.76	$21,327.76
Replace glass - 1st floor. (1% of glass) - alum. window	1	416.00 S.F.	$5,678.96	$6,668.14	30.0000	30	30	$200,044.09	$200,044.09
Repair 3' x 4' aluminum window - 1st floor	20	2,596.00 Ea.	$782,460.45	$919,609.55	1.5000	1	1	$919,609.55	$919,609.55
Repair 3' x 4' aluminum window - 2nd floor	20	2,596.00 Ea.	$915,199.98	$1,084,724.57	1.5000	1	1	$1,084,724.57	$1,084,724.57
Refinish steel shutter - 1st floor	5	31.00 Ea.	$3,425.05	$4,238.21	6.0000	6	6	$25,429.25	$25,429.25
Refinish steel shutter - 2nd floor	5	31.00 Ea.	$4,770.01	$5,911.44	6.0000	6	6	$35,468.65	$35,468.65
Refinish steel shutter - 3rd floor	5	31.00 Ea.	$6,114.97	$7,584.67	6.0000	6	6	$45,508.05	$45,508.05
Repair aluminum storefront door	12	43.00 Ea.	$23,632.25	$28,179.40	2.5000	2	2	$56,358.80	$56,358.80
Repair steel, painted, door	14	37.00 Ea.	$28,769.68	$34,068.42	2.1429	2	2	$68,136.83	$68,136.83
Repair 12' x 12' steel roll-up door	10	8.00 Ea.	$7,217.35	$8,504.98	3.0000	3	3	$25,514.93	$25,514.93
Refinish 12' x 12' steel roll-up door	5	8.00 Ea.	$2,048.39	$2,485.15	6.0000	6	6	$14,910.89	$14,910.89
Repair 12' x 12' aluminum single roll-up door	10	5.00 Ea.	$5,525.08	$6,425.51	3.0000	3	3	$19,276.54	$19,276.54
Refinish 12' x 12' aluminum single roll-up door	5	5.00 Ea.	$1,280.24	$1,553.22	6.0000	6	6	$9,319.30	$9,319.30
Non-destructive moisture inspection of built-up roofing	5	277.00 M.S.F.	$35,015.08	$42,762.88	6.0000	6	6	$256,577.29	$256,577.29
BUR flashing repairs, 2 S.F. per sq. repaired	1	131.90 S.F.	$506.31	$615.02	30.0000	30	30	$18,450.56	$18,450.56
Minor BUR membrane replacement, 25% of roof area	15	442.00 Sq.	$445,075.47	$525,394.83	2.0000	2	2	$1,050,789.66	$1,050,789.66
Place new BUR membrane over existing	20	1,769.00 Sq.	$1,050,615.37	$1,233,837.60	1.5000	1	1	$1,233,837.60	$1,233,837.60
Total BUR roof replacement	28	1,769.00 Sq.	$1,720,076.32	$2,024,382.84	1.0714	1	1	$2,024,382.84	$2,024,382.84
Replace aluminum downspout, 3" x 4", .024" thick	25	63.00 L.F.	$721.93	$860.54	1.2000	1	1	$860.54	$860.54
Repair 8" concrete block wall - (2% of walls) painted	25	260.28 C.S.F.	$316,484.49	$380,145.04	1.2000	1	1	$380,145.04	$380,145.04
Refinish concrete block wall painted	4	1,260.28 C.S.F.	$172,851.20	$207,803.69	7.5000	7	7	$1,454,625.86	$1,454,625.86
Repair 4" glazed C.M.U. wall - (2% of walls)	25	51.60 C.S.F.	$113,518.18	$133,777.16	1.2000	1	1	$133,777.16	$133,777.16
Remove and reinstall demountable partitions	5	49.70 C.L.F.	$299,744.58	$355,932.89	6.0000	6	6	$2,135,597.32	$2,135,597.32
Repair plate glass interior wall - (2% of total)	25	76.00 C.S.F.	$656,559.18	$758,012.65	1.2000	1	1	$758,012.65	$758,012.65
Repair fully glazed wood door	10	8.00 Ea.	$2,374.80	$2,770.57	3.0000	3	3	$8,311.72	$8,311.72
Refinish 3'-0" x 7'-0" fully glazed wood door	4	8.00 Ea.	$645.92	$798.18	7.5000	7	7	$5,587.28	$5,587.28
Repair steel painted interior door	14	79.00 Ea.	$23,451.13	$27,359.42	2.1429	2	2	$54,718.84	$54,718.84
Refinish 3'-0" x 7'-0" steel painted interior door	4	39.00 Ea.	$2,347.93	$2,886.95	7.5000	7	7	$20,208.68	$20,208.68
Repair steel unpainted door steel	14	12.00 Ea.	$3,562.20	$4,155.86	2.1429	2	2	$8,311.72	$8,311.72
Repair 2'-6" x 6'-8" bi-fold louvered door	15	744.00 Ea.	$60,216.19	$74,389.52	2.0000	2	2	$148,779.04	$148,779.04
Refinish 2'-6" x 6'-8" louvered door	8	744.00 Ea.	$76,415.98	$93,946.99	3.7500	3	3	$281,840.97	$281,840.97
Replace 2'-6" x 6'-8" wood louver bi-fold door and frame	24	744.00 Ea.	$867,721.47	$998,011.72	1.2500	1	1	$998,011.72	$998,011.72
Repair aluminum interior door	12	45.00 Ea.	$13,358.24	$15,584.48	2.5000	2	2	$31,168.96	$31,168.96
Replace safety glass (3% of glass) aluminum interior door	1	420.14 S.F.	$10,788.20	$12,726.42	30.0000	30	30	$381,792.56	$381,792.56
Repair 3'-0" x 7'-0" aluminum sliding door, interior door	14	44.00 Ea.	$2,778.88	$3,342.73	2.1429	2	2	$6,685.47	$6,685.47
Replace 3'-0" x 7'-0" aluminum sliding door, interior door	50	44.00 Ea.	$174,886.97	$201,051.92	0.6000	0	0	$0.00	$0.00
Repair solid core wood door, interior	11	616.00 Ea.	$182,859.43	$213,334.21	2.7273	2	2	$426,668.42	$426,668.42
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	616.00 Ea.	$33,683.75	$40,977.59	7.5000	7	7	$286,843.13	$286,843.13
Replace toilet partitions, painted metal-overhead braced, per stall	20	47.00 Ea.	$50,716.78	$58,962.78	1.5000	1	1	$58,962.78	$58,962.78
Replace urinal screen, stainless steel	30	16.00 Ea.	$14,371.07	$16,612.70	1.0000	1	1	$16,612.70	$16,612.70
Replace metal lockers, single tier	20	335.00 Ea.	$114,022.53	$132,156.15	1.5000	1	1	$132,156.15	$132,156.15
Repair concrete steps	15	11,860.00 S.F.	$365,811.47	$421,985.73	2.0000	2	2	$843,971.47	$843,971.47
Repair metal steps	15	594.00 S.F.	$63,121.86	$73,316.80	2.0000	2	2	$146,633.61	$146,633.61
Refinish metal steps	9	594.00 S.F.	$1,701.37	$2,073.48	3.3333	3	3	$6,220.44	$6,220.44
Refinish metal stair railing, interior	7	66.00 S.F.	$109.09	$134.33	4.2857	4	4	$537.32	$537.32
Refinish wood stair railing, interior	7	1,444.00 L.F.	$3,480.16	$4,294.05	4.2857	4	4	$17,176.18	$17,176.18
Replace rubber steps	18	364.00 L.F.	$17,248.11	$19,987.20	1.6667	1	1	$19,987.20	$19,987.20
Repair medium weight vinyl wall covering - (2% of walls)	1	27.30 C.S.F.	$14,446.78	$16,859.64	30.0000	30	30	$505,789.11	$505,789.11
Replace medium weight vinyl wall covering	15	1,365.00 C.S.F.	$823,454.93	$968,777.49	2.0000	2	2	$1,937,554.98	$1,937,554.98
Repair acoustical tile - (2% of walls)	25	1,260.00 C.S.F.	$1,369,062.64	$1,579,893.64	1.2000	1	1	$1,579,893.64	$1,579,893.64
Refinish acoustical tile	10	1,260.00 C.S.F.	$237,076.56	$288,297.10	3.0000	3	3	$864,891.31	$864,891.31
Repair 5/8" drywall - (2% of walls)	20	900,280.00 S.F.	$1,681,728.53	$2,045,563.19	1.5000	1	1	$2,045,563.19	$2,045,563.19
Refinish drywall	4	900,280.00 S.F.	$650,053.58	$797,111.51	7.5000	7	7	$5,579,780.59	$5,579,780.59
Office painting, 10' x 15', 10' high walls	5	216.00 Ea.	$64,002.68	$78,188.81	6.0000	6	6	$469,132.83	$469,132.83
Repair 4" x 4" thin set ceramic tile - (2% of walls)	10	394.00 C.S.F.	$362,888.77	$436,758.00	3.0000	3	3	$1,310,273.99	$1,310,273.99
Refinish concrete floor finished	25	325.00 C.S.F.	$149,016.60	$179,034.01	1.2000	1	1	$179,034.01	$179,034.01
Replace epoxy flooring	15	1,161.00 C.S.F.	$1,464,502.58	$1,751,062.48	2.0000	2	2	$3,502,124.96	$3,502,124.96
Replace vinyl tile flooring	18	21,536.00 S.Y.	$1,218,038.95	$1,490,917.16	1.6667	1	1	$1,490,917.16	$1,490,917.16
Replace vinyl sheet flooring	18	3,120.00 S.Y.	$248,892.35	$301,818.00	1.6667	1	1	$301,818.00	$301,818.00
Replace rubber tile floor	18	1,990.00 S.Y.	$229,537.85	$279,371.16	1.6667	1	1	$279,371.16	$279,371.16
Ceramic tile floor repairs - (2% of floors)	15	252.00 C.S.F.	$175,550.35	$218,871.49	2.0000	2	2	$437,742.98	$437,742.98
Terrazzo floor repairs - (2% of floors)	15	8,475.00 S.F.	$158,299.13	$189,051.69	2.0000	2	2	$378,103.39	$378,103.39
Replace carpet	8	28,252.00 S.Y.	$1,573,594.40	$1,819,734.31	3.7500	3	3	$5,459,202.94	$5,459,202.94
Repair gypsum board ceiling - (2% of ceilings)	20	588.00 C.S.F.	$240,287.92	$294,629.69	1.5000	1	1	$294,629.69	$294,629.69
Refinish gypsum board ceiling, up to 12' high	20	3,208.00 C.S.F.	$488,056.26	$600,036.63	1.5000	1	1	$600,036.63	$600,036.63
Acoustic tile repairs - (2% of ceilings)	9	2,622.00 C.S.F.	$3,017,166.90	$3,496,923.67	3.3333	3	3	$10,490,771.00	$10,490,771.00
Refinish acoustic tile ceiling and grid (occupied area)	5	2,622.00 C.S.F.	$70,463.98	$87,659.46	6.0000	6	6	$525,956.75	$525,956.75
Replace acoustic tile ceiling, fire-rated	20	2,622.00 C.S.F.	$1,637,944.29	$1,926,214.76	1.5000	1	1	$1,926,214.76	$1,926,214.76
Unplug clogged line flush-tank water closet	5	168.00 Ea.	$38,603.25	$48,348.37	6.0000	6	6	$290,090.22	$290,090.22
Replace washer / diaphragm in ball cock flush-tank water closet	5	168.00 Ea.	$3,317.81	$4,094.80	6.0000	6	6	$24,568.79	$24,568.79
Replace valve and ball cock assembly flush-tank water closet	15	168.00 Ea.	$16,325.87	$20,197.82	2.0000	2	2	$40,395.64	$40,395.64
Install gasket between tank and bowl flush-tank water closet	20	168.00 Ea.	$7,379.68	$9,174.30	1.5000	1	1	$9,174.30	$9,174.30
Replace flush valve diaphragm for a urinal	7	117.00 Ea.	$3,227.98	$4,010.32	4.2857	4	4	$16,041.27	$16,041.27
Rebuild flush valve for a urinal	20	117.00 Ea.	$22,612.71	$27,255.63	1.5000	1	1	$27,255.63	$27,255.63
Replace washer in spud connection lavatory, vitreous china	7	378.00 Ea.	$6,574.59	$8,026.34	4.2857	4	4	$32,105.35	$32,105.35
Replace washer in faucet lavatory, vitreous china	2	378.00 Ea.	$5,139.89	$6,411.96	15.0000	15	15	$96,179.41	$96,179.41
Replace faucets lavatory, vitreous china	10	378.00 Ea.	$75,079.35	$90,260.15	3.0000	3	3	$270,780.46	$270,780.46
Replace faucet washer sink, stainless steel	2	264.00 Ea.	$3,565.08	$4,447.28	15.0000	15	15	$66,709.19	$66,709.19
Replace faucets sink, stainless steel	10	264.00 Ea.	$52,436.37	$63,038.84	3.0000	3	3	$189,116.51	$189,116.51
Unstop sink, stainless steel	2	264.00 Ea.	$11,656.32	$14,598.88	15.0000	15	15	$218,983.21	$218,983.21
Replace washer in faucet laundry sink, plastic	2	103.00 Ea.	$1,390.92	$1,735.11	15.0000	15	15	$26,026.69	$26,026.69
Replace faucets laundry sink, plastic	10	103.00 Ea.	$20,458.13	$24,594.70	3.0000	3	3	$73,784.09	$73,784.09
Clean out strainer and P trap laundry sink, plastic	2	103.00 Ea.	$3,820.10	$4,784.45	15.0000	15	15	$71,766.77	$71,766.77
Replace group wash fountain, 54" diameter	20	14.00 Ea.	$196,017.03	$224,577.00	1.5000	1	1	$224,577.00	$224,577.00
Inspect / clean shower head bathtub, fiberglass	3	104.00 Ea.	$5,414.10	$6,780.85	10.0000	10	10	$67,808.55	$67,808.55
Replace mixing valve barrel bathtub, fiberglass	2	104.00 Ea.	$31,308.31	$36,824.65	15.0000	15	15	$552,369.71	$552,369.71
Replace mixing valve bathtub, fiberglass	10	104.00 Ea.	$30,557.71	$37,181.97	3.0000	3	3	$111,545.91	$111,545.91
Inspect / clean shower head fiberglass	3	58.00 Ea.	$3,019.40	$3,781.63	10.0000	10	10	$37,816.31	$37,816.31
Replace mixing valve barrel shower, fiberglass	2	58.00 Ea.	$17,460.40	$20,536.82	15.0000	15	15	$308,052.34	$308,052.34
Inspect and clean spray heads, emergency eye wash	3	32.00 Ea.	$1,665.88	$2,086.42	10.0000	10	10	$20,864.17	$20,864.17
Replace eye wash station, emergency eye wash	25	32.00 Ea.	$25,294.33	$30,769.53	1.2000	1	1	$30,769.53	$30,769.53
Inspect for leaks steam converter, domestic hot water	1	16.00 Ea.	$114.36	$143.23	30.0000	30	30	$4,296.91	$4,296.91
Inspect/check pump/motor operation, lubricate circulation pump, bronze 1 HP	0.5	6.00 Ea.	$50.80	$63.63	60.0000	60	60	$3,817.57	$3,817.57
Replace pump / motor assembly circulation pump, bronze 1 HP	20	6.00 Ea.	$32,773.01	$37,621.93	1.5000	1	1	$37,621.93	$37,621.93
Replace water softener	15	4.00 Ea.	$4,834.17	$5,775.08	2.0000	2	2	$11,550.16	$11,550.16
Unclog main drain pipe & fittings, cast iron	10	152.00 Ea.	$7,421.82	$9,295.40	3.0000	3	3	$27,886.20	$27,886.20
Repair joint pipe and fittings, PVC	10	88.00 Ea.	$13,834.05	$17,240.19	3.0000	3	3	$51,720.56	$51,720.56
Unclog 4" - 12" diameter main drain per L.F.	10	305.00 L.F.	$1,219.91	$1,527.87	3.0000	3	3	$4,583.62	$4,583.62
Clean floor drain w/o bucket	4	51.00 Ea.	$6,305.01	$7,896.67	7.5000	7	7	$55,276.67	$55,276.67
General maintenance & repair distribution: gutters, pipe	1	2.20 M.L.F.	$701.09	$878.08	30.0000	30	30	$26,342.39	$26,342.39
General maintenance & repair drain: roof, scupper, area	1	45.00 Ea.	$1,764.81	$2,210.33	30.0000	30	30	$66,309.75	$66,309.75
Insp/chk pump/mtr oper, lub, chk align, rainwater sump pump	1	4.00 Ea.	$50.41	$63.13	30.0000	30	30	$1,893.95	$1,893.95
Resolder joint pipe & fittings, anesthesia	12	68.00 Ea.	$4,444.30	$5,435.59	2.5000	2	2	$10,871.18	$10,871.18
Replace pipe and fittings, anesthesia	25	19,412.00 L.F.	$465,784.08	$566,053.16	1.2000	1	1	$566,053.16	$566,053.16
Resolder joint pipe & fittings, oxygen	12	68.00 Ea.	$5,681.99	$6,985.73	2.5000	2	2	$13,971.46	$13,971.46
Replace pipe and fittings, oxygen	25	19,412.00 L.F.	$465,784.08	$566,053.16	1.2000	1	1	$566,053.16	$566,053.16
General maintenance pipe & fittings, compressed air	2	4.20 M.L.F.	$163.62	$204.93	15.0000	15	15	$3,073.96	$3,073.96
Check and adjust 10 H.P. compressor	1	3.00 Ea.	$267.60	$335.15	30.0000	30	30	$10,054.49	$10,054.49
Replace 10 H.P. compressor	25	3.00 Ea.	$47,740.98	$55,526.39	1.2000	1	1	$55,526.39	$55,526.39
Check and adjust 25 H.P. compressor	1	11.00 Ea.	$981.19	$1,228.88	30.0000	30	30	$36,866.47	$36,866.47
Replace 25 H.P. compressor	25	11.00 Ea.	$305,197.57	$354,111.33	1.2000	1	1	$354,111.33	$354,111.33
Replace 275 gallon fuel oil storage tank	30	9.00 Ea.	$17,989.23	$20,902.49	1.0000	1	1	$20,902.49	$20,902.49
Install 10' sect. 3/8" type L copper per M.L.F. fuel oil storage	20	14.50 Ea.	$2,552.18	$3,142.74	1.5000	1	1	$3,142.74	$3,142.74
Install new 2" gasket, 1 per M.L.F. natural gas, steel/iron	30	22.00 Ea.	$3,030.81	$3,765.87	1.0000	1	1	$3,765.87	$3,765.87
Replace 10' of hung 2" diam steel pipe/M.L.F. natural gas	12	14.00 Ea.	$10,056.73	$12,228.72	2.5000	2	2	$24,457.44	$24,457.44
Replace solar panel 3' x 8'	15	62.00 Ea.	$88,173.60	$103,045.93	2.0000	2	2	$206,091.86	$206,091.86
Repair boiler, gas/oil, 20,000 MBH	7	3.00 Ea.	$57,900.12	$66,917.78	4.2857	4	3	$267,671.12	$200,753.34
Replace boiler, gas/oil, 20,000 MBH	30	3.00 Ea.	$2,089,604.39	$2,496,361.89	1.0000	1	1	$2,496,361.89	$2,496,361.89
Repair feed water supply pump	15	3.00 Ea.	$17,862.18	$20,556.25	2.0000	2	2	$41,112.49	$41,112.49
Replace feed water pump	15	3.00 Ea.	$89,783.20	$102,867.51	2.0000	2	2	$205,735.01	$205,735.01
Repair deaerator	10	3.00 Ea.	$235.31	$294.71	3.0000	3	3	$884.13	$884.13

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Replace metal flue, all fuel SS, 10" diameter metal flue / chimney	15	24.00 L.F.	$6,621.88	$7,613.73	2.0000	2	2	$15,227.45	$15,227.45
Repair cooling tower, 1000 ton	10	4.00 Ea.	$102,762.25	$119,503.26	3.0000	3	2	$358,509.77	$239,006.51
Replace cooling tower, 1000 ton	15	4.00 Ea.	$465,625.52	$539,756.25	2.0000	2	2	$1,079,512.51	$1,079,512.51
Repair open centrifugal chiller, 1000 ton	10	4.00 Ea.	$707,049.29	$824,191.94	3.0000	3	2	$2,472,575.83	$1,648,383.89
Replace open centrifugal chiller, 1000 ton	20	4.00 Ea.	$2,365,803.65	$2,710,264.77	1.5000	1	1	$2,710,264.77	$2,710,264.77
Replace fan coil, DX 1-1/2 ton, no heat	15	14.00 Ea.	$18,812.34	$22,120.51	2.0000	2	2	$44,241.02	$44,241.02
Replace fan coil, DX 3 ton, with heat	15	148.00 Ea.	$377,238.79	$442,744.53	2.0000	2	2	$885,489.07	$885,489.07
Repair unit ventilator, 750 CFM, 2 ton	10	14.00 Ea.	$7,199.91	$8,666.43	3.0000	3	3	$25,999.30	$25,999.30
Repair fan, induced draft, 6700 CFM	10	11.00 Ea.	$3,522.30	$4,303.08	3.0000	3	3	$12,909.23	$12,909.23
Replace fan, induced draft, 6700 CFM	20	11.00 Ea.	$73,184.32	$84,318.71	1.5000	1	1	$84,318.71	$84,318.71
Repair fan, induced draft, 17,700 CFM	10	12.00 Ea.	$4,176.96	$5,098.92	3.0000	3	3	$15,296.77	$15,296.77
Replace fan, induced draft, 17,700 CFM	20	12.00 Ea.	$211,400.99	$243,854.95	1.5000	1	1	$243,854.95	$243,854.95
Replace fan & motor, propeller exhaust, 1000 CFM exhaust fan	15	8.00 Ea.	$7,447.79	$8,772.39	2.0000	2	2	$17,544.78	$17,544.78
Replace roof mounted exhaust fan, 2000 CFM exhaust fan	20	14.00 Ea.	$42,212.13	$49,046.46	1.5000	1	1	$49,046.46	$49,046.46
Replace axial flow fan, 6400 CFM exhaust fan	10	4.00 Ea.	$14,628.45	$17,064.31	3.0000	3	3	$51,192.93	$51,192.93
Replace axial flow fan, 28,000 CFM exhaust fan	10	2.00 Ea.	$14,781.73	$17,225.38	3.0000	3	3	$51,676.14	$51,676.14
Repair steam converter, commercial	5	12.00 Ea.	$5,610.00	$7,026.20	6.0000	6	6	$42,157.20	$42,157.20
Inspect for leaks steam converter, commercial	2	12.00 Ea.	$87.02	$108.98	15.0000	15	15	$1,634.76	$1,634.76
Replace steam converter, commercial	30	12.00 Ea.	$58,483.51	$67,072.12	1.0000	1	1	$67,072.12	$67,072.12
Repair flash tank 24 gallon	5	3.00 Ea.	$1,402.50	$1,756.55	6.0000	6	6	$10,539.30	$10,539.30
Replace steam trap, 15 PSIG, 3/4" threaded	7	15.00 Ea.	$5,659.11	$6,563.77	4.2857	4	4	$26,255.06	$26,255.06
Replace steam trap, 15 PSIG, 1" threaded	7	18.00 Ea.	$5,220.80	$6,103.13	4.2857	4	4	$24,412.51	$24,412.51
Replace steam trap, 15 PSIG, 2" threaded	7	24.00 Ea.	$30,047.38	$34,713.46	4.2857	4	4	$138,853.86	$138,853.86
Repair circulator pump, 1/12 - 3/4 H.P.	5	6.00 Ea.	$628.95	$741.88	6.0000	6	6	$4,451.28	$4,451.28
Repair circulator pump, 1 H.P.	5	6.00 Ea.	$630.32	$743.60	6.0000	6	6	$4,461.58	$4,461.58
Refill expansion tank	5	3.00 Ea.	$47.06	$58.94	6.0000	6	6	$353.65	$353.65
Repair damaged pipe insulation, fiberglass 2"	5	158.00 Ea.	$4,344.55	$5,284.34	6.0000	6	6	$31,706.03	$31,706.03
Repair single zone rooftop unit, 7.5 ton	10	26.00 Ea.	$100,477.12	$119,058.05	3.0000	3	3	$357,174.16	$357,174.16
Replace single zone rooftop unit, 7.5 ton	15	26.00 Ea.	$313,466.30	$370,948.22	2.0000	2	2	$741,896.45	$741,896.45
Repair central station A.H.U., 16,000 CFM	10	16.00 Ea.	$34,098.43	$39,412.93	3.0000	3	2	$118,238.78	$78,825.86
Replace central station A.H.U., 16,000 CFM	15	16.00 Ea.	$1,202,118.01	$1,382,829.80	2.0000	2	2	$2,765,659.60	$2,765,659.60
Inspect sprinkler system	1	4.00 Ea.	$145.03	$181.64	30.0000	30	30	$5,449.21	$5,449.21
Replace sprinkler head	20	3,192.00 Ea.	$292,676.55	$360,687.19	1.5000	1	1	$360,687.19	$360,687.19
Rebuild double check 6" backflow preventer sprinkler system	1	2.00 Ea.	$1,850.14	$2,219.89	30.0000	30	30	$66,596.79	$66,596.79
Replace fire pump / electric motor assembly 100 H.P.	25	2.00 Ea.	$92,100.15	$106,304.77	1.2000	1	1	$106,304.77	$106,304.77
Repair 500 kva transformer, primary, liquid filled	10	4.00 Ea.	$12,248.43	$14,081.72	3.0000	3	3	$42,245.15	$42,245.15
Maintenance and inspection primary transformer, liquid filled	0.5	4.00 Ea.	$175.26	$219.87	60.0000	60	60	$13,192.14	$13,192.14
Repair switchgear 1200 A mainframe	5	12.00 Ea.	$24,824.14	$29,040.90	6.0000	6	6	$174,245.43	$174,245.43
Maintenance and inspection switchgear, mainframe	1	12.00 Ea.	$839.81	$1,053.54	30.0000	30	30	$31,606.17	$31,606.17
Repair switchgear, - (5% of total C.B.), indoor, less than 600 V	10	20.00 Ea.	$17,839.46	$20,589.88	3.0000	3	3	$61,769.63	$61,769.63
Maintenance and repair motor starter, up to 600 V	5	96.00 Ea.	$33,556.96	$40,217.24	6.0000	6	6	$241,303.43	$241,303.43
Replace starter motor starter, up to 600 V	18	96.00 Ea.	$78,619.86	$93,835.29	1.6667	1	1	$93,835.29	$93,835.29
Maintenance and repair motor starter, 600 V	3	96.00 Ea.	$71,494.19	$87,896.68	10.0000	10	10	$878,966.76	$878,966.76
Maintenance and inspection motor starter, 600 V	0.25	96.00 Ea.	$5,608.45	$7,035.81	120.0000	120	120	$844,296.93	$844,296.93
Maintenance and repair secondary transformer, dry	10	21.00 Ea.	$6,205.70	$7,376.53	3.0000	3	2	$22,129.59	$14,753.06
Replace transformer 15 KVA	30	32.00 Ea.	$119,909.69	$142,541.59	1.0000	1	1	$142,541.59	$142,541.59
Replace transformer 112.5 KVA	30	11.00 Ea.	$87,409.06	$102,465.24	1.0000	1	1	$102,465.24	$102,465.24
Replace transformer 500 KVA	30	10.00 Ea.	$310,767.83	$358,947.28	1.0000	1	1	$358,947.28	$358,947.28
Maintenance and inspection lighting panel, indoor	3	26.00 Ea.	$1,139.22	$1,429.15	10.0000	10	10	$14,291.48	$14,291.48
Replace wireway, 8" x 8"	20	5,785.00 L.F.	$476,408.32	$574,021.36	1.5000	1	1	$574,021.36	$574,021.36
Maintenance and repair breaker, molded case, 480 V, 2 pole	20	10.00 Ea.	$772.87	$969.56	1.5000	1	1	$969.56	$969.56
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	320.00 Ea.	$14,021.13	$17,589.52	3.7500	3	3	$52,768.56	$52,768.56
Maintenance and inspection safety switch, 3 pole, heavy duty	1	320.00 Ea.	$14,021.13	$17,589.52	30.0000	30	30	$527,685.58	$527,685.58
Replace receptacle/plug receptacles and plugs	20	7,466.00 Ea.	$602,828.47	$741,531.06	1.5000	1	1	$741,531.06	$741,531.06
Replace 4-pin receptacle	20	1,056.00 Ea.	$168,896.94	$200,788.10	1.5000	1	1	$200,788.10	$200,788.10
Maintenance and repair contactors and relays	3	16.00 Ea.	$4,377.41	$5,402.24	10.0000	10	10	$54,022.39	$54,022.39
Maintenance and inspection contactors and relays	0.5	16.00 Ea.	$349.55	$438.52	60.0000	60	60	$26,310.99	$26,310.99
Replace wiring devices, switches	15	1,520.00 Ea.	$105,692.63	$131,607.81	2.0000	2	2	$263,215.63	$263,215.63
Maintenance and repair incandescent lighting fixtures	10	1,183.00 Ea.	$87,934.05	$104,713.34	3.0000	3	3	$314,140.03	$314,140.03
Replace incandescent lighting fixture lamp, 200 W	5	1,183.00 Ea.	$15,492.51	$18,668.24	6.0000	6	6	$112,009.46	$112,009.46
Replace fluorescent light fixture ballast, 80 W	10	7,257.00 Ea.	$790,519.46	$974,813.35	3.0000	3	3	$2,924,440.04	$2,924,440.04
Replace lamps (2 lamps), 4', 34 W energy saver	10	7,257.00 Ea.	$197,039.32	$247,073.05	3.0000	3	3	$741,219.16	$741,219.16
Replace metal halide ballast, 175 W	10	146.00 Ea.	$25,047.98	$30,002.59	3.0000	3	3	$90,007.77	$90,007.77
Replace metal halide fixture lamp, 175 W	5	146.00 Ea.	$8,882.51	$10,792.82	6.0000	6	6	$64,756.95	$64,756.95
Replace high pressure sodium ballast, 250 W	10	58.00 Ea.	$11,797.07	$14,017.13	3.0000	3	2	$42,051.40	$28,034.26
Replace high pressure sodium fixture lamp, 250 W	10	58.00 Ea.	$4,006.21	$4,830.22	3.0000	3	3	$14,490.67	$14,490.67
Replace high pressure sodium fixture, 250 W	20	58.00 Ea.	$72,816.53	$84,879.41	1.5000	1	1	$84,879.41	$84,879.41
Maintenance and repair master clock control	10	1.00 Ea.	$208.09	$249.77	3.0000	3	3	$749.30	$749.30
Check operation master clock control	1	1.00 Ea.	$46.25	$58.02	30.0000	30	30	$1,740.63	$1,740.63
Replace master clock program bell	15	1.00 Ea.	$265.11	$318.44	2.0000	2	2	$636.88	$636.88
Maintenance and repair TV cable outlet	10	568.00 Ea.	$31,633.99	$39,541.22	3.0000	3	3	$118,623.65	$118,623.65
Inspect intercom master station	0.5	12.00 Ea.	$2,220.01	$2,785.01	60.0000	60	60	$167,100.43	$167,100.43
Inspect intercom remote station	1	120.00 Ea.	$3,359.23	$4,214.16	30.0000	30	30	$126,424.67	$126,424.67
Repair smoke detector	10	180.00 Ea.	$10,937.70	$13,536.94	3.0000	3	3	$40,610.81	$40,610.81
Check operation smoke detector	1	180.00 Ea.	$3,143.80	$3,943.90	30.0000	30	30	$118,317.00	$118,317.00
Repair heat detector	10	180.00 Ea.	$11,925.72	$14,659.69	3.0000	3	3	$43,979.06	$43,979.06
Check operation heat detector	1	180.00 Ea.	$3,143.80	$3,943.90	30.0000	30	30	$118,317.00	$118,317.00
Check and repair manual pull station	10	43.00 Ea.	$4,084.51	$5,026.99	3.0000	3	3	$15,080.97	$15,080.97
Minor repairs to fire alarm control panel	5	3.00 Ea.	$480.83	$586.28	6.0000	6	6	$3,517.65	$3,517.65
Maintenance and inspection fire alarm control panel	0.5	3.00 Ea.	$138.75	$174.06	60.0000	60	60	$10,443.78	$10,443.78
Minor repairs to annunciation panel	5	28.00 Ea.	$4,487.74	$5,471.91	6.0000	6	6	$32,831.43	$32,831.43
Maintenance and inspection annunciation panel	0.5	28.00 Ea.	$1,295.01	$1,624.59	60.0000	60	60	$97,475.25	$97,475.25
Maintenance and repair electrical service ground	25	24.90 M.L.F.	$2,376.95	$2,971.39	1.2000	1	1	$2,971.39	$2,971.39
Maintenance and repair building structure ground	7	24.90 M.L.F.	$2,376.95	$2,971.39	4.2857	4	4	$11,885.56	$11,885.56
Maintenance and repair of general wiring lightning protection system	1	24.90 M.L.F.	$2,771.94	$3,420.25	30.0000	30	30	$102,607.39	$102,607.39
Maintenance and repair lightning ground rod	1	24.00 Ea.	$2,291.04	$2,863.99	30.0000	30	30	$85,919.69	$85,919.69
Maintenance and inspection generator, diesel, 750 KW	0.08	6.00 Ea.	$419.90	$526.77	375.0000	375	375	$197,538.55	$197,538.55
Replace diesel generator component, 750 KW	25	6.00 Ea.	$1,602,538.48	$1,834,524.84	1.2000	1	1	$1,834,524.84	$1,834,524.84
Maintenance and repair transfer switch	5	12.00 Ea.	$4,647.10	$5,610.35	6.0000	6	6	$33,662.11	$33,662.11
Maintenance and inspection transfer switch	0.5	12.00 Ea.	$525.79	$659.61	60.0000	60	60	$39,576.42	$39,576.42
Replace lamp emergency lighting fixture	2	65.00 Ea.	$3,725.51	$4,496.62	15.0000	15	15	$67,449.36	$67,449.36
Replace emergency lighting fixture	20	65.00 Ea.	$40,545.82	$47,872.14	1.5000	1	1	$47,872.14	$47,872.14
Maintenance and repair exit light	20	120.00 Ea.	$4,789.84	$5,928.72	1.5000	1	1	$5,928.72	$5,928.72
Replace lighting fixture with exit light L.E.D. w/battery unit	20	120.00 Ea.	$77,935.33	$91,466.96	1.5000	1	1	$91,466.96	$91,466.96
Maintenance and inspection battery, dry	0.08	22.00 Ea.	$963.95	$1,209.28	375.0000	375	375	$453,479.80	$453,479.80
Replace battery, dry	5	22.00 Ea.	$4,835.38	$5,583.79	6.0000	6	6	$33,502.77	$33,502.77
Maintenance and inspection UPS battery	0.17	4.00 Ea.	$279.94	$351.18	176.4706	176	176	$61,807.62	$61,807.62
Replace motor generator UPS battery	15	4.00 Ea.	$4,782.33	$5,654.46	2.0000	2	2	$11,308.92	$11,308.92
Maintenance and repair voice/data outlet	10	612.00 Ea.	$34,084.51	$42,604.27	3.0000	3	3	$127,812.80	$127,812.80
Replace voice/data outlet	20	612.00 Ea.	$17,330.03	$21,105.57	1.5000	1	1	$21,105.57	$21,105.57
Maintenance and inspection patch panel	0.5	36.00 Ea.	$3,330.02	$4,177.51	60.0000	60	60	$250,650.65	$250,650.65
Replace patch panel	15	36.00 Ea.	$34,098.47	$40,979.04	2.0000	2	2	$81,958.07	$81,958.07
Replace fume hood sash	20	8.00 Ea.	$10,043.70	$11,538.69	1.5000	1	1	$11,538.69	$11,538.69
Remove and replace hydraulic dock leveler lift cylinder	15	2.00 Ea.	$16,605.83	$18,912.06	2.0000	2	2	$37,824.13	$37,824.13
Remove and replace waste compactor hydraulic cylinder	15	2.00 Ea.	$11,328.58	$12,915.19	2.0000	2	2	$25,830.38	$25,830.38
Refinish metal handicap ramp	3	1.00 S.F.	$2.07	$2.52	10.0000	10	10	$25.24	$25.24
			$44,976,220.76	$53,279,364.53				MR Subtotal:	$98,053,137.42
								MR Per Year:	$3,268,437.91
								PM Total:	$625,229.60
								Subtotal:	$3,893,667.51
								Total Per Unit:	$9.68

FAC 5100 Hospital

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM
FY25 SUC: $9.68
UM: SF
Expected Service Life: 30
Model Size: 402128

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, sliding, electric, annualized	42	102.82	$1,270.08	$4,630.92	$0.0000	5,901.00	7,417.28	8,997.07
Fire doors, swinging, annualized	102	39.98	$1,477.86	$1,639.65	$0.0000	3,117.51	3,757.19	4,470.77
Elevator, cable, electric, passenger / freight, annually	8	64.90	$11,918.00	$5,981.04	$0.0000	17,899.04	20,885.15	24,467.16
Elevator, hydraulic, passenger / freight, annualized	12	122.69	$15,756.00	$11,352.90	$0.0000	27,108.90	32,090.37	37,859.64
Wheelchair lift, annualized	4	4.83	$113.12	$446.73	$0.0000	559.85	705.18	856.17
Escalator, electric, annualized	8	428.07	$33,330.00	$39,319.80	$0.0000	72,649.80	87,778.74	104,574.18
Pneumatic Tube System, annualized	14	19.66	$862.54	$1,369.73	$0.0000	2,232.27	2,729.45	3,269.75
Urinals, annualized	117	26.68	$800.16	$1,435.24	$0.0000	2,235.40	2,745.99	3,296.59
Toilet (vacuum breaker type), annualized	168	29.74	$1,542.88	$1,606.05	$0.0000	3,148.92	3,785.03	4,498.27
Lavatories, annualized	378	131.54	$2,917.52	$8,314.49	$0.0000	11,232.01	14,018.10	16,950.08
Showers, annualized	162	36.94	$2,271.23	$2,336.74	$0.0000	4,607.97	5,536.11	6,577.82
Drink fountain, annualized	57	35.34	$2,060.49	$1,904.77	$0.0000	3,965.26	4,742.74	5,623.25
Valve, butterfly, above 4", annualized	6	1.00	$41.33	$53.55	$0.0000	94.88	115.08	137.34
Valve, diaphragm, above 4", annualized	54	6.59	$371.94	$354.05	$0.0000	725.99	869.40	1,031.41
Water heater, gas, to 120 gal., annualized	36	61.96	$3,183.07	$3,319.70	$0.0000	6,502.77	7,816.99	9,290.36
Valve, pressure relief, above 4", annualized	3	0.44	$18.32	$23.86	$0.0000	42.18	51.16	61.07
Valve, sediment strainer, above 4", annually	3	0.94	$18.32	$50.51	$0.0000	68.82	85.81	103.71
Submersible, 1 H.P. and over, annually	4	7.70	$85.98	$412.85	$0.0000	498.82	631.28	768.03
Oxygen monitor, annualized	22	110.00	$10,854.47	$5,955.84	$0.0000	16,810.31	19,682.51	23,097.43
Boiler, steam, oil, gas, or comb. fired, over 1000 MBH, annualized	3	67.35	$310.69	$4,314.60	$0.0000	4,625.29	5,950.73	7,291.72
Deaerator tank, annualized	3	4.52	$76.21	$289.33	$0.0000	365.54	459.96	558.19
Pump, boiler fuel oil, annualized	4	4.93	$425.97	$316.40	$0.0000	742.38	879.89	1,038.71
Pump, condensate return unit, 2 pumps, annualized	4	4.57	$306.78	$291.02	$0.0000	597.80	715.79	849.11
Water cooling tower, 500 thru 1000 tons, annualized	4	70.91	$879.30	$4,483.80	$0.0000	5,363.10	6,796.17	8,273.21
Chiller, recip., water cooled, over 50 tons, annually	4	5.18	$117.24	$329.94	$0.0000	447.18	557.89	674.45
Compressor, DX Refrigeration, to 25 tons, annualized	4	9.76	$209.08	$622.66	$0.0000	831.73	1,039.44	1,257.60
Compressor, DX refrigeration, 25 to 100 tons, annualized	4	13.02	$209.08	$832.46	$0.0000	1,041.54	1,312.19	1,593.29
Air handling unit, over 50 tons, annualized	24	78.62	$6,073.03	$4,223.23	$0.0000	10,296.26	12,170.54	14,348.46
Air handling unit, computer room, annualized	2	6.83	$195.40	$367.16	$0.0000	562.56	692.25	831.71
Fan coil unit, annually	48	70.13	$1,617.91	$3,776.54	$0.0000	5,394.46	6,689.21	8,064.86
Air filter, electrostatic, annualized	86	653.77	$987.26	$35,286.66	$0.0000	36,273.92	46,958.64	57,692.73
VAV Boxes, annually	302	141.03	$1,439.86	$9,069.97	$0.0000	10,509.83	13,374.81	16,311.78
Fire dampers, annualized	84	97.19	$705.78	$6,218.10	$0.0000	6,923.88	8,859.89	10,831.19
Fan, axial, 5,000 to 10,000 CFM, annualized	30	38.70	$1,069.82	$2,081.16	$0.0000	3,150.98	3,882.30	4,667.12
Hood and blower, annualized	24	55.63	$1,430.33	$2,984.69	$0.0000	4,415.02	5,453.46	6,563.41
Centrifugal, over 1 HP, annualized	16	19.14	$220.41	$1,028.74	$0.0000	1,249.15	1,579.81	1,921.49
Heat exchanger, steam, annualized	10	9.24	$249.14	$494.91	$0.0000	744.04	917.43	1,103.27
Package unit, air cooled, 25 thru 50 ton, annualized	10	32.49	$1,651.13	$2,081.16	$0.0000	3,732.29	4,521.75	5,393.77
Package unit with duct gas heater, annualized	16	79.30	$2,704.34	$5,076.00	$0.0000	7,780.34	9,573.57	11,502.02
Controls, central system, electro/pneumatic, annualized	4	7.68	$719.07	$490.68	$0.0000	1,209.75	1,428.86	1,683.93
Air compressor, reciprocating, 5 to 40 H.P., annualized	14	67.98	$1,545.61	$4,323.06	$0.0000	5,868.67	7,320.15	8,848.91
Steam humidification system, annualized	24	60.96	$679.99	$3,898.37	$0.0000	4,578.36	5,815.87	7,087.38
Dehumidifier, desiccant wheel, annually	24	22.44	$1,641.36	$1,208.09	$0.0000	2,849.45	3,376.01	3,984.64
Backflow prevention device, over 4", annualized	7	3.45	$101.90	$219.11	$0.0000	321.02	396.94	477.96
Extinguishing system, wet pipe, annualized	2	22.68	$109.42	$1,429.74	$0.0000	1,539.16	1,979.03	2,424.36
Fire pump, electric motor driven, annualized	2	95.50	$123.10	$6,006.60	$0.0000	6,129.70	7,943.99	9,764.44
Extinguishing system, dry chemical, annualized	4	22.42	$16.73	$1,201.32	$0.0000	1,218.05	1,580.11	1,943.02
Switchboard, with air circuit breaker, annualized	18	239.72	$344.01	$17,121.24	$0.0000	17,465.25	22,636.02	27,824.00
Circuit breaker, high voltage air, annually	22	10.34	$363.37	$734.05	$0.0000	1,097.42	1,353.98	1,628.70
Switch, selector, high voltage, air, annualized	14	5.71	$231.24	$411.35	$0.0000	642.58	789.11	947.20
Transformer, dry type 500 KVA and over, annualized	10	7.69	$165.17	$547.80	$0.0000	712.97	893.83	1,082.94
Panelboard, 225 A and above, annualized	32	14.11	$830.34	$1,003.97	$0.0000	1,834.30	2,218.53	2,644.27
Motor control center, over 400 A, annualized	96	37.34	$2,491.01	$2,677.25	$0.0000	5,168.26	6,220.53	7,397.36
Central clock systems, annualized	1	1.32	$13.22	$83.66	$0.0000	96.89	123.31	150.39
Fire alarm annuciator system, annualized	1	11.05	$195.61	$697.20	$0.0000	892.81	1,121.53	1,360.03
Emergency diesel or gas generator, over 15 KVA, annualized	6	96.90	$532.93	$6,125.40	$0.0000	6,658.33	8,549.25	10,466.80
Power stablizer, annualized	6	3.75	$65.87	$236.05	$0.0000	301.92	379.32	460.02
Uninterrupted power system, up to 200 KVA, annualized	4	91.70	$1,013.97	$5,776.80	$0.0000	6,790.77	8,625.20	10,510.34
Uninterrupted power system, 200 KVA to 800 KVA, annualized	4	312.23	$1,057.88	$19,720.80	$0.0000	20,778.68	26,800.71	32,875.63
Battery system and charger, annualized	4	34.93	$87.82	$2,211.12	$0.0000	2,298.94	2,971.06	3,647.57
Light, emergency, hardwired system, annualized	210	52.50	$1,907.18	$3,315.19	$0.0000	5,222.36	6,407.64	7,688.27
Light, emergency, wet cell, annualized	210	81.90	$7,859.25	$5,229.00	$0.0000	13,088.25	15,442.88	18,190.46
Hoist / winch, chain / cable, electric, annualized	2	3.30	$452.48	$128.19	$0.0000	580.67	664.37	770.70
Dishwasher, electric, annualized	36	169.63	$6,072.12	$6,469.20	$0.0000	12,541.32	15,089.29	17,940.87
Oven, convection, gas / electric, annualized	8	89.94	$420.16	$3,426.28	$0.0000	3,846.44	4,916.34	6,007.25
Refrigerator freezer, walk-in box w/external condenser, annually	16	11.73	$3,442.08	$445.66	$0.0000	3,887.74	4,365.64	5,015.65
Water flow meter, turbine, annualized	2	1.18	$39.73	$64.05	$0.0000	103.78	126.97	152.14
Pump, centrifugal ejector, annualized	3	3.59	$57.95	$194.71	$0.0000	252.66	316.87	383.98
De-ionization, annualized	4	16.05	$4,740.20	$871.08	$0.0000	5,611.28	6,346.62	7,318.98
Water softner, annualized	13	70.67	$374.01	$3,830.19	$0.0000	4,204.20	5,390.66	6,595.82
Fuel oil storage tank, above ground, annualized	4	13.10	$96.45	$710.53	$0.0000	806.98	1,029.78	1,257.40
						$423,047.95	$520,449.68	$625,229.60

FAC 5302 Medical Laboratory

FY25 SUC:	$12.24 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 5302 Medical Laboratory

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $12.24
UM: SF
Expected Service Life: 30
Model Size: 180000

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	3,756.00 S.F.	$152,810.50	$186,111.08	2.0000	2	2	$372,222.16	$372,222.16
Repair concrete stairs	30	386.00 S.F.	$12,304.64	$14,241.11	1.0000	1	1	$14,241.11	$14,241.11
Refinish fire escape stair and platform	7	2.00 Flight	$1,149.46	$1,388.68	4.2857	4	4	$5,554.71	$5,554.71
Replace fire escape stair and platform	25	2.00 Flight	$13,249.41	$16,147.07	1.2000	1	1	$16,147.07	$16,147.07
Metal floor grating repairs - (2% of grating)	10	240.00 S.F.	$8,297.97	$9,992.80	3.0000	3	3	$29,978.39	$29,978.39
Repair 8" concrete block wall, 1st floor	25	47,766.00 S.F.	$1,278,858.16	$1,564,483.15	1.2000	1	1	$1,564,483.15	$1,564,483.15
Waterproof concrete block wall, 1st floor	10	1,477.00 C.S.F.	$286,601.43	$345,360.85	3.0000	3	3	$1,036,082.54	$1,036,082.54
Waterproof concrete block wall, 2nd floor	10	1,477.00 C.S.F.	$1,190,911.27	$1,422,631.63	3.0000	3	3	$4,267,894.90	$4,267,894.90
Repair clay brick wall, 1st floor	25	27,766.00 S.F.	$1,322,513.52	$1,622,576.65	1.2000	1	1	$1,622,576.65	$1,622,576.65
Waterproof clay brick wall, 1st floor	10	32.00 C.S.F.	$6,209.37	$7,482.43	3.0000	3	3	$22,447.29	$22,447.29
Refinish steel louver, 1st floor	5	6.00 Ea.	$662.91	$820.30	6.0000	6	6	$4,921.79	$4,921.79
Refinish steel louver, 2nd floor	5	6.00 Ea.	$923.23	$1,144.15	6.0000	6	6	$6,864.90	$6,864.90
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	754.20 S.F.	$10,295.85	$12,089.20	30.0000	30	30	$362,676.09	$362,676.09
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	264.00 Ea.	$42,635.48	$50,808.36	1.5000	1	1	$50,808.36	$50,808.36
Replace glass - 2nd floor (1% of glass) - alum. window fixed	1	754.20 S.F.	$87,423.86	$108,028.92	30.0000	30	30	$3,240,867.56	$3,240,867.56
Repair 2'-0" x 3'-0" aluminum window - 2nd floor	20	264.00 Ea.	$56,134.42	$67,599.72	1.5000	1	1	$67,599.72	$67,599.72
Repair aluminum storefront door	12	6.00 Ea.	$3,297.52	$3,932.01	2.5000	2	2	$7,864.02	$7,864.02
Replace insulating glass - (3% of glass) aluminum storefront door	1	4.10 S.F.	$277.17	$322.78	30.0000	30	30	$9,683.26	$9,683.26
Repair steel, painted, door	14	12.00 Ea.	$9,330.71	$11,049.22	2.1429	2	2	$22,098.43	$22,098.43
Refinish 3'-0" x 7'-0" steel, painted, door	4	12.00 Ea.	$575.91	$705.03	7.5000	7	7	$4,935.22	$4,935.22
Repair steel sliding painted door	14	54.00 Ea.	$25,575.64	$30,788.22	2.1429	2	2	$61,576.44	$61,576.44
Refinish 3'-0" x 7'-0" steel sliding painted door	4	54.00 Ea.	$4,841.88	$5,975.29	7.5000	7	7	$41,827.06	$41,827.06
Repair 12' x 12' steel roll-up door	10	3.00 Ea.	$2,706.51	$3,189.37	3.0000	3	3	$9,568.10	$9,568.10
Refinish 12' x 12' steel roll-up door	5	3.00 Ea.	$768.15	$931.93	6.0000	6	6	$5,591.58	$5,591.58
Replace door panic device	25	10.00 Ea.	$23,709.55	$27,096.94	1.2000	1	1	$27,096.94	$27,096.94
Debris removal and visual inspection of built-up roofing	0.5	90.00 M.S.F.	$3,659.60	$4,469.37	60.0000	60	60	$268,161.94	$268,161.94
Non-destructive moisture inspection of built-up roofing	5	90.00 M.S.F.	$11,376.74	$13,894.08	6.0000	6	6	$83,364.46	$83,364.46
Minor BUR membrane repairs, 2% of roof area	1	18.00 Sq.	$10,513.44	$12,427.97	30.0000	30	30	$372,839.10	$372,839.10
BUR flashing repairs, 2 S.F. per sq. repaired	1	1,445.00 S.F.	$5,546.81	$6,737.70	30.0000	30	30	$202,130.90	$202,130.90
Minor BUR membrane replacement, 25% of roof area	15	525.00 Sq.	$528,652.99	$624,054.95	2.0000	2	2	$1,248,109.89	$1,248,109.89
Total BUR roof replacement	28	900.00 Sq.	$875,109.49	$1,029,929.09	1.0714	1	1	$1,029,929.09	$1,029,929.09
Replace Roof edges, aluminum, duranodic, .050" thick, 6" face	25	1,200.00 L.F.	$36,807.20	$43,471.54	1.2000	1	1	$43,471.54	$43,471.54
Replace aluminum downspout, 3" x 4", .024" thick	25	192.00 L.F.	$2,200.16	$2,622.60	1.2000	1	1	$2,622.60	$2,622.60
Repair 8" concrete block wall - (2% of walls) painted	25	184.00 C.S.F.	$223,732.70	$268,736.31	1.2000	1	1	$268,736.31	$268,736.31
Refinish concrete block wall painted	4	1,184.00 C.S.F.	$162,389.17	$195,226.12	7.5000	7	7	$1,366,582.83	$1,366,582.83
Repair 4" glazed C.M.U. wall - (2% of walls)	25	694.00 C.S.F.	$1,526,775.53	$1,799,251.01	1.2000	1	1	$1,799,251.01	$1,799,251.01
Repair plate glass interior wall - (2% of total)	25	1,244.00 C.S.F.	$10,746,837.14	$12,407,470.21	1.2000	1	1	$12,407,470.21	$12,407,470.21
Repair steel painted interior door	14	74.00 Ea.	$21,966.88	$25,627.81	2.1429	2	2	$51,255.62	$51,255.62
Refinish 3'-0" x 7'-0" steel painted interior door	4	74.00 Ea.	$4,455.04	$5,477.81	7.5000	7	7	$38,344.67	$38,344.67
Repair aluminum interior door	12	65.00 Ea.	$19,295.23	$22,510.92	2.5000	2	2	$45,021.83	$45,021.83
Repair solid core wood door, interior	11	31.00 Ea.	$9,202.34	$10,735.97	2.7273	2	2	$21,471.95	$21,471.95
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	31.00 Ea.	$1,695.12	$2,062.18	7.5000	7	7	$14,435.29	$14,435.29
Replace toilet partitions, painted metal-overhead braced, per stall	20	76.00 Ea.	$82,010.12	$95,344.07	1.5000	1	1	$95,344.07	$95,344.07
Replace metal lockers, single tier	20	112.00 Ea.	$38,120.97	$44,183.55	1.5000	1	1	$44,183.55	$44,183.55
Repair concrete steps	15	136.00 S.F.	$4,194.80	$4,838.96	2.0000	2	2	$9,677.92	$9,677.92
Repair metal steps	15	136.00 S.F.	$14,452.14	$16,786.34	2.0000	2	2	$33,572.68	$33,572.68
Refinish metal steps	9	136.00 S.F.	$389.54	$474.74	3.3333	3	3	$1,424.21	$1,424.21
Refinish metal stair railing, interior	7	26.00 S.F.	$42.98	$52.92	4.2857	4	4	$211.67	$211.67
Replace rubber steps	18	342.00 L.F.	$16,205.64	$18,779.18	1.6667	1	1	$18,779.18	$18,779.18
Repair medium weight vinyl wall covering - (2% of walls)	1	119.40 C.S.F.	$63,184.84	$73,737.75	30.0000	30	30	$2,212,132.61	$2,212,132.61
Replace medium weight vinyl wall covering	15	119.40 C.S.F.	$72,029.68	$84,741.42	2.0000	2	2	$169,482.83	$169,482.83
Repair acoustical tile - (2% of walls)	25	136.00 C.S.F.	$147,771.84	$170,528.20	1.2000	1	1	$170,528.20	$170,528.20
Refinish acoustical tile	10	136.00 C.S.F.	$25,589.22	$31,117.78	3.0000	3	3	$93,353.35	$93,353.35
Repair 5/8" drywall - (2% of walls)	20	122,471.00 S.F.	$228,776.58	$278,271.39	1.5000	1	1	$278,271.39	$278,271.39
Refinish drywall	4	122,471.00 S.F.	$88,431.06	$108,436.31	7.5000	7	7	$759,054.19	$759,054.19
Office painting, 10' x 12', 10' high walls	5	306.00 Ea.	$79,767.29	$97,447.28	6.0000	6	6	$584,683.69	$584,683.69
Refinish concrete floor finished	25	53.60 C.S.F.	$24,576.28	$29,526.84	1.2000	1	1	$29,526.84	$29,526.84
Replace epoxy flooring	15	453.00 C.S.F.	$571,420.90	$683,231.10	2.0000	2	2	$1,366,462.19	$1,366,462.19
Replace vinyl sheet flooring	18	98.70 S.Y.	$7,873.61	$9,547.90	1.6667	1	1	$9,547.90	$9,547.90
Replace rubber cove base	9	3,540.00 L.F.	$13,201.83	$15,749.26	3.3333	3	3	$47,247.78	$47,247.78
Terrazzo floor repairs - (2% of floors)	15	256.00 S.F.	$4,781.66	$5,710.59	2.0000	2	2	$11,421.18	$11,421.18
Quarry tile floor repairs - (2% of floors)	15	48.00 S.F.	$334.38	$416.90	2.0000	2	2	$833.80	$833.80
Replace carpet	8	2,667.00 S.Y.	$148,547.93	$171,783.64	3.7500	3	3	$515,350.92	$515,350.92
Repair gypsum board ceiling - (2% of ceilings)	20	502.50 C.S.F.	$205,348.10	$251,788.13	1.5000	1	1	$251,788.13	$251,788.13
Refinish gypsum board ceiling, up to 12' high	20	502.50 C.S.F.	$76,448.96	$93,989.53	1.5000	1	1	$93,989.53	$93,989.53
Acoustic tile repairs - (2% of ceilings)	9	24.50 C.S.F.	$28,192.44	$32,675.30	3.3333	3	3	$98,025.89	$98,025.89
Replace acoustic tile ceiling, fire-rated	20	1,227.00 C.S.F.	$766,497.96	$901,397.98	1.5000	1	1	$901,397.98	$901,397.98
Replace flush valve diaphragm tankless water closet	10	38.00 Ea.	$1,048.41	$1,302.50	3.0000	3	3	$3,907.49	$3,907.49
Rebuild flush valve tankless water closet	20	38.00 Ea.	$7,344.30	$8,852.26	1.5000	1	1	$8,852.26	$8,852.26
Unplug clogged line tankless water closet	5	38.00 Ea.	$8,731.69	$10,935.94	6.0000	6	6	$65,615.64	$65,615.64
Replace flush valve diaphragm for a urinal	7	32.00 Ea.	$882.87	$1,096.84	4.2857	4	4	$4,387.36	$4,387.36
Rebuild flush valve for a urinal	20	32.00 Ea.	$6,184.67	$7,454.53	1.5000	1	1	$7,454.53	$7,454.53
Unplug line urinal	5	32.00 Ea.	$4,892.91	$6,128.09	6.0000	6	6	$36,768.57	$36,768.57
Replace washer in spud connection lavatory, vitreous china	7	40.00 Ea.	$695.72	$849.35	4.2857	4	4	$3,397.39	$3,397.39
Replace washer in faucet lavatory, vitreous china	2	40.00 Ea.	$543.90	$678.51	15.0000	15	15	$10,177.72	$10,177.72
Replace faucets lavatory, vitreous china	10	40.00 Ea.	$7,944.91	$9,551.34	3.0000	3	3	$28,654.02	$28,654.02
Replace faucet washer sink, stainless steel	2	14.00 Ea.	$189.06	$235.84	15.0000	15	15	$3,537.61	$3,537.61
Clean trap sink, stainless steel	3	14.00 Ea.	$126.25	$158.12	10.0000	10	10	$1,581.16	$1,581.16
Replace faucet washer sink, laboratory	2	44.00 Ea.	$594.18	$741.21	15.0000	15	15	$11,118.20	$11,118.20
Replace faucets sink, laboratory	10	44.00 Ea.	$8,739.40	$10,506.47	3.0000	3	3	$31,519.42	$31,519.42
Replace sink and fittings, polyethylene lab.	15	44.00 Ea.	$102,765.55	$119,925.55	2.0000	2	2	$239,851.11	$239,851.11
Replace group wash fountain, 54" diameter	20	8.00 Ea.	$112,009.73	$128,329.72	1.5000	1	1	$128,329.72	$128,329.72
Inspect / clean shower head fiberglass	3	12.00 Ea.	$624.70	$782.41	10.0000	10	10	$7,824.06	$7,824.06
Replace mixing valve barrel shower, fiberglass	2	12.00 Ea.	$3,612.50	$4,249.00	15.0000	15	15	$63,734.97	$63,734.97
Replace mixing valve shower, fiberglass	10	12.00 Ea.	$3,525.89	$4,290.23	3.0000	3	3	$12,870.68	$12,870.68
Check / minor repairs drinking fountain	1	18.00 Ea.	$935.00	$1,171.03	30.0000	30	30	$35,131.00	$35,131.00
Repair internal leaks drinking fountain	4	18.00 Ea.	$860.20	$1,077.35	7.5000	7	7	$7,541.45	$7,541.45
Replace refrigerant drinking fountain	2	18.00 Ea.	$661.88	$773.95	15.0000	15	15	$11,609.23	$11,609.23
Repair drain leak drinking fountain	4	18.00 Ea.	$549.18	$662.55	7.5000	7	7	$4,637.86	$4,637.86
Inspect and clean shower head emergency shower station	3	14.00 Ea.	$728.82	$912.81	10.0000	10	10	$9,128.07	$9,128.07
Replace shower emergency shower station	25	14.00 Ea.	$14,782.58	$17,684.75	1.2000	1	1	$17,684.75	$17,684.75
Inspect and clean spray heads, emergency eye wash	3	14.00 Ea.	$728.82	$912.81	10.0000	10	10	$9,128.07	$9,128.07
Replace eye wash station, emergency eye wash	25	14.00 Ea.	$11,066.27	$13,461.67	1.2000	1	1	$13,461.67	$13,461.67
Resolder joint pipe & fittings, copper	10	432.00 Ea.	$21,989.90	$27,123.44	3.0000	3	3	$81,370.31	$81,370.31
Replace pipe and fittings, copper 3/4"	20	1,145.00 L.F.	$27,592.82	$33,537.14	1.5000	1	1	$33,537.14	$33,537.14
Replace pipe and fittings, copper 2"	25	540.00 L.F.	$30,543.37	$36,603.38	1.2000	1	1	$36,603.38	$36,603.38
Replace old valve, non-drain, 2"	10	32.00 Ea.	$35,229.56	$40,450.37	3.0000	3	3	$121,351.10	$121,351.10
Replace old valve, non-drain, 4"	10	32.00 Ea.	$132,288.71	$153,608.23	3.0000	3	3	$460,824.68	$460,824.68
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	2,331.00 L.F.	$24,041.05	$29,371.43	2.0000	2	2	$58,742.86	$58,742.86
Remove old insulation & replace with new, pipe 1-1/2", wall 3/4"	15	2,331.00 L.F.	$34,399.81	$41,859.56	2.0000	2	2	$83,719.13	$83,719.13
Minor repairs, adjustments water heater, gas / oil, 1150 GPH	2	3.00 Ea.	$310.11	$388.39	15.0000	15	14	$5,825.89	$5,437.50
Clean & service water heater, gas / oil, 1150 GPH	2	3.00 Ea.	$1,854.42	$2,322.55	15.0000	15	15	$34,838.24	$34,838.24
Replace water heater, gas / oil, 1150 GPH	20	3.00 Ea.	$117,599.23	$135,534.83	1.5000	1	1	$135,534.83	$135,534.83
Replace 1000 gallon solar storage tank	20	3.00 Ea.	$24,785.13	$28,724.22	1.5000	1	1	$28,724.22	$28,724.22
Refill expansion chamber	5	3.00 Ea.	$9.07	$11.36	6.0000	6	6	$68.15	$68.15
Insp./chk. pump/mtr. oper., lub., chk. align. circulation pump, 1/2 HP	1	6.00 Ea.	$75.61	$94.70	30.0000	30	30	$2,840.93	$2,840.93
Inspect/check pump/motor operation, lubricate circulation pump, bronze 1 HP	0.5	2.00 Ea.	$16.93	$21.21	60.0000	60	60	$1,272.52	$1,272.52
Replace pump / motor assembly circulation pump, bronze 1 HP	20	2.00 Ea.	$10,924.34	$12,540.64	1.5000	1	1	$12,540.64	$12,540.64
Overhaul water meter	13	2.00 Ea.	$51.54	$64.00	2.3077	2	2	$128.00	$128.00
Replace water softener	15	4.00 Ea.	$4,834.17	$5,775.08	2.0000	2	2	$11,550.16	$11,550.16
Unclog floor drain, PVC	20	54.00 Ea.	$2,720.85	$3,407.71	1.5000	1	1	$3,407.71	$3,407.71
Repair joint pipe and fittings, PVC	10	54.00 Ea.	$8,489.08	$10,579.21	3.0000	3	3	$31,737.62	$31,737.62
Clean floor drain w/o bucket	4	31.00 Ea.	$3,832.46	$4,799.93	7.5000	7	7	$33,599.54	$33,599.54
General maintenance & repair distribution: gutters, pipe	1	1.20 M.L.F.	$382.41	$478.95	30.0000	30	30	$14,368.58	$14,368.58
Replace pipe or gutter distribution	20	1,200.00 L.F.	$68,886.62	$83,641.84	1.5000	1	1	$83,641.84	$83,641.84
General maintenance & repair drain: roof, scupper, area	1	6.00 Ea.	$235.31	$294.71	30.0000	30	30	$8,841.30	$8,841.30
Insp/chk pump/mtr oper, lub, chk align, rainwater sump pump	1	3.00 Ea.	$37.81	$47.35	30.0000	30	30	$1,420.46	$1,420.46
Replace rainwater sump pump / motor assembly	20	3.00 Ea.	$1,897.71	$2,247.66	1.5000	1	1	$2,247.66	$2,247.66
General maintenance pipe & fittings, industrial gas	2	3.20 M.L.F.	$124.67	$156.14	15.0000	15	15	$2,342.07	$2,342.07
General maintenance pipe & fittings, compressed air	2	3.20 M.L.F.	$124.67	$156.14	15.0000	15	15	$2,342.07	$2,342.07
Check and adjust 10 H.P. compressor	1	4.00 Ea.	$356.80	$446.87	30.0000	30	30	$13,405.99	$13,405.99
Replace 10 H.P. compressor	25	4.00 Ea.	$63,654.64	$74,035.19	1.2000	1	1	$74,035.19	$74,035.19
Replace 275 gallon fuel oil storage tank	30	2.00 Ea.	$3,997.61	$4,645.00	1.0000	1	1	$4,645.00	$4,645.00
Preventive maintenance oil filter	1	4.00 Ea.	$31.89	$38.14	30.0000	30	30	$1,144.32	$1,144.32
Install 10' sect. 5/8" type L copper per M.L.F. fuel oil storage	20	7.00 Ea.	$1,449.50	$1,771.84	1.5000	1	1	$1,771.84	$1,771.84
Install new 2" gasket, 1 per M.L.F. natural gas, steel/iron	30	5.00 Ea.	$688.82	$855.88	1.0000	1	1	$855.88	$855.88
Repair boiler, gas, 10,000 MBH	7	2.00 Ea.	$37,438.83	$43,202.63	4.2857	4	4	$172,810.50	$172,810.50
Replace boiler, gas, 10,000 MBH	30	2.00 Ea.	$561,029.56	$656,375.11	1.0000	1	1	$656,375.11	$656,375.11
Repair feed water supply pump	15	2.00 Ea.	$11,908.12	$13,704.16	2.0000	2	2	$27,408.33	$27,408.33
Replace feed water pump	15	3.00 Ea.	$89,783.20	$102,867.51	2.0000	2	2	$205,735.01	$205,735.01
Repair deaerator	10	2.00 Ea.	$156.87	$196.47	3.0000	3	3	$589.42	$589.42

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Replace deaerator	20	2.00 Ea.	$106,092.55	$123,967.69	1.5000	1	1	$123,967.69	$123,967.69
Replace metal flue, all fuel SS, 10" diameter metal flue / chimney	15	84.00 L.F.	$23,176.58	$26,648.04	2.0000	2	2	$53,296.08	$53,296.08
Repair cooling tower, 300 ton	10	3.00 Ea.	$30,104.34	$35,378.93	3.0000	3	2	$106,136.79	$70,757.86
Replace cooling tower, 300 ton	15	3.00 Ea.	$135,167.43	$156,377.82	2.0000	2	2	$312,755.65	$312,755.65
Repair open centrifugal chiller, 300 ton	10	3.00 Ea.	$274,307.09	$321,481.28	3.0000	3	2	$964,443.84	$642,962.56
Replace open centrifugal chiller, 300 ton	20	3.00 Ea.	$675,005.50	$777,067.60	1.5000	1	1	$777,067.60	$777,067.60
Repair fan coil unit, 10 ton	10	24.00 Ea.	$26,126.46	$30,476.39	3.0000	3	3	$91,429.18	$91,429.18
Replace fan coil, DX 2 ton, with heat	15	44.00 Ea.	$81,587.38	$95,997.41	2.0000	2	2	$191,994.82	$191,994.82
Repair fan, induced draft, 2000 CFM	10	18.00 Ea.	$5,763.77	$7,041.40	3.0000	3	3	$21,124.19	$21,124.19
Repair fan, induced draft, 17,700 CFM	10	2.00 Ea.	$696.16	$849.82	3.0000	3	3	$2,549.46	$2,549.46
Replace roof mounted exhaust fan, 2000 CFM exhaust fan	20	16.00 Ea.	$48,242.44	$56,053.10	1.5000	1	1	$56,053.10	$56,053.10
Replace steam regulator valve 1-1/2" diameter	6	68.00 Ea.	$598,338.08	$680,671.76	5.0000	5	5	$3,403,358.82	$3,403,358.82
Repair condensate meter	15	16.00 Ea.	$24,927.94	$28,923.42	2.0000	2	2	$57,846.83	$57,846.83
Replace steam trap, 15 PSIG, 1" threaded	7	112.00 Ea.	$32,484.98	$37,975.01	4.2857	4	4	$151,900.05	$151,900.05
Repack gate valve gland, 3/8" - 1-1/2" valves	10	56.00 Ea.	$1,655.35	$1,981.36	3.0000	3	3	$5,944.09	$5,944.09
Repair circulator pump, 1/12 - 3/4 H.P.	5	14.00 Ea.	$1,467.55	$1,731.05	6.0000	6	6	$10,386.32	$10,386.32
Refill expansion tank	5	6.00 Ea.	$94.12	$117.88	6.0000	6	6	$707.30	$707.30
Repair damaged pipe insulation, fiberglass 1-1/2"	5	54.00 Ea.	$1,405.03	$1,709.55	6.0000	6	6	$10,257.30	$10,257.30
Repair damaged pipe insulation, fiberglass 4"	5	35.00 Ea.	$1,334.35	$1,619.01	6.0000	6	6	$9,714.06	$9,714.06
Repair unit heater, 36 MBH, 2 PSI steam	10	46.00 Ea.	$20,861.21	$24,974.03	3.0000	3	3	$74,922.09	$74,922.09
Repair terminal reheat, 12" x 24" coil	10	72.00 Ea.	$6,769.39	$8,478.28	3.0000	3	3	$25,434.84	$25,434.84
Repair computer room air conditioner, air cooled, 5 ton	10	1.00 Ea.	$4,758.71	$5,661.71	3.0000	3	3	$16,985.13	$16,985.13
Replace computer room air conditioner, air cooled, 5 ton	20	1.00 Ea.	$40,439.57	$46,356.83	1.5000	1	1	$46,356.83	$46,356.83
Repair single zone rooftop unit, 7.5 ton	10	6.00 Ea.	$23,187.03	$27,474.94	3.0000	3	3	$82,424.81	$82,424.81
Replace single zone rooftop unit, 7.5 ton	15	6.00 Ea.	$72,338.38	$85,603.44	2.0000	2	2	$171,206.87	$171,206.87
Repair central station A.H.U., 8000 CFM	10	22.00 Ea.	$39,266.64	$45,474.14	3.0000	3	2	$136,422.43	$90,948.29
Replace central station A.H.U., 8000 CFM	15	22.00 Ea.	$898,844.63	$1,036,006.16	2.0000	2	2	$2,072,012.32	$2,072,012.32
Rebuild 4" diameter reduced pressure backflow preventer	10	19.00 Ea.	$19,201.27	$22,318.20	3.0000	3	3	$66,954.61	$66,954.61
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	30.0000	30	30	$1,362.30	$1,362.30
Replace sprinkler head	20	895.00 Ea.	$82,063.13	$101,132.53	1.5000	1	1	$101,132.53	$101,132.53
Replace fire pump / electric motor assembly 100 H.P.	25	2.00 Ea.	$92,100.15	$106,304.77	1.2000	1	1	$106,304.77	$106,304.77
Repair 500 kva transformer, primary, liquid filled	10	2.00 Ea.	$6,124.21	$7,040.86	3.0000	3	3	$21,122.58	$21,122.58
Maintenance and inspection primary transformer, liquid filled	0.5	2.00 Ea.	$87.63	$109.93	60.0000	60	60	$6,596.07	$6,596.07
Repair switchgear 1200 A mainframe	5	2.00 Ea.	$4,137.36	$4,840.15	6.0000	6	6	$29,040.90	$29,040.90
Maintenance and inspection switchgear, mainframe	1	2.00 Ea.	$139.97	$175.59	30.0000	30	30	$5,267.69	$5,267.69
Replace switchgear, 225 A	30	16.00 Ea.	$7,692.15	$9,649.81	1.0000	1	1	$9,649.81	$9,649.81
Maintenance and repair - (5% of total fuses) switchgear, indoor, 600 V	10	5.00 Ea.	$3,038.55	$3,481.15	3.0000	3	3	$10,443.46	$10,443.46
Maintenance and repair motor starter, up to 600 V	5	24.00 Ea.	$8,389.24	$10,054.31	6.0000	6	6	$60,325.86	$60,325.86
Replace starter motor starter, up to 600 V	18	24.00 Ea.	$19,654.96	$23,458.82	1.6667	1	1	$23,458.82	$23,458.82
Maintenance and repair secondary transformer, dry	10	14.00 Ea.	$4,137.13	$4,917.69	3.0000	3	3	$14,753.06	$14,753.06
Maintenance and inspection lighting panel, indoor	3	14.00 Ea.	$613.42	$769.54	10.0000	10	10	$7,695.41	$7,695.41
Replace wireway, 8" x 8"	20	994.00 L.F.	$81,858.23	$98,630.46	1.5000	1	1	$98,630.46	$98,630.46
Maintenance and repair breaker, molded case, 480 V, 3 pole	20	14.00 Ea.	$1,082.01	$1,357.39	1.5000	1	1	$1,357.39	$1,357.39
Maintenance and repair breaker, enclosed, 240 V, 1 pole	25	212.00 Ea.	$16,384.76	$20,554.70	1.2000	1	1	$20,554.70	$20,554.70
Maintenance and repair breaker, enclosed, 240 V, 2 pole	25	154.00 Ea.	$11,902.14	$14,931.24	1.2000	1	1	$14,931.24	$14,931.24
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	8.00 Ea.	$350.53	$439.74	3.7500	3	3	$1,319.21	$1,319.21
Maintenance and repair safety switch general, 2 pole	8	19.00 Ea.	$832.50	$1,044.38	3.7500	3	3	$3,133.13	$3,133.13
Replace receptacle/plug receptacles and plugs	20	2,738.00 Ea.	$221,074.78	$271,941.07	1.5000	1	1	$271,941.07	$271,941.07
Replace contactor and relays	18	1,566.00 Ea.	$1,648,555.70	$1,932,040.08	1.6667	1	1	$1,932,040.08	$1,932,040.08
Replace wiring devices, switches	15	647.00 Ea.	$44,988.90	$56,019.90	2.0000	2	2	$112,039.81	$112,039.81
Maintenance and repair incandescent lighting fixtures	10	965.00 Ea.	$71,729.80	$85,417.06	3.0000	3	3	$256,251.17	$256,251.17
Replace incandescent lighting fixture lamp, 200 W	5	965.00 Ea.	$12,637.59	$15,228.11	6.0000	6	6	$91,368.66	$91,368.66
Replace fluorescent light fixture ballast, 80 W	10	1,281.00 Ea.	$139,541.88	$172,073.29	3.0000	3	3	$516,219.88	$516,219.88
Replace lamps (2 lamps), 4', 34 W energy saver	10	1,281.00 Ea.	$34,781.23	$43,613.14	3.0000	3	3	$130,839.43	$130,839.43
Replace metal halide ballast, 175 W	10	218.00 Ea.	$37,400.40	$44,798.39	3.0000	3	3	$134,395.16	$134,395.16
Replace metal halide fixture lamp, 175 W	5	218.00 Ea.	$13,262.93	$16,115.31	6.0000	6	6	$96,691.88	$96,691.88
Maintenance and repair master clock control	10	1.00 Ea.	$208.09	$249.77	3.0000	3	3	$749.30	$749.30
Check operation master clock control	1	1.00 Ea.	$46.25	$58.02	30.0000	30	30	$1,740.63	$1,740.63
Maintenance and repair TV cable outlet	10	98.00 Ea.	$5,457.98	$6,822.25	3.0000	3	3	$20,466.76	$20,466.76
Repair smoke detector	10	124.00 Ea.	$7,534.86	$9,325.44	3.0000	3	2	$27,976.33	$18,650.89
Replace smoke detector	15	124.00 Ea.	$41,840.25	$49,786.91	2.0000	2	2	$99,573.81	$99,573.81
Repair heat detector	10	124.00 Ea.	$8,215.50	$10,098.89	3.0000	3	3	$30,296.68	$30,296.68
Replace heat detector	15	124.00 Ea.	$23,535.61	$28,745.47	2.0000	2	2	$57,490.95	$57,490.95
Check and repair manual pull station	10	32.00 Ea.	$3,039.64	$3,741.02	3.0000	3	3	$11,223.05	$11,223.05
Minor repairs to fire alarm control panel	5	4.00 Ea.	$641.11	$781.70	6.0000	6	6	$4,690.20	$4,690.20
Maintenance and inspection fire alarm control panel	0.5	4.00 Ea.	$185.00	$232.08	60.0000	60	60	$13,925.04	$13,925.04
Minor repairs to annunciation panel	5	4.00 Ea.	$641.11	$781.70	6.0000	6	6	$4,690.20	$4,690.20
Replace fire alarm bell, 6"	20	15.00 Ea.	$3,006.53	$3,642.33	1.5000	1	1	$3,642.33	$3,642.33
Replace EMS, Three Phase, 5 Meters	15	5.00 Ea.	$76,298.35	$88,852.51	2.0000	2	2	$177,705.02	$177,705.02
Replace EMS, Mech, BTU, 3 Meters, 3 Duct Sensors, 3 Space Sensors	20	5.00 Ea.	$82,713.48	$96,694.16	1.5000	1	1	$96,694.16	$96,694.16
Maintenance and repair electrical service ground	25	1.20 M.L.F.	$114.55	$143.20	1.2000	1	1	$143.20	$143.20
Maintenance and repair building structure ground	7	1.20 M.L.F.	$114.55	$143.20	4.2857	4	4	$572.80	$572.80
Maintenance and repair of general wiring lightning protection system	1	1.20 M.L.F.	$133.59	$164.83	30.0000	30	30	$4,944.93	$4,944.93
Maintenance and repair lightning ground rod	1	17.00 Ea.	$1,622.82	$2,028.66	30.0000	30	30	$60,859.78	$60,859.78
Maintenance and inspection generator, diesel, 750 KW	0.08	4.00 Ea.	$279.94	$351.18	375.0000	375	375	$131,692.36	$131,692.36
Replace diesel generator component, 750 KW	25	4.00 Ea.	$1,068,358.99	$1,223,016.56	1.2000	1	1	$1,223,016.56	$1,223,016.56
Maintenance and repair transfer switch	5	4.00 Ea.	$1,549.03	$1,870.12	6.0000	6	6	$11,220.70	$11,220.70
Maintenance and inspection transfer switch	0.5	4.00 Ea.	$175.26	$219.87	60.0000	60	60	$13,192.14	$13,192.14
Replace lamp emergency lighting fixture	2	36.00 Ea.	$2,063.36	$2,490.44	15.0000	15	15	$37,356.57	$37,356.57
Replace emergency lighting fixture	20	36.00 Ea.	$22,456.15	$26,513.80	1.5000	1	1	$26,513.80	$26,513.80
Maintenance and repair exit light	20	42.00 Ea.	$1,676.45	$2,075.05	1.5000	1	1	$2,075.05	$2,075.05
Replace lamp exit light	5	42.00 Ea.	$768.53	$911.01	6.0000	6	6	$5,466.08	$5,466.08
Maintenance and inspection battery, dry	0.08	18.00 Ea.	$788.69	$989.41	375.0000	375	375	$371,028.92	$371,028.92
Replace battery, dry	5	18.00 Ea.	$3,956.22	$4,568.56	6.0000	6	6	$27,411.35	$27,411.35
Maintenance and repair voice/data outlet	10	204.00 Ea.	$11,361.50	$14,201.42	3.0000	3	3	$42,604.27	$42,604.27
Replace glove box gloves	5	14.00 Ea.	$5,529.89	$6,467.12	6.0000	6	6	$38,802.73	$38,802.73
Replace fume hood sash	20	24.00 Ea.	$30,131.10	$34,616.08	1.5000	1	1	$34,616.08	$34,616.08
Remove and replace hydraulic dock leveler lift cylinder	15	4.00 Ea.	$33,211.67	$37,824.13	2.0000	2	2	$75,648.26	$75,648.26
Remove and replace hydraulic dock leveler hydraulic pump	20	4.00 Ea.	$8,701.80	$9,952.59	1.5000	1	1	$9,952.59	$9,952.59
Replace commercial dishwasher, 10 to 12 racks per hour	10	8.00 Ea.	$349,955.64	$398,578.53	3.0000	3	3	$1,195,735.58	$1,195,735.58
Remove and replace dishwasher pump	15	8.00 Ea.	$10,559.45	$12,090.22	2.0000	2	2	$24,180.45	$24,180.45
			$30,630,127.85	$35,928,492.69				MR Subtotal:	$59,763,570.10
								MR Per Year:	$1,992,119.00
								PM Total:	$211,165.06
								Subtotal:	$2,203,284.06
								Total Per Unit:	$12.24

FAC 5302 Medical Laboratory

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $12.24
UM: SF
Expected Service Life: 30
Model Size: 180000

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	2	8.14	$165.24	$368.03	$0.0000	533.27	660.20	795.40
Fire doors, swinging, annualized	8	3.14	$115.91	$128.60	$0.0000	244.51	294.68	350.65
Fire doors, sliding, annualized	4	6.64	$126.59	$257.20	$0.0000	383.79	473.61	569.76
Elevator, hydraulic, passenger / freight, annualized	4	40.90	$5,252.00	$3,784.30	$0.0000	9,036.30	10,696.79	12,619.88
Urinals, annualized	32	7.30	$218.85	$392.54	$0.0000	611.39	751.04	901.63
Toilet (vacuum breaker type), annualized	38	6.73	$348.98	$363.27	$0.0000	712.26	856.14	1,017.47
Lavatories, annualized	40	13.92	$308.73	$879.84	$0.0000	1,188.57	1,483.40	1,793.66
Showers, annualized	18	4.10	$252.36	$259.64	$0.0000	512.00	615.12	730.87
Drink fountain, annualized	12	7.44	$433.79	$401.00	$0.0000	834.79	998.47	1,183.84
Valve, butterfly, above 4", annually	16	2.66	$110.21	$142.80	$0.0000	253.01	306.87	366.24
Valve, check, above 4", annually	33	8.48	$227.30	$455.06	$0.0000	682.36	841.61	1,012.23
Valve, motor operated, above 4", annually	28	14.00	$385.72	$746.17	$0.0000	1,131.89	1,394.32	1,676.02
Duplex sump, annualized	4	6.62	$125.06	$355.32	$0.0000	480.38	599.48	724.83
Boiler, hot water, oil, gas, or comb. fired, 500 to 1000 MBH, annually	4	21.31	$322.41	$1,353.60	$0.0000	1,676.01	2,114.33	2,568.77
Boiler, hot water, oil, gas, or comb. fired, over 1000 MBH, annualized	2	39.40	$180.74	$2,538.00	$0.0000	2,718.74	3,498.22	4,286.73
Deaerator tank, annualized	3	4.52	$76.21	$289.33	$0.0000	365.54	459.96	558.19
Water cooling tower, 50 thru 500 tons, annualized	3	29.74	$659.48	$1,903.50	$0.0000	2,562.98	3,199.97	3,869.94
Chiller, centrif., water cooled, over 100 tons, annualized	3	100.09	$342.93	$6,408.45	$0.0000	6,751.38	8,708.20	10,682.18
Compressor, DX Refrigeration, to 25 tons, annualized	4	9.76	$209.08	$622.66	$0.0000	831.73	1,039.44	1,257.60
Air handling unit, over 50 tons, annualized	16	52.42	$4,048.69	$2,815.49	$0.0000	6,864.18	8,113.69	9,565.64
Air handling unit, computer room, annualized	2	6.83	$195.40	$367.16	$0.0000	562.56	692.25	831.71
Fan coil unit, annualized	46	153.55	$3,954.90	$8,250.19	$0.0000	12,205.09	15,075.64	18,143.93
Air filter, electrostatic, annualized	46	349.69	$528.07	$18,874.26	$0.0000	19,402.33	25,117.41	30,858.90
VAV Boxes, annualized	64	59.78	$609.65	$3,817.15	$0.0000	4,426.80	5,632.91	6,869.50
Fire dampers, annualized	6	6.94	$50.41	$444.15	$0.0000	494.56	632.85	773.66
Fan, axial, 5,000 to 10,000 CFM, annualized	18	23.22	$641.89	$1,248.70	$0.0000	1,890.58	2,329.38	2,800.27
Hood and blower, annualized	42	97.36	$2,503.07	$5,223.20	$0.0000	7,726.28	9,543.55	11,485.97
Heat exchanger, steam, annualized	3	2.77	$74.74	$148.47	$0.0000	223.21	275.23	330.98
Package unit, computer room, annualized	2	8.67	$269.65	$558.36	$0.0000	828.01	1,022.49	1,230.44
Controls, central system, electro/pneumatic, annualized	2	3.84	$359.54	$245.34	$0.0000	604.88	714.43	841.96
Air compressor, centrifugal, to 40 H.P., annualized	4	13.65	$273.56	$873.07	$0.0000	1,146.63	1,435.91	1,738.87
Steam humidification system, annualized	1	2.54	$28.33	$162.43	$0.0000	190.76	242.33	295.31
Backflow prevention device, up to 4", annualized	2	0.67	$29.11	$42.30	$0.0000	71.41	87.02	104.07
Extinguishing system, wet pipe, annualized	2	22.68	$109.42	$1,429.74	$0.0000	1,539.16	1,979.03	2,424.36
Switchboard, annualized	12	8.41	$57.01	$603.58	$0.0000	660.58	847.36	1,036.98
Transformer, dry type 500 KVA and over, annualized	4	3.08	$66.07	$219.12	$0.0000	285.19	357.53	433.18
Panelboard, 225 A and above, annualized	24	10.58	$622.75	$752.98	$0.0000	1,375.73	1,663.90	1,983.20
Motor control center, over 400 A, annualized	14	5.45	$363.27	$390.43	$0.0000	753.70	907.16	1,078.78
Fire alarm annuciator system, annualized	2	22.10	$391.22	$1,394.40	$0.0000	1,785.62	2,243.06	2,720.06
Emergency diesel or gas generator, over 15 KVA, annualized	4	64.60	$355.29	$4,083.60	$0.0000	4,438.89	5,699.50	6,977.87
Uninterrupted power system, 200 KVA to 800 KVA, annualized	4	312.23	$1,057.88	$19,720.80	$0.0000	20,778.68	26,800.71	32,875.63
Light, emergency, hardwired system, annualized	60	15.00	$544.91	$947.20	$0.0000	1,492.10	1,830.75	2,196.65
Hydraulic lift, loading dock, annually	2	1.63	$62.62	$62.30	$0.0000	124.92	149.87	177.95
Oven, convection, gas / electric, annualized	12	134.90	$630.24	$5,139.42	$0.0000	5,769.66	7,374.51	9,010.87
Refrigerated unit, display case, freezer w/ ext. condenser annualized	16	47.87	$6,868.00	$1,820.96	$0.0000	8,688.96	9,922.05	11,498.54
Vacuum, annualized	5	6.16	$131.30	$233.61	$0.0000	364.91	448.12	537.90
Pump, vacuum, annualized	4	4.95	$145.22	$268.16	$0.0000	413.38	508.34	610.57
De-ionization, annualized	1	4.01	$1,185.05	$217.77	$0.0000	1,402.82	1,586.66	1,829.74
Water softner, annualized	4	21.74	$115.08	$1,178.52	$0.0000	1,293.60	1,658.66	2,029.48
Ejector pump, sump type, annualized	2	3.30	$120.56	$179.34	$0.0000	299.90	365.76	437.64
Fuel oil storage tank, above ground, annualized	1	3.28	$24.11	$177.63	$0.0000	201.74	257.44	314.35
						$139,927.94	$174,637.98	$211,165.06

FAC 5303 Morgue

FY25 SUC:	$9.36 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 5304 Veterinary Facility

FY25 SUC:	$4.43 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 5306 Medical Warehouse

FY25 SUC:	$3.56 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 5307 Ambulance Building

FY25 SUC:	$4.47 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 5307 Ambulance Building

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.47
UM: SF
Expected Service Life: 35
Model Size: 1859

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair 8" concrete block wall, 1st floor	25	480.00 S.F.	$12,851.23	$15,721.47	1.4000	1	1	$15,721.47	$15,721.47
Refinish synthetic veneer plaster, 1st floor	10	28.00 C.S.F.	$10,059.35	$11,906.44	3.5000	3	3	$35,719.33	$35,719.33
Repair 2'-0" x 3'-0" steel frame window - 1st floor.	20	8.00 Ea.	$1,291.98	$1,539.65	1.7500	1	1	$1,539.65	$1,539.65
Refinish 2'-0" x 3'-0" steel frame window - 1st floor.	5	8.00 Ea.	$726.99	$899.11	7.0000	7	7	$6,293.79	$6,293.79
Repair steel, painted, door	14	2.00 Ea.	$1,555.12	$1,841.54	2.5000	2	2	$3,683.07	$3,683.07
Refinish 3'-0" x 7'-0" steel, painted, door	4	2.00 Ea.	$95.98	$117.51	8.7500	8	8	$940.04	$940.04
Refinish 12' x 24' steel double roll-up door	5	2.00 Ea.	$1,025.70	$1,244.45	7.0000	7	7	$8,711.16	$8,711.16
Replace 12' x 24' steel double roll-up door	35	2.00 Ea.	$14,434.69	$17,009.96	1.0000	1	1	$17,009.96	$17,009.96
Debris removal and visual inspection of built-up roofing	0.5	1.80 M.S.F.	$73.19	$89.39	70.0000	70	70	$6,257.11	$6,257.11
Non-destructive moisture inspection of built-up roofing	5	1.80 M.S.F.	$227.53	$277.88	7.0000	7	7	$1,945.17	$1,945.17
BUR flashing repairs, 2 S.F. per sq. repaired	1	24.00 S.F.	$92.13	$111.91	35.0000	35	35	$3,916.72	$3,916.72
Total BUR roof replacement	28	18.60 Sq.	$18,085.60	$21,285.20	1.2500	1	1	$21,285.20	$21,285.20
Replace aluminum downspout, 3" x 4", .024" thick	25	48.00 L.F.	$550.04	$655.65	1.4000	1	1	$655.65	$655.65
Refinish concrete floor finished	25	16.20 C.S.F.	$7,427.90	$8,924.16	1.4000	1	1	$8,924.16	$8,924.16
Replace faucet washer sink, enameled steel	2	1.00 Ea.	$13.50	$16.85	17.5000	17	17	$286.38	$286.38
Replace faucets sink, enameled steel	10	1.00 Ea.	$198.62	$238.78	3.5000	3	3	$716.35	$716.35
Replace sink, enameled steel	35	1.00 Ea.	$948.61	$1,122.58	1.0000	1	1	$1,122.58	$1,122.58
Replace faucet washer sink, service/utility	2	1.00 Ea.	$13.50	$16.85	17.5000	17	17	$286.38	$286.38
Replace faucets sink, service/utility	10	1.00 Ea.	$198.62	$238.78	3.5000	3	3	$716.35	$716.35
Replace sink, P.E.C.I. service/utility	35	1.00 Ea.	$1,659.02	$1,940.60	1.0000	1	1	$1,940.60	$1,940.60
Overhaul water heater, gas / oil, 70 gallon	5	1.00 Ea.	$173.21	$216.94	7.0000	7	7	$1,518.58	$1,518.58
Unclog main drain pipe & fittings, cast iron	10	1.00 Ea.	$48.83	$61.15	3.5000	3	3	$183.46	$183.46
Replace pressure regulator 1" diam. pipe natural gas	14	1.00 Ea.	$218.88	$256.30	2.5000	2	2	$512.60	$512.60
Maintenance and repair infrared heater suspended, commercial	1	2.00 Ea.	$90.98	$114.13	35.0000	35	33	$3,994.51	$3,766.25
Replace infrared heater suspended, commercial	15	2.00 Ea.	$1,142.25	$1,346.62	2.3333	2	2	$2,693.25	$2,693.25
Repair single zone rooftop unit, 3 ton	10	1.00 Ea.	$2,677.35	$3,203.28	3.5000	3	3	$9,609.85	$9,609.85
Replace single zone rooftop unit, 3 ton	15	1.00 Ea.	$4,736.95	$5,698.85	2.3333	2	2	$11,397.70	$11,397.70
Replace fuse	25	8.00 Ea.	$4,861.68	$5,569.85	1.4000	1	1	$5,569.85	$5,569.85
Maintenance and inspection lighting panel, indoor	3	1.00 Ea.	$43.82	$54.97	11.6667	11	11	$604.64	$604.64
Replace safety switch, heavy duty 30 A	25	4.00 Ea.	$3,070.28	$3,644.16	1.4000	1	1	$3,644.16	$3,644.16
Replace fluorescent light fixture ballast, 80 W	10	20.00 Ea.	$2,178.64	$2,686.55	3.5000	3	3	$8,059.64	$8,059.64
Replace lamps (2 lamps), 4', 34 W energy saver	10	20.00 Ea.	$543.03	$680.92	3.5000	3	3	$2,042.77	$2,042.77
Replace high pressure sodium ballast, 250 W	10	4.00 Ea.	$813.59	$966.70	3.5000	3	3	$2,900.10	$2,900.10
Replace high pressure sodium fixture lamp, 250 W	10	4.00 Ea.	$276.29	$333.12	3.5000	3	3	$999.36	$999.36
Inspect intercom remote station	1	1.00 Ea.	$27.99	$35.12	35.0000	35	35	$1,229.13	$1,229.13
Replace intercom remote station	15	1.00 Ea.	$687.09	$794.52	2.3333	2	2	$1,589.03	$1,589.03
Repair smoke detector	10	2.00 Ea.	$121.53	$150.41	3.5000	3	3	$451.23	$451.23
Check operation smoke detector	1	2.00 Ea.	$34.93	$43.82	35.0000	35	35	$1,533.74	$1,533.74
Replace fire alarm bell, 6"	20	1.00 Ea.	$200.44	$242.82	1.7500	1	1	$242.82	$242.82
Replace lamp emergency lighting fixture	2	2.00 Ea.	$114.63	$138.36	17.5000	17	17	$2,352.08	$2,352.08
Replace emergency lighting fixture	20	2.00 Ea.	$1,247.56	$1,472.99	1.7500	1	1	$1,472.99	$1,472.99
Maintenance and repair exit light	20	2.00 Ea.	$79.83	$98.81	1.7500	1	1	$98.81	$98.81
Replace lamp with exit light L.E.D. retrofit kits	15	2.00 Ea.	$206.03	$237.33	2.3333	2	2	$474.66	$474.66
Maintenance and repair voice/data outlet	10	2.00 Ea.	$111.39	$139.23	3.5000	3	3	$417.69	$417.69
Replace voice/data outlet	20	2.00 Ea.	$56.63	$68.97	1.7500	1	1	$68.97	$68.97
Automotive equipment, compressor, electric, 5 HP, remove and replace motor	10	1.00 Ea.	$715.72	$825.69	3.5000	3	3	$2,477.06	$2,477.06
			$96,008.85	$114,280.37				MR Subtotal:	$203,581.54
								MR Per Year:	$5,816.62
								PM Total:	$2,496.13
								Subtotal:	$8,312.75
								Total Per Unit:	$4.47

FAC 5307 Ambulance Building

Release:	2024 Qtr 3	FY25 SUC:	$4.47
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	35
		Model Size:	1859

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	2	8.14	$165.24	$368.03	$0.0000	533.27	660.20	795.40
Water heater, gas, to 120 gal., annualized	1	1.72	$88.42	$92.21	$0.0000	180.63	217.14	258.07
Panelboard, 225 A and above, annualized	1	0.44	$25.95	$31.37	$0.0000	57.32	69.33	82.63
Fire alarm annuciator system, annualized	1	11.05	$195.61	$697.20	$0.0000	892.81	1,121.53	1,360.03
						$1,664.03	$2,068.20	$2,496.13

FAC 5400 Dental Facility

FY25 SUC:	$11.15 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 5500 Dispensary And Clinic

FY25 SUC:	$11.81 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 5501 Ambulatory Care Clinic

FY25 SUC:	$8.80 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 6100 General Administrative Building

FY25 SUC:	$5.04 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 6100 General Administrative Building

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $5.04
UM: SF
Expected Service Life: 55
Model Size: 9783

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair concrete stairs	30	134.00 S.F.	$4,271.56	$4,943.80	1.8333	1	1	$4,943.80	$4,943.80
Repair 8" concrete block wall, 1st floor	25	120.00 S.F.	$3,212.81	$3,930.37	2.2000	2	2	$7,860.74	$7,860.74
Waterproof concrete block wall, 1st floor	10	8.80 C.S.F.	$1,707.58	$2,057.67	5.5000	5	5	$10,288.34	$10,288.34
Waterproof concrete block wall, 2nd floor	10	8.80 C.S.F.	$7,095.48	$8,476.07	5.5000	5	5	$42,380.36	$42,380.36
Repair clay brick wall, 1st floor	25	25.00 S.F.	$1,190.77	$1,460.94	2.2000	2	2	$2,921.88	$2,921.88
Waterproof clay brick wall, 1st floor	10	25.00 C.S.F.	$4,851.07	$5,845.65	5.5000	5	5	$29,228.24	$29,228.24
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	3.24 S.F.	$44.23	$51.93	55.0000	55	55	$2,856.40	$2,856.40
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	24.00 Ea.	$3,875.95	$4,618.94	2.7500	2	2	$9,237.88	$9,237.88
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	24.00 Ea.	$19,722.33	$23,042.72	1.1000	1	1	$23,042.72	$23,042.72
Repair 2'-0" x 3'-0" aluminum window - 2nd floor	20	26.00 Ea.	$5,528.39	$6,657.55	2.7500	2	2	$13,315.10	$13,315.10
Replace 2'-0" x 3'-0" aluminum window - 2nd floor	50	26.00 Ea.	$22,695.30	$26,616.64	1.1000	1	1	$26,616.64	$26,616.64
Repair aluminum storefront door	12	2.00 Ea.	$1,099.17	$1,310.67	4.5833	4	4	$5,242.68	$5,242.68
Replace 3'-0" x 7'-0" aluminum storefront doors	50	2.00 Ea.	$5,728.92	$6,718.40	1.1000	1	1	$6,718.40	$6,718.40
Replace insulating glass - (3% of glass) aluminum storefront door	1	2.00 S.F.	$135.21	$157.45	55.0000	55	55	$8,659.83	$8,659.83
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	3.9286	3	3	$11,049.22	$11,049.22
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.00 Ea.	$191.97	$235.01	13.7500	13	13	$3,055.13	$3,055.13
Replace 3'-0" x 7'-0" steel, painted, door	45	4.00 Ea.	$2,943.44	$3,426.28	1.2222	1	1	$3,426.28	$3,426.28
Debris removal, by hand and visual inspection, metal panel roofing	1	4.90 M.S.F.	$120.42	$147.07	55.0000	55	55	$8,088.59	$8,088.59
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	98.00 S.F.	$475.13	$563.85	11.0000	11	11	$6,202.36	$6,202.36
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	8.60 S.F.	$243.02	$289.20	55.0000	55	55	$15,906.19	$15,906.19
Total metal roof panel replacement	30	49.30 Sq.	$47,387.91	$56,037.49	1.8333	1	1	$56,037.49	$56,037.49
Repair steel painted interior door	14	2.00 Ea.	$593.70	$692.64	3.9286	3	3	$2,077.93	$2,077.93
Refinish 3'-0" x 7'-0" steel painted interior door	4	2.00 Ea.	$120.41	$148.05	13.7500	13	13	$1,924.64	$1,924.64
Repair solid core wood door, interior	11	18.00 Ea.	$5,343.30	$6,233.79	5.0000	5	5	$31,168.96	$31,168.96
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	18.00 Ea.	$984.27	$1,197.40	13.7500	13	12	$15,566.16	$14,368.77
Replace 3'-0" x 7'-0" solid core wood door, interior	40	18.00 Ea.	$11,587.99	$13,361.41	1.3750	1	1	$13,361.41	$13,361.41
Replace toilet partitions, painted metal-overhead braced, per stall	20	7.00 Ea.	$7,553.56	$8,781.69	2.7500	2	2	$17,563.38	$17,563.38
Repair concrete steps	15	164.00 S.F.	$5,058.44	$5,835.22	3.6667	3	3	$17,505.65	$17,505.65
Refinish metal stair railing, interior	7	26.00 S.F.	$42.98	$52.92	7.8571	7	7	$370.43	$370.43
Repair 5/8" drywall - (2% of walls)	20	1,642.00 S.F.	$3,067.27	$3,730.86	2.7500	2	2	$7,461.71	$7,461.71
Office painting, 10' x 12', 10' high walls	5	12.00 Ea.	$3,128.13	$3,821.46	11.0000	11	11	$42,036.08	$42,036.08
Repair 4" x 4" thin set ceramic tile - (2% of walls)	10	1.70 C.S.F.	$1,565.76	$1,884.49	5.5000	5	5	$9,422.44	$9,422.44
Refinish concrete floor finished	25	1.50 C.S.F.	$687.77	$826.31	2.2000	2	2	$1,652.62	$1,652.62
Replace vinyl tile flooring	18	238.00 S.Y.	$13,460.87	$16,476.52	3.0556	3	3	$49,429.55	$49,429.55
Terrazzo floor repairs - (2% of floors)	15	42.00 S.F.	$784.49	$936.89	3.6667	3	3	$2,810.68	$2,810.68
Replace carpet	8	88.00 S.Y.	$4,901.47	$5,668.15	6.8750	6	6	$34,008.91	$34,008.91
Acoustic tile repairs - (2% of ceilings)	9	1.68 C.S.F.	$1,933.20	$2,240.59	6.1111	6	6	$13,443.55	$13,443.55
Replace acoustic tile ceiling, fire-rated	20	8.80 C.S.F.	$5,497.30	$6,464.79	2.7500	2	2	$12,929.59	$12,929.59
Replace flush valve diaphragm tankless water closet	10	8.00 Ea.	$220.72	$274.21	5.5000	5	5	$1,371.05	$1,371.05
Rebuild flush valve tankless water closet	20	8.00 Ea.	$1,546.17	$1,863.63	2.7500	2	2	$3,727.27	$3,727.27
Replace tankless flush valve	25	8.00 Ea.	$2,181.24	$2,560.22	2.2000	2	2	$5,120.45	$5,120.45
Replace wax ring gasket for tankless water closet	5	8.00 Ea.	$1,198.04	$1,499.06	11.0000	11	11	$16,489.61	$16,489.61
Replace flush valve diaphragm for a urinal	7	4.00 Ea.	$110.36	$137.10	7.8571	7	7	$959.73	$959.73
Rebuild flush valve for a urinal	20	4.00 Ea.	$773.08	$931.82	2.7500	2	2	$1,863.63	$1,863.63
Replace washer in spud connection lavatory, vitreous china	7	8.00 Ea.	$139.14	$169.87	7.8571	7	7	$1,189.09	$1,189.09
Replace washer in faucet lavatory, vitreous china	2	8.00 Ea.	$108.78	$135.70	27.5000	27	27	$3,663.98	$3,663.98
Replace faucets lavatory, vitreous china	10	8.00 Ea.	$1,588.98	$1,910.27	5.5000	5	5	$9,551.34	$9,551.34
Clean out strainer and P trap lavatory, vitreous china	2	8.00 Ea.	$296.71	$371.61	27.5000	27	27	$10,033.41	$10,033.41
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	27.5000	27	27	$454.84	$454.84
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	18.3333	18	18	$203.29	$203.29
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	5.5000	5	5	$1,193.92	$1,193.92
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	1.00 Ea.	$910.17	$1,070.70	5.5000	5	5	$5,353.51	$5,353.51
Resolder joint pipe & fittings, copper	10	25.00 Ea.	$1,272.56	$1,569.64	5.5000	5	5	$7,848.22	$7,848.22
Overhaul water heater, gas / oil, 70 gallon	5	2.00 Ea.	$346.43	$433.88	11.0000	11	11	$4,772.69	$4,772.69
Clean & service water heater, gas / oil, 70 gallon	1	1.00 Ea.	$206.74	$258.93	55.0000	55	55	$14,241.06	$14,241.06
Replace water heater, gas / oil, 70 gallon	12	1.00 Ea.	$5,470.45	$6,302.52	4.5833	4	4	$25,210.08	$25,210.08
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	1.00 Ea.	$8.47	$10.60	110.0000	110	110	$1,166.48	$1,166.48
Replace pump / motor assembly circulation pump, 1/12 HP	10	1.00 Ea.	$1,265.32	$1,479.95	5.5000	5	5	$7,399.75	$7,399.75
Unclog main drain pipe & fittings, cast iron	10	1.00 Ea.	$48.83	$61.15	5.5000	5	5	$305.77	$305.77
Replace pipe & fittings, cast iron, 4"	40	20.00 L.F.	$1,219.29	$1,477.69	1.3750	1	1	$1,477.69	$1,477.69
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.7500	2	2	$126.21	$126.21
Unclog 4" - 12" diameter PVC main drain per L.F.	10	0.35 L.F.	$1.40	$1.75	5.5000	5	5	$8.77	$8.77
General maintenance & repair distribution: gutters, pipe	1	0.28 M.L.F.	$89.23	$111.76	55.0000	55	55	$6,146.56	$6,146.56
Replace pipe or gutter distribution	20	0.28 L.F.	$16.07	$19.52	2.7500	2	2	$39.03	$39.03
Install new 2" gasket, 1 per M.L.F. natural gas, steel/iron	30	2.00 Ea.	$275.53	$342.35	1.8333	1	1	$342.35	$342.35
Check gas pressure natural gas, pressure reducing valve	5	1.00 Ea.	$10.18	$12.75	11.0000	11	11	$140.26	$140.26
Replace 10' steel pipe 1-1/2" diam. M.L.F. LPG distribution	12	1.00 Ea.	$513.61	$623.68	4.5833	4	4	$2,494.71	$2,494.71
Replace fan coil, DX 1-1/2 ton, with heat	15	8.00 Ea.	$14,900.27	$17,509.04	3.6667	3	3	$52,527.13	$52,527.13
Repair fan, induced draft, 2000 CFM	10	1.00 Ea.	$320.21	$391.19	5.5000	5	5	$1,955.94	$1,955.94
Replace fan, induced draft, 2000 CFM	20	1.00 Ea.	$5,295.32	$6,090.44	2.7500	2	2	$12,180.87	$12,180.87
Repair single zone rooftop unit, 5 ton	10	2.00 Ea.	$5,825.07	$6,949.51	5.5000	5	5	$34,747.55	$34,747.55
Replace single zone rooftop unit, 5 ton	15	2.00 Ea.	$17,297.38	$20,578.66	3.6667	3	3	$61,735.97	$61,735.97
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	55.0000	55	55	$2,497.55	$2,497.55
Replace sprinkler head	20	55.00 Ea.	$5,042.99	$6,214.85	2.7500	2	2	$12,429.70	$12,429.70
Repair 15 KV primary transformer, dry	15	1.00 Ea.	$245.95	$300.05	3.6667	3	3	$900.16	$900.16
Maintenance and repair motor starter, up to 600 V	5	1.00 Ea.	$349.55	$418.93	11.0000	11	11	$4,608.23	$4,608.23
Maintenance and inspection motor starter, up to 600 V	0.5	1.00 Ea.	$58.42	$73.29	110.0000	110	110	$8,061.86	$8,061.86
Replace starter motor starter, up to 600 V	18	1.00 Ea.	$818.96	$977.45	3.0556	3	3	$2,932.35	$2,932.35
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	18.3333	18	18	$1,978.82	$1,978.82
Replace load center, 100 A	20	4.00 Ea.	$4,526.80	$5,554.37	2.7500	2	2	$11,108.73	$11,108.73
Maintenance and repair breaker, molded case, 480 V, 2 pole	20	12.00 Ea.	$927.44	$1,163.47	2.7500	2	2	$2,326.95	$2,326.95
Maintenance and repair breaker, molded case, 480 V, 3 pole	20	12.00 Ea.	$927.44	$1,163.47	2.7500	2	2	$2,326.95	$2,326.95
Maintenance and repair breaker, enclosed, 240 V, 3 pole	25	8.00 Ea.	$618.29	$775.65	2.2000	2	2	$1,551.30	$1,551.30
Repair failed breaker, enclosed, 600 V, 2 pole	4	2.00 Ea.	$1,630.04	$1,895.74	13.7500	13	13	$24,644.61	$24,644.61
Replace receptacle/plug receptacles and plugs	20	125.00 Ea.	$10,092.90	$12,415.13	2.7500	2	2	$24,830.27	$24,830.27
Maintenance and repair wiring devices, switches	10	44.00 Ea.	$2,013.40	$2,515.71	5.5000	5	5	$12,578.57	$12,578.57
Maintenance and repair incandescent lighting fixtures	10	10.00 Ea.	$743.31	$885.15	5.5000	5	3	$4,425.75	$2,655.45
Replace incandescent lighting fixture lamp	5	10.00 Ea.	$136.33	$163.89	11.0000	11	11	$1,802.78	$1,802.78
Replace incandescent lighting fixture	20	10.00 Ea.	$1,478.87	$1,791.70	2.7500	2	2	$3,583.39	$3,583.39
Replace lamps (2 lamps), 4', 34 W energy saver	10	64.00 Ea.	$1,737.70	$2,178.95	5.5000	5	5	$10,894.77	$10,894.77
Replace fluorescent fixture, lay-in, recess mtd, 2' x 4', two 40 W	20	64.00 Ea.	$17,318.47	$21,008.07	2.7500	2	2	$42,016.14	$42,016.14
Maintenance and repair master clock control	10	1.00 Ea.	$208.09	$249.77	5.5000	5	5	$1,248.84	$1,248.84
Check operation master clock control	1	1.00 Ea.	$46.25	$58.02	55.0000	55	55	$3,191.15	$3,191.15
Replace time control clock master clock	15	1.00 Ea.	$307.56	$366.25	3.6667	3	3	$1,098.76	$1,098.76
Maintenance and repair TV cable outlet	10	22.00 Ea.	$1,225.26	$1,531.53	5.5000	5	5	$7,657.63	$7,657.63
Replace TV cable outlet	20	22.00 Ea.	$1,694.03	$2,109.62	2.7500	2	2	$4,219.23	$4,219.23
Repair smoke detector	10	20.00 Ea.	$1,215.30	$1,504.10	5.5000	5	4	$7,520.52	$6,016.42
Check operation smoke detector	1	20.00 Ea.	$349.31	$438.21	55.0000	55	55	$24,101.61	$24,101.61
Replace smoke detector	15	20.00 Ea.	$6,748.43	$8,030.15	3.6667	3	3	$24,090.44	$24,090.44
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	5.5000	5	4	$3,507.20	$2,805.76
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	3.6667	3	3	$4,977.08	$4,977.08
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.6667	3	3	$8,524.19	$8,524.19
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection annunciation panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Replace annunciation panel	15	1.00 Ea.	$1,250.41	$1,502.49	3.6667	3	3	$4,507.48	$4,507.48
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.7500	2	2	$971.29	$971.29
Maintenance and repair of general wiring lightning protection system	1	0.80 M.L.F.	$89.06	$109.89	55.0000	55	55	$6,043.81	$6,043.81
Replace lightning protection general wiring system	25	0.20 M.L.F.	$2,684.86	$3,179.13	2.2000	2	2	$6,358.26	$6,358.26
Replace lightning ground rod	25	4.00 Ea.	$1,031.13	$1,274.23	2.2000	2	2	$2,548.46	$2,548.46
Maintenance and repair computer ground system	4	1.00 Ea.	$23.25	$29.16	13.7500	13	13	$379.12	$379.12
Replace lamp emergency lighting fixture	2	6.00 Ea.	$343.89	$415.07	27.5000	27	27	$11,206.97	$11,206.97
Replace emergency lighting fixture	20	6.00 Ea.	$3,742.69	$4,418.97	2.7500	2	2	$8,837.93	$8,837.93
Maintenance and repair exit light	20	8.00 Ea.	$319.32	$395.25	2.7500	2	2	$790.50	$790.50
Replace lamp exit light	5	8.00 Ea.	$146.39	$173.53	11.0000	11	11	$1,908.79	$1,908.79
Replace lamp with exit light L.E.D. retrofit kits	15	4.00 Ea.	$412.07	$474.66	3.6667	3	3	$1,423.98	$1,423.98
Maintenance and repair voice/data outlet	10	22.00 Ea.	$1,225.26	$1,531.53	5.5000	5	5	$7,657.63	$7,657.63
Maintenance and inspection patch panel	0.5	2.00 Ea.	$185.00	$232.08	110.0000	110	110	$25,529.23	$25,529.23
Replace patch panel	15	2.00 Ea.	$1,894.36	$2,276.61	3.6667	3	3	$6,829.84	$6,829.84
			$344,701.34	$410,249.05				MR Subtotal:	$1,228,373.74
								MR Per Year:	$22,334.07
								PM Total:	$26,987.13
								Subtotal:	$49,321.20
								Total Per Unit:	$5.04

FAC 6100 General Administrative Building

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $5.04
UM: SF
Expected Service Life: 55
Model Size: 9783

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	3	0.78	$47.47	$35.20	$0.0000	82.67	97.97	115.65
Fire doors, swinging, annualized	3	1.18	$43.47	$48.22	$0.0000	91.69	110.51	131.49
Elevator, cable, electric, passenger / freight, annualized	1	47.90	$3,787.50	$4,430.40	$0.0000	8,217.90	9,925.77	11,823.02
Urinals, annualized	4	0.91	$27.36	$49.07	$0.0000	76.42	93.88	112.70
Toilet (vacuum breaker type), annualized	8	1.42	$73.47	$76.48	$0.0000	149.95	180.24	214.20
Lavatories, annualized	8	2.78	$61.75	$175.97	$0.0000	237.71	296.68	358.73
Drink fountain, annualized	2	1.24	$72.30	$66.83	$0.0000	139.13	166.41	197.31
Air handling unit, 3 thru 24 tons, annualized	2	4.12	$326.32	$221.65	$0.0000	547.97	647.10	762.54
Fan coil unit, annualized	8	26.70	$687.81	$1,434.82	$0.0000	2,122.62	2,621.85	3,155.47
Fan, centrifugal, up to 5,000 CFM, annualized	1	1.08	$35.66	$58.37	$0.0000	94.03	115.11	137.97
Package unit, air cooled, 3 thru 24 ton, annualized	2	4.79	$330.23	$307.94	$0.0000	638.17	763.58	905.49
Controls, central system, electro/pneumatic, annualized	4	7.68	$719.07	$490.68	$0.0000	1,209.75	1,428.86	1,683.93
Backflow prevention device, up to 4", annualized	2	0.67	$29.11	$42.30	$0.0000	71.41	87.02	104.07
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Circuit breaker, high voltage air, annually	28	13.16	$462.47	$934.25	$0.0000	1,396.72	1,723.24	2,072.89
Switch, interrupt, high voltage, fused air, annualized	3	1.09	$49.55	$77.69	$0.0000	127.24	155.50	186.24
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Motor control center, over 400 A, annualized	1	0.39	$25.95	$27.89	$0.0000	53.84	64.80	77.06
Fire alarm annuciator system, annualized	2	22.10	$391.22	$1,394.40	$0.0000	1,785.62	2,243.06	2,720.06
Uninterrupted power system, up to 200 KVA, annually	1	3.01	$201.60	$191.23	$0.0000	392.83	470.36	557.97
Light, emergency, hardwired system, annualized	8	2.00	$72.65	$126.29	$0.0000	198.95	244.10	292.89
						$18,518.84	$22,564.21	$26,987.13

FAC 6101 Small Unit Headquarters Building

FY25 SUC:	$5.69 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 6102 Large Unit Headquarters Building

FY25 SUC:	$5.89 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 6103 Printing And Reproduction Plant

FY25 SUC:	$5.25 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 6104 Automated Data Processing Center

FY25 SUC:	$4.20 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 6105 Pentagon

FY25 SUC:	$11.00 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 6106 Remote Delivery Facility

FY25 SUC:	$15.54 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 6107 General Administrative Building, High-Rise

FY25 SUC:	$4.51 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 6107 General Administrative Building, High-Rise

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.51
UM: SF
Expected Service Life: 55
Model Size: 466680

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	1,450.00 S.F.	$58,992.34	$71,847.99	3.6667	3	3	$215,543.98	$215,543.98
Repair concrete stairs	30	5,920.00 S.F.	$188,713.72	$218,412.87	1.8333	1	1	$218,412.87	$218,412.87
Repair metal stairs	15	660.00 S.F.	$55,041.03	$63,520.25	3.6667	3	3	$190,560.76	$190,560.76
Replace metal hand rail	30	580.00 L.F.	$35,747.64	$41,564.73	1.8333	1	1	$41,564.73	$41,564.73
Refinish metal hand rail	7	580.00 L.F.	$1,215.69	$1,500.28	7.8571	7	7	$10,501.96	$10,501.96
Refinish fire escape stair and platform	7	4.00 Flight	$2,298.93	$2,777.35	7.8571	7	7	$19,441.48	$19,441.48
Replace fire escape stair and platform	25	4.00 Flight	$26,498.81	$32,294.13	2.2000	2	2	$64,588.27	$64,588.27
Metal floor grating repairs - (2% of grating)	10	46.00 S.F.	$1,590.44	$1,915.29	5.5000	5	5	$9,576.43	$9,576.43
Replace metal floor grating	30	890.00 S.F.	$25,605.52	$29,543.75	1.8333	1	1	$29,543.75	$29,543.75
Replace precast concrete coping, 12" wide	50	896.00 L.F.	$65,608.11	$80,575.72	1.1000	1	1	$80,575.72	$80,575.72
Repair 8" concrete block wall, 1st floor	25	14,262.00 S.F.	$381,842.21	$467,124.29	2.2000	2	2	$934,248.57	$934,248.57
Waterproof concrete block wall, 1st floor	10	189.00 C.S.F.	$36,674.12	$44,193.09	5.5000	5	5	$220,965.47	$220,965.47
Replace 8" concrete block wall, 2nd floor	60	189.00 C.S.F.	$271,143.02	$327,806.30	0.9167	0	0	$0.00	$0.00
Waterproof concrete block wall, 2nd floor	10	189.00 C.S.F.	$152,391.49	$182,042.91	5.5000	5	5	$910,214.55	$910,214.55
Replace 8" concrete block wall, 3rd floor	60	189.00 C.S.F.	$271,052.63	$327,694.07	0.9167	0	0	$0.00	$0.00
Waterproof concrete block wall, 3rd floor	10	189.00 C.S.F.	$153,764.75	$183,616.89	5.5000	5	5	$918,084.46	$918,084.46
Repair clay brick wall, 1st floor	25	8,944.00 S.F.	$426,008.82	$522,665.33	2.2000	2	2	$1,045,330.66	$1,045,330.66
Refinish steel louver, 1st floor	5	26.00 Ea.	$2,872.62	$3,554.63	11.0000	11	11	$39,100.89	$39,100.89
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	680.00 Ea.	$109,818.66	$130,870.01	2.7500	2	2	$261,740.02	$261,740.02
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	680.00 Ea.	$558,799.29	$652,877.04	1.1000	1	1	$652,877.04	$652,877.04
Repair 2'-0" x 3'-0" aluminum window - 2nd floor	20	680.00 Ea.	$144,588.65	$174,120.48	2.7500	2	2	$348,240.96	$348,240.96
Replace 2'-0" x 3'-0" aluminum window - 2nd floor	50	680.00 Ea.	$593,569.27	$696,127.51	1.1000	1	1	$696,127.51	$696,127.51
Repair 2'-0" x 3'-0" aluminum window - 3rd floor	20	680.00 Ea.	$178,714.74	$216,570.01	2.7500	2	2	$433,140.03	$433,140.03
Replace 2'-0" x 3'-0" aluminum window - 3rd floor	50	680.00 Ea.	$627,695.37	$738,577.05	1.1000	1	1	$738,577.05	$738,577.05
Replace plate glass storefront - 1st floor	50	8.20 C.S.F.	$43,434.25	$50,309.00	1.1000	1	1	$50,309.00	$50,309.00
Replace plate glass storefront - 2nd floor	50	8.20 C.S.F.	$44,847.40	$52,066.81	1.1000	1	1	$52,066.81	$52,066.81
Replace plate glass storefront - 3rd floor	50	8.20 C.S.F.	$45,553.97	$52,945.72	1.1000	1	1	$52,945.72	$52,945.72
Repair aluminum storefront door	12	14.00 Ea.	$7,694.22	$9,174.69	4.5833	4	4	$36,698.75	$36,698.75
Repair steel, painted, door	14	12.00 Ea.	$9,330.71	$11,049.22	3.9286	3	3	$33,147.65	$33,147.65
Repair 12' x 12' steel roll-up door	10	4.00 Ea.	$3,608.67	$4,252.49	5.5000	5	5	$21,262.45	$21,262.45
Refinish 12' x 12' steel roll-up door	5	4.00 Ea.	$1,024.19	$1,242.57	11.0000	11	11	$13,668.31	$13,668.31
Debris removal, by hand and visual inspection, thermosetting	1	50.00 M.S.F.	$2,033.11	$2,482.98	55.0000	55	55	$136,563.95	$136,563.95
Total EPDM roof replacement	25	500.00 Sq.	$410,048.61	$482,570.67	2.2000	2	2	$965,141.34	$965,141.34
Replace Roof edges, aluminum, duranodic, .050" thick, 6" face	25	896.00 L.F.	$27,482.71	$32,458.75	2.2000	2	2	$64,917.50	$64,917.50
Replace aluminum downspout, 3" x 4", .024" thick	25	263.00 L.F.	$3,013.76	$3,592.41	2.2000	2	2	$7,184.82	$7,184.82
Replace roof hatch and structure single unit	40	2.00 Ea.	$3,797.91	$4,368.33	1.3750	1	1	$4,368.33	$4,368.33
Replace galvanized smoke hatch single unit 4' x 4'	40	1.00 Ea.	$5,947.80	$6,784.34	1.3750	1	1	$6,784.34	$6,784.34
Repair 8" concrete block wall - (2% of walls) painted	25	260.28 C.S.F.	$316,484.49	$380,145.04	2.2000	2	2	$760,290.08	$760,290.08
Refinish concrete block wall painted	4	1,260.28 C.S.F.	$172,851.20	$207,803.69	13.7500	13	13	$2,701,448.02	$2,701,448.02
Repair 4" glazed C.M.U. wall - (2% of walls)	25	51.60 C.S.F.	$113,518.18	$133,777.16	2.2000	2	2	$267,554.33	$267,554.33
Remove and reinstall demountable partitions	5	19.70 C.L.F.	$118,812.24	$141,084.06	11.0000	11	11	$1,551,924.68	$1,551,924.68
Repair plate glass interior wall - (2% of total)	25	25.60 C.S.F.	$221,156.78	$255,330.58	2.2000	2	2	$510,661.15	$510,661.15
Repair fully glazed wood door	10	8.00 Ea.	$2,374.80	$2,770.57	5.5000	5	5	$13,852.87	$13,852.87
Refinish 3'-0" x 7'-0" fully glazed wood door	4	8.00 Ea.	$645.92	$798.18	13.7500	13	13	$10,376.37	$10,376.37
Repair steel painted interior door	14	79.00 Ea.	$23,451.13	$27,359.42	3.9286	3	3	$82,078.26	$82,078.26
Refinish 3'-0" x 7'-0" steel painted interior door	4	39.00 Ea.	$2,347.93	$2,886.95	13.7500	13	13	$37,530.40	$37,530.40
Repair steel unpainted door steel	14	12.00 Ea.	$3,562.20	$4,155.86	3.9286	3	3	$12,467.58	$12,467.58
Repair aluminum interior door	12	445.00 Ea.	$132,098.13	$154,113.19	4.5833	4	4	$616,452.76	$616,452.76
Replace safety glass (3% of glass) aluminum interior door	1	420.14 S.F.	$10,788.20	$12,726.42	55.0000	55	55	$699,953.03	$699,953.03
Repair 3'-0" x 7'-0" aluminum sliding door, interior door	14	44.00 Ea.	$2,778.88	$3,342.73	3.9286	3	3	$10,028.20	$10,028.20
Replace 3'-0" x 7'-0" aluminum sliding door, interior door	50	44.00 Ea.	$174,886.97	$201,051.92	1.1000	1	1	$201,051.92	$201,051.92
Replace toilet partitions, painted metal-overhead braced, per stall	20	47.00 Ea.	$50,716.78	$58,962.78	2.7500	2	2	$117,925.56	$117,925.56
Replace urinal screen, stainless steel	30	16.00 Ea.	$14,371.07	$16,612.70	1.8333	1	1	$16,612.70	$16,612.70
Replace metal lockers, single tier	20	335.00 Ea.	$114,022.53	$132,156.15	2.7500	2	2	$264,312.31	$264,312.31
Repair concrete steps	15	11,860.00 S.F.	$365,811.47	$421,985.73	3.6667	3	3	$1,265,957.20	$1,265,957.20
Repair metal steps	15	594.00 S.F.	$63,121.86	$73,316.80	3.6667	3	3	$219,950.41	$219,950.41
Refinish metal steps	9	594.00 S.F.	$1,701.37	$2,073.48	6.1111	6	6	$12,440.87	$12,440.87
Refinish metal stair railing, interior	7	66.00 S.F.	$109.09	$134.33	7.8571	7	7	$940.31	$940.31
Refinish wood stair railing, interior	7	1,444.00 L.F.	$3,480.16	$4,294.05	7.8571	7	7	$30,058.32	$30,058.32
Repair medium weight vinyl wall covering - (2% of walls)	1	27.30 C.S.F.	$14,446.78	$16,859.64	55.0000	55	55	$927,280.04	$927,280.04
Replace medium weight vinyl wall covering	15	1,365.00 C.S.F.	$823,454.93	$968,777.49	3.6667	3	3	$2,906,332.47	$2,906,332.47
Repair acoustical tile - (2% of walls)	25	1,260.00 C.S.F.	$1,369,062.64	$1,579,893.64	2.2000	2	2	$3,159,787.29	$3,159,787.29
Refinish acoustical tile	10	1,260.00 C.S.F.	$237,076.56	$288,297.10	5.5000	5	5	$1,441,485.52	$1,441,485.52
Repair 5/8" drywall - (2% of walls)	20	90,280.00 S.F.	$168,643.59	$205,128.90	2.7500	2	2	$410,257.80	$410,257.80
Refinish drywall	4	90,280.00 S.F.	$65,187.32	$79,934.27	13.7500	13	13	$1,039,145.55	$1,039,145.55
Office painting, 10' x 15', 10' high walls	5	1,115.00 Ea.	$330,384.20	$403,613.51	11.0000	11	11	$4,439,748.60	$4,439,748.60
Repair 4" x 4" thin set ceramic tile - (2% of walls)	10	394.00 C.S.F.	$362,888.77	$436,758.00	5.5000	5	5	$2,183,789.98	$2,183,789.98
Refinish concrete floor finished	25	1,325.00 C.S.F.	$607,529.20	$729,907.90	2.2000	2	2	$1,459,815.79	$1,459,815.79
Replace epoxy flooring	15	1,161.00 C.S.F.	$1,464,502.58	$1,751,062.48	3.6667	3	3	$5,253,187.44	$5,253,187.44
Replace vinyl tile flooring	18	21,536.00 S.Y.	$1,218,038.95	$1,490,917.16	3.0556	3	3	$4,472,751.47	$4,472,751.47
Replace vinyl sheet flooring	18	3,120.00 S.Y.	$248,892.35	$301,818.00	3.0556	3	3	$905,454.01	$905,454.01
Ceramic tile floor repairs - (2% of floors)	15	252.00 C.S.F.	$175,550.35	$218,871.49	3.6667	3	3	$656,614.46	$656,614.46
Terrazzo floor repairs - (2% of floors)	15	8,475.00 S.F.	$158,299.13	$189,051.69	3.6667	3	3	$567,155.08	$567,155.08
Replace carpet	8	22,840.00 S.Y.	$1,272,154.04	$1,471,142.99	6.8750	6	6	$8,826,857.93	$8,826,857.93
Repair gypsum board ceiling - (2% of ceilings)	20	1,588.00 C.S.F.	$648,940.85	$795,700.59	2.7500	2	2	$1,591,401.19	$1,591,401.19
Refinish gypsum board ceiling, up to 12' high	20	3,208.00 C.S.F.	$488,056.26	$600,036.63	2.7500	2	2	$1,200,073.26	$1,200,073.26
Acoustic tile repairs - (2% of ceilings)	9	426.00 C.S.F.	$490,203.32	$568,150.07	6.1111	6	6	$3,408,900.42	$3,408,900.42
Refinish acoustic tile ceiling and grid (occupied area)	5	3,622.00 C.S.F.	$97,338.11	$121,091.75	11.0000	11	11	$1,332,009.20	$1,332,009.20
Replace acoustic tile ceiling, fire-rated	20	3,622.00 C.S.F.	$2,262,637.00	$2,660,850.44	2.7500	2	2	$5,321,700.87	$5,321,700.87
Replace flush valve diaphragm tankless water closet	10	108.00 Ea.	$2,979.68	$3,701.83	5.5000	5	5	$18,509.16	$18,509.16
Rebuild flush valve tankless water closet	20	108.00 Ea.	$20,873.27	$25,159.05	2.7500	2	2	$50,318.09	$50,318.09
Replace tankless water closet	35	108.00 Ea.	$148,678.90	$172,065.15	1.5714	1	1	$172,065.15	$172,065.15
Replace flush valve diaphragm for a urinal	7	62.00 Ea.	$1,710.56	$2,125.13	7.8571	7	7	$14,875.88	$14,875.88
Rebuild flush valve for a urinal	20	62.00 Ea.	$11,982.80	$14,443.16	2.7500	2	2	$28,886.31	$28,886.31
Replace washer in spud connection lavatory, vitreous china	7	62.00 Ea.	$1,078.37	$1,316.49	7.8571	7	7	$9,215.42	$9,215.42
Replace washer in faucet lavatory, vitreous china	2	62.00 Ea.	$843.05	$1,051.70	27.5000	27	27	$28,395.83	$28,395.83
Replace faucets lavatory, vitreous china	10	132.00 Ea.	$26,218.19	$31,519.42	5.5000	5	5	$157,597.10	$157,597.10
Replace lavatory, vitreous china	35	132.00 Ea.	$99,181.57	$118,916.87	1.5714	1	1	$118,916.87	$118,916.87
Replace faucets laundry sink, plastic	10	103.00 Ea.	$20,458.13	$24,594.70	5.5000	5	5	$122,973.49	$122,973.49
Clean out strainer and P trap laundry sink, plastic	2	103.00 Ea.	$3,820.10	$4,784.45	27.5000	27	27	$129,180.19	$129,180.19
Replace group wash fountain, 54" diameter	20	14.00 Ea.	$196,017.03	$224,577.00	2.7500	2	2	$449,154.01	$449,154.01
Inspect / clean shower head shower, terrazzo	3	22.00 Ea.	$1,145.29	$1,434.41	18.3333	18	18	$25,819.41	$25,819.41
Replace mixing valve shower, terrazzo	10	22.00 Ea.	$6,464.13	$7,865.42	5.5000	5	5	$39,327.08	$39,327.08
Replace terrazzo shower surface	30	22.00 Ea.	$30,844.86	$37,126.07	1.8333	1	1	$37,126.07	$37,126.07
Inspect and clean spray heads, emergency eye wash	3	2.00 Ea.	$104.12	$130.40	18.3333	18	18	$2,347.22	$2,347.22
Replace eye wash station, emergency eye wash	25	2.00 Ea.	$1,580.90	$1,923.10	2.2000	2	2	$3,846.19	$3,846.19
Inspect for leaks steam converter, domestic hot water	1	16.00 Ea.	$114.36	$143.23	55.0000	55	55	$7,877.67	$7,877.67
Inspect/check pump/motor operation, lubricate circulation pump, bronze 1 HP	0.5	6.00 Ea.	$50.80	$63.63	110.0000	110	110	$6,998.88	$6,998.88
Replace pump / motor assembly circulation pump, bronze 1 HP	20	6.00 Ea.	$32,773.01	$37,621.93	2.7500	2	2	$75,243.86	$75,243.86
Replace water softener	15	4.00 Ea.	$4,834.17	$5,775.08	3.6667	3	3	$17,325.25	$17,325.25
Unclog main drain pipe & fittings, cast iron	10	152.00 Ea.	$7,421.82	$9,295.40	5.5000	5	5	$46,477.01	$46,477.01
Repair joint pipe and fittings, PVC	10	88.00 Ea.	$13,834.05	$17,240.19	5.5000	5	5	$86,200.93	$86,200.93
Unclog 4" - 12" diameter main drain per L.F.	10	305.00 L.F.	$1,219.91	$1,527.87	5.5000	5	5	$7,639.37	$7,639.37
Clean floor drain w/o bucket	4	51.00 Ea.	$6,305.01	$7,896.67	13.7500	13	13	$102,656.67	$102,656.67
General maintenance & repair distribution: gutters, pipe	1	2.20 M.L.F.	$701.09	$878.08	55.0000	55	55	$48,294.39	$48,294.39
General maintenance & repair drain: roof, scupper, area	1	16.00 Ea.	$627.49	$785.89	55.0000	55	55	$43,224.14	$43,224.14
Insp/chk pump/mtr oper, lub, chk align, rainwater sump pump	1	4.00 Ea.	$50.41	$63.13	55.0000	55	55	$3,472.24	$3,472.24
General maintenance pipe & fittings, compressed air	2	4.20 M.L.F.	$163.62	$204.93	27.5000	27	27	$5,533.13	$5,533.13
Check and adjust 10 H.P. compressor	1	3.00 Ea.	$267.60	$335.15	55.0000	55	55	$18,433.23	$18,433.23
Replace 10 H.P. compressor	25	3.00 Ea.	$47,740.98	$55,526.39	2.2000	2	2	$111,052.78	$111,052.78
Replace 275 gallon fuel oil storage tank	30	9.00 Ea.	$17,989.23	$20,902.49	1.8333	1	1	$20,902.49	$20,902.49
Install 10' sect. 3/8" type L copper per M.L.F. fuel oil storage	20	14.50 Ea.	$2,552.18	$3,142.74	2.7500	2	2	$6,285.47	$6,285.47
Install new 2" gasket, 1 per M.L.F. natural gas, steel/iron	30	22.00 Ea.	$3,030.81	$3,765.87	1.8333	1	1	$3,765.87	$3,765.87
Replace 10' of hung 2" diam steel pipe/M.L.F. natural gas	12	14.00 Ea.	$10,056.73	$12,228.72	4.5833	4	4	$48,914.87	$48,914.87
Repair boiler, gas/oil, 20,000 MBH	7	3.00 Ea.	$57,900.12	$66,917.78	7.8571	7	6	$468,424.47	$401,506.69
Replace boiler, gas/oil, 20,000 MBH	30	3.00 Ea.	$2,089,604.39	$2,496,361.89	1.8333	1	1	$2,496,361.89	$2,496,361.89
Repair feed water supply pump	15	3.00 Ea.	$17,862.18	$20,556.25	3.6667	3	3	$61,668.74	$61,668.74
Replace feed water pump	15	3.00 Ea.	$89,783.20	$102,867.51	3.6667	3	3	$308,602.52	$308,602.52
Repair deaerator	10	3.00 Ea.	$235.31	$294.71	5.5000	5	5	$1,473.55	$1,473.55
Replace metal flue, all fuel SS, 10" diameter metal flue / chimney	15	24.00 L.F.	$6,621.88	$7,613.73	3.6667	3	3	$22,841.18	$22,841.18
Repair cooling tower, 1000 ton	10	2.00 Ea.	$51,381.13	$59,751.63	5.5000	5	4	$298,758.14	$239,006.51
Replace cooling tower, 1000 ton	15	2.00 Ea.	$232,812.76	$269,878.13	3.6667	3	3	$809,634.38	$809,634.38
Repair open centrifugal chiller, 1000 ton	10	2.00 Ea.	$353,524.64	$412,095.97	5.5000	5	3	$2,060,479.86	$1,236,287.91
Replace open centrifugal chiller, 1000 ton	20	2.00 Ea.	$1,182,901.82	$1,355,132.38	2.7500	2	2	$2,710,264.77	$2,710,264.77
Replace fan coil, DX 1-1/2 ton, with heat	15	54.00 Ea.	$100,576.81	$118,186.03	3.6667	3	3	$354,558.10	$354,558.10
Repair unit ventilator, 750 CFM, 2 ton	10	14.00 Ea.	$7,199.91	$8,666.43	5.5000	5	5	$43,332.16	$43,332.16
Maintenance and inspection duct heater	0.5	18.00 Ea.	$1,525.91	$1,914.25	110.0000	110	110	$210,567.61	$210,567.61
Replace duct heater	15	18.00 Ea.	$48,046.83	$55,018.55	3.6667	3	3	$165,055.66	$165,055.66
Repair fan, induced draft, 6700 CFM	10	11.00 Ea.	$3,522.30	$4,303.08	5.5000	5	5	$21,515.38	$21,515.38
Replace fan, induced draft, 6700 CFM	20	11.00 Ea.	$73,184.32	$84,318.71	2.7500	2	2	$168,637.41	$168,637.41
Repair steam converter, commercial	5	12.00 Ea.	$5,610.00	$7,026.20	11.0000	11	11	$77,288.19	$77,288.19

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Inspect for leaks steam converter, commercial	2	12.00 Ea.	$87.02	$108.98	27.5000	27	27	$2,942.57	$2,942.57
Replace steam converter, commercial	30	12.00 Ea.	$58,483.51	$67,072.12	1.8333	1	1	$67,072.12	$67,072.12
Repair flash tank 24 gallon	5	3.00 Ea.	$1,402.50	$1,756.55	11.0000	11	11	$19,322.05	$19,322.05
Replace steam trap, 15 PSIG, 3/4" threaded	7	15.00 Ea.	$5,659.11	$6,563.77	7.8571	7	7	$45,946.36	$45,946.36
Replace steam trap, 15 PSIG, 1" threaded	7	18.00 Ea.	$5,220.80	$6,103.13	7.8571	7	7	$42,721.89	$42,721.89
Replace steam trap, 15 PSIG, 2" threaded	7	24.00 Ea.	$30,047.38	$34,713.46	7.8571	7	7	$242,994.25	$242,994.25
Repair circulator pump, 1/12 - 3/4 H.P.	5	6.00 Ea.	$628.95	$741.88	11.0000	11	11	$8,160.68	$8,160.68
Repair circulator pump, 1 H.P.	5	6.00 Ea.	$630.32	$743.60	11.0000	11	11	$8,179.57	$8,179.57
Refill expansion tank	5	3.00 Ea.	$47.06	$58.94	11.0000	11	11	$648.36	$648.36
Repair damaged pipe insulation, fiberglass 2"	5	158.00 Ea.	$4,344.55	$5,284.34	11.0000	11	11	$58,127.73	$58,127.73
Repair single zone rooftop unit, 7.5 ton	10	4.00 Ea.	$15,458.02	$18,316.62	5.5000	5	5	$91,583.12	$91,583.12
Replace single zone rooftop unit, 7.5 ton	15	4.00 Ea.	$48,225.58	$57,068.96	3.6667	3	3	$171,206.87	$171,206.87
Repair central station A.H.U., 16,000 CFM	10	9.00 Ea.	$19,180.37	$22,169.77	5.5000	5	4	$110,848.86	$88,679.09
Replace central station A.H.U., 16,000 CFM	15	9.00 Ea.	$676,191.38	$777,841.76	3.6667	3	3	$2,333,525.29	$2,333,525.29
Inspect sprinkler system	1	4.00 Ea.	$145.03	$181.64	55.0000	55	55	$9,990.21	$9,990.21
Replace sprinkler head	20	3,192.00 Ea.	$292,676.55	$360,687.19	2.7500	2	2	$721,374.39	$721,374.39
Rebuild double check 6" backflow preventer sprinkler system	1	2.00 Ea.	$1,850.14	$2,219.89	55.0000	55	55	$122,094.12	$122,094.12
Replace fire pump / electric motor assembly 100 H.P.	25	4.00 Ea.	$184,200.30	$212,609.54	2.2000	2	2	$425,219.07	$425,219.07
Repair 500 kva transformer, primary, liquid filled	10	4.00 Ea.	$12,248.43	$14,081.72	5.5000	5	5	$70,408.59	$70,408.59
Maintenance and inspection primary transformer, liquid filled	0.5	4.00 Ea.	$175.26	$219.87	110.0000	110	110	$24,185.59	$24,185.59
Repair switchgear 1200 A mainframe	5	6.00 Ea.	$12,412.07	$14,520.45	11.0000	11	11	$159,724.97	$159,724.97
Maintenance and inspection switchgear, mainframe	1	6.00 Ea.	$419.90	$526.77	55.0000	55	55	$28,972.32	$28,972.32
Repair switchgear, - (5% of total C.B.), indoor, less than 600 V	10	6.00 Ea.	$5,351.84	$6,176.96	5.5000	5	5	$30,884.82	$30,884.82
Maintenance and repair motor starter, up to 600 V	5	8.00 Ea.	$2,796.41	$3,351.44	11.0000	11	11	$36,865.80	$36,865.80
Replace starter motor starter, up to 600 V	18	8.00 Ea.	$6,551.65	$7,819.61	3.0556	3	3	$23,458.82	$23,458.82
Maintenance and repair motor starter, 600 V	3	8.00 Ea.	$5,957.85	$7,324.72	18.3333	18	18	$131,845.01	$131,845.01
Maintenance and inspection motor starter, 600 V	0.25	8.00 Ea.	$467.37	$586.32	220.0000	220	220	$128,989.81	$128,989.81
Maintenance and repair secondary transformer, dry	10	18.00 Ea.	$5,319.17	$6,322.74	5.5000	5	5	$31,613.70	$31,613.70
Replace transformer 15 KVA	30	18.00 Ea.	$67,449.20	$80,179.65	1.8333	1	1	$80,179.65	$80,179.65
Maintenance and inspection lighting panel, indoor	3	27.00 Ea.	$1,183.03	$1,484.12	18.3333	18	18	$26,714.08	$26,714.08
Replace wireway, 8" x 8"	20	2,785.00 L.F.	$229,351.28	$276,343.91	2.7500	2	2	$552,687.81	$552,687.81
Maintenance and repair breaker, molded case, 480 V, 2 pole	20	10.00 Ea.	$772.87	$969.56	2.7500	2	2	$1,939.12	$1,939.12
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	32.00 Ea.	$1,402.11	$1,758.95	6.8750	6	6	$10,553.71	$10,553.71
Maintenance and inspection safety switch, 3 pole, heavy duty	1	32.00 Ea.	$1,402.11	$1,758.95	55.0000	55	55	$96,742.36	$96,742.36
Replace receptacle/plug receptacles and plugs	20	3,439.00 Ea.	$277,675.74	$341,565.14	2.7500	2	2	$683,130.27	$683,130.27
Replace 4-pin receptacle	20	52.00 Ea.	$8,316.89	$9,887.29	2.7500	2	2	$19,774.59	$19,774.59
Maintenance and repair contactors and relays	3	116.00 Ea.	$31,736.23	$39,166.23	18.3333	18	18	$704,992.21	$704,992.21
Maintenance and inspection contactors and relays	0.5	116.00 Ea.	$2,534.27	$3,179.24	110.0000	110	110	$349,716.90	$349,716.90
Replace wiring devices, switches	15	1,520.00 Ea.	$105,692.63	$131,607.81	3.6667	3	3	$394,823.44	$394,823.44
Maintenance and repair incandescent lighting fixtures	10	1,183.00 Ea.	$87,934.05	$104,713.34	5.5000	5	5	$523,566.72	$523,566.72
Replace incandescent lighting fixture lamp, 200 W	5	1,183.00 Ea.	$15,492.51	$18,668.24	11.0000	11	11	$205,350.67	$205,350.67
Replace fluorescent light fixture ballast, 80 W	10	2,257.00 Ea.	$245,859.50	$303,176.76	5.5000	5	5	$1,515,883.78	$1,515,883.78
Replace lamps (2 lamps), 4', 34 W energy saver	10	2,257.00 Ea.	$61,281.21	$76,842.20	5.5000	5	5	$384,211.02	$384,211.02
Replace metal halide ballast, 175 W	10	146.00 Ea.	$25,047.98	$30,002.59	5.5000	5	5	$150,012.95	$150,012.95
Replace metal halide fixture lamp, 175 W	5	146.00 Ea.	$8,882.51	$10,792.82	11.0000	11	11	$118,721.07	$118,721.07
Maintenance and repair master clock control	10	1.00 Ea.	$208.09	$249.77	5.5000	5	5	$1,248.84	$1,248.84
Check operation master clock control	1	1.00 Ea.	$46.25	$58.02	55.0000	55	55	$3,191.15	$3,191.15
Replace master clock program bell	15	1.00 Ea.	$265.11	$318.44	3.6667	3	3	$955.31	$955.31
Maintenance and repair TV cable outlet	10	568.00 Ea.	$31,633.99	$39,541.22	5.5000	5	5	$197,706.08	$197,706.08
Repair smoke detector	10	450.00 Ea.	$27,344.26	$33,842.34	5.5000	5	5	$169,211.70	$169,211.70
Check operation smoke detector	1	450.00 Ea.	$7,859.50	$9,859.75	55.0000	55	55	$542,286.26	$542,286.26
Repair heat detector	10	450.00 Ea.	$29,814.31	$36,649.22	5.5000	5	5	$183,246.08	$183,246.08
Check operation heat detector	1	450.00 Ea.	$7,859.50	$9,859.75	55.0000	55	55	$542,286.26	$542,286.26
Check and repair manual pull station	10	43.00 Ea.	$4,084.51	$5,026.99	5.5000	5	5	$25,134.94	$25,134.94
Minor repairs to fire alarm control panel	5	4.00 Ea.	$641.11	$781.70	11.0000	11	11	$8,598.71	$8,598.71
Maintenance and inspection fire alarm control panel	0.5	4.00 Ea.	$185.00	$232.08	110.0000	110	110	$25,529.23	$25,529.23
Minor repairs to annunciation panel	5	28.00 Ea.	$4,487.74	$5,471.91	11.0000	11	11	$60,190.96	$60,190.96
Maintenance and inspection annunciation panel	0.5	28.00 Ea.	$1,295.01	$1,624.59	110.0000	110	110	$178,704.63	$178,704.63
Maintenance and repair electrical service ground	25	24.90 M.L.F.	$2,376.95	$2,971.39	2.2000	2	2	$5,942.78	$5,942.78
Maintenance and repair building structure ground	7	24.90 M.L.F.	$2,376.95	$2,971.39	7.8571	7	7	$20,799.73	$20,799.73
Maintenance and repair of general wiring lightning protection system	1	24.90 M.L.F.	$2,771.94	$3,420.25	55.0000	55	55	$188,113.54	$188,113.54
Maintenance and repair lightning ground rod	1	24.00 Ea.	$2,291.04	$2,863.99	55.0000	55	55	$157,519.44	$157,519.44
Maintenance and inspection generator, diesel, 750 KW	0.08	4.00 Ea.	$279.94	$351.18	687.5000	687	687	$241,260.41	$241,260.41
Replace diesel generator component, 750 KW	25	4.00 Ea.	$1,068,358.99	$1,223,016.56	2.2000	2	2	$2,446,033.13	$2,446,033.13
Maintenance and repair transfer switch	5	4.00 Ea.	$1,549.03	$1,870.12	11.0000	11	11	$20,571.29	$20,571.29
Maintenance and inspection transfer switch	0.5	4.00 Ea.	$175.26	$219.87	110.0000	110	110	$24,185.59	$24,185.59
Replace lamp emergency lighting fixture	2	65.00 Ea.	$3,725.51	$4,496.62	27.5000	27	27	$121,408.85	$121,408.85
Replace emergency lighting fixture	20	65.00 Ea.	$40,545.82	$47,872.14	2.7500	2	2	$95,744.28	$95,744.28
Maintenance and repair exit light	20	120.00 Ea.	$4,789.84	$5,928.72	2.7500	2	2	$11,857.43	$11,857.43
Replace lighting fixture with exit light L.E.D. w/battery unit	20	120.00 Ea.	$77,935.33	$91,466.96	2.7500	2	2	$182,933.92	$182,933.92
Maintenance and inspection battery, dry	0.08	22.00 Ea.	$963.95	$1,209.28	687.5000	687	687	$830,774.99	$830,774.99
Replace battery, dry	5	22.00 Ea.	$4,835.38	$5,583.79	11.0000	11	11	$61,421.74	$61,421.74
Maintenance and inspection UPS battery	0.17	4.00 Ea.	$279.94	$351.18	323.5294	323	323	$113,431.02	$113,431.02
Replace motor generator UPS battery	15	4.00 Ea.	$4,782.33	$5,654.46	3.6667	3	3	$16,963.37	$16,963.37
Maintenance and repair voice/data outlet	10	312.00 Ea.	$17,376.42	$21,719.82	5.5000	5	5	$108,599.11	$108,599.11
Replace voice/data outlet	20	312.00 Ea.	$8,834.92	$10,759.70	2.7500	2	2	$21,519.41	$21,519.41
Maintenance and inspection patch panel	0.5	36.00 Ea.	$3,330.02	$4,177.51	110.0000	110	110	$459,526.19	$459,526.19
Replace patch panel	15	36.00 Ea.	$34,098.47	$40,979.04	3.6667	3	3	$122,937.11	$122,937.11
Remove and replace waste compactor hydraulic cylinder	15	2.00 Ea.	$11,328.58	$12,915.19	3.6667	3	3	$38,745.57	$38,745.57
Prepare & paint 100K gal. ground level water stor tank, 30' dia x 19' tall	10	1.00 Ea.	$32,280.89	$38,733.94	5.5000	5	5	$193,669.70	$193,669.70
			$28,445,655.74	$33,701,188.87				MR Subtotal:	$100,197,072.47
								MR Per Year:	$1,821,764.95
								PM Total:	$282,306.99
								Subtotal:	$2,104,071.94
								Total Per Unit:	$4.51

FAC 6107 General Administrative Building, High-Rise

Release:	2024 Qtr 3	FY25 SUC:	$4.51
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	55
		Model Size:	466680

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, sliding, electric, annualized	8	19.58	$241.92	$882.08	$0.0000	1,124.00	1,412.82	1,713.73
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	4	16.28	$330.48	$736.06	$0.0000	1,066.54	1,320.41	1,590.80
Fire doors, swinging, annualized	14	5.49	$202.84	$225.05	$0.0000	427.89	515.69	613.63
Elevator, cable, electric, passenger / freight, annualized	4	191.58	$15,150.00	$17,721.60	$0.0000	32,871.60	39,703.08	47,292.06
Elevator, hydraulic, passenger / freight, annualized	2	20.45	$2,626.00	$1,892.15	$0.0000	4,518.15	5,348.40	6,309.94
Wheelchair lift, annualized	1	1.21	$28.28	$111.68	$0.0000	139.96	176.30	214.04
Urinals, annualized	62	14.14	$424.02	$760.55	$0.0000	1,184.57	1,455.14	1,746.91
Toilet (vacuum breaker type), annualized	108	19.12	$991.85	$1,032.46	$0.0000	2,024.31	2,433.23	2,891.75
Lavatories, annualized	132	45.94	$1,018.82	$2,903.47	$0.0000	3,922.29	4,895.21	5,919.07
Showers, annualized	22	5.02	$308.44	$317.33	$0.0000	625.77	751.82	893.28
Valve, butterfly, above 4", annualized	6	1.00	$41.33	$53.55	$0.0000	94.88	115.08	137.34
Valve, diaphragm, above 4", annualized	54	6.59	$371.94	$354.05	$0.0000	725.99	869.40	1,031.41
Water heater, gas, to 120 gal., annualized	18	30.98	$1,591.53	$1,659.85	$0.0000	3,251.38	3,908.49	4,645.18
Valve, pressure relief, above 4", annualized	3	0.44	$18.32	$23.86	$0.0000	42.18	51.16	61.07
Valve, sediment strainer, above 4", annually	3	0.94	$18.32	$50.51	$0.0000	68.82	85.81	103.71
Submersible, 1 H.P. and over, annually	4	7.70	$85.98	$412.85	$0.0000	498.82	631.28	768.03
Boiler, steam, oil, gas, or comb. fired, over 1000 MBH, annualized	3	67.35	$310.69	$4,314.60	$0.0000	4,625.29	5,950.73	7,291.72
Deaerator tank, annualized	3	4.52	$76.21	$289.33	$0.0000	365.54	459.96	558.19
Pump, boiler fuel oil, annualized	3	3.70	$319.48	$237.30	$0.0000	556.78	659.92	779.03
Pump, condensate return unit, 2 pumps, annualized	6	6.85	$460.17	$436.54	$0.0000	896.70	1,073.68	1,273.67
Water cooling tower, 500 thru 1000 tons, annualized	2	35.46	$439.65	$2,241.90	$0.0000	2,681.55	3,398.08	4,136.60
Chiller, centrif., water cooled, over 100 tons, annualized	2	66.73	$228.62	$4,272.30	$0.0000	4,500.92	5,805.47	7,121.45
Compressor, DX Refrigeration, to 25 tons, annualized	4	9.76	$209.08	$622.66	$0.0000	831.73	1,039.44	1,257.60
Compressor, DX refrigeration, 25 to 100 tons, annualized	4	13.02	$209.08	$832.46	$0.0000	1,041.54	1,312.19	1,593.29
Air handling unit, over 50 tons, annualized	9	29.48	$2,277.39	$1,583.71	$0.0000	3,861.10	4,563.95	5,380.67
Air handling unit, computer room, annualized	2	6.83	$195.40	$367.16	$0.0000	562.56	692.25	831.71
Fan coil unit, annually	54	78.89	$1,820.15	$4,248.61	$0.0000	6,068.76	7,525.36	9,072.97
Air filter, electrostatic, annualized	12	91.22	$137.76	$4,923.72	$0.0000	5,061.48	6,552.37	8,050.15
VAV Boxes, annually	202	94.33	$963.09	$6,066.67	$0.0000	7,029.75	8,946.06	10,910.52
Fire dampers, annualized	18	20.83	$151.24	$1,332.45	$0.0000	1,483.69	1,898.55	2,320.97
Fan, axial, 5,000 to 10,000 CFM, annualized	30	38.70	$1,069.82	$2,081.16	$0.0000	3,150.98	3,882.30	4,667.12
Centrifugal, over 1 HP, annualized	16	19.14	$220.41	$1,028.74	$0.0000	1,249.15	1,579.81	1,921.49
Heat exchanger, steam, annualized	18	16.63	$448.44	$890.84	$0.0000	1,339.28	1,651.38	1,985.89
Package unit, air cooled, 25 thru 50 ton, annualized	4	13.00	$660.45	$832.46	$0.0000	1,492.92	1,808.70	2,157.51
Controls, central system, electro/pneumatic, annualized	9	17.29	$1,617.91	$1,104.03	$0.0000	2,721.94	3,214.94	3,788.84
Air compressor, reciprocating, 5 to 40 H.P., annualized	2	9.71	$220.80	$617.58	$0.0000	838.38	1,045.74	1,264.13
Steam humidification system, annualized	2	5.08	$56.67	$324.86	$0.0000	381.53	484.66	590.61
Dehumidifier, desiccant wheel, annually	2	1.87	$136.78	$100.67	$0.0000	237.45	281.33	332.05
Backflow prevention device, over 4", annualized	7	3.45	$101.90	$219.11	$0.0000	321.02	396.94	477.96
Extinguishing system, wet pipe, annualized	5	56.71	$273.56	$3,574.35	$0.0000	3,847.91	4,947.57	6,060.91
Fire pump, electric motor driven, annualized	2	95.50	$123.10	$6,006.60	$0.0000	6,129.70	7,943.99	9,764.44
Extinguishing system, dry chemical, annualized	2	11.21	$8.36	$600.66	$0.0000	609.02	790.06	971.51
Switchboard, with air circuit breaker, annualized	6	79.91	$114.67	$5,707.08	$0.0000	5,821.75	7,545.34	9,274.67
Circuit breaker, high voltage air, annually	22	10.34	$363.37	$734.05	$0.0000	1,097.42	1,353.98	1,628.70
Switch, selector, high voltage, air, annualized	6	2.45	$99.10	$176.29	$0.0000	275.39	338.19	405.94
Transformer, dry type 500 KVA and over, annualized	18	13.84	$297.30	$986.04	$0.0000	1,283.34	1,608.89	1,949.29
Panelboard, 225 A and above, annualized	32	14.11	$830.34	$1,003.97	$0.0000	1,834.30	2,218.53	2,644.27
Motor control center, over 400 A, annualized	16	6.22	$415.17	$446.21	$0.0000	861.38	1,036.76	1,232.89
Central clock systems, annualized	1	1.32	$13.22	$83.66	$0.0000	96.89	123.31	150.39
Fire alarm annuciator system, annualized	18	198.92	$3,520.94	$12,549.60	$0.0000	16,070.54	20,187.52	24,480.54
Emergency diesel or gas generator, over 15 KVA, annualized	4	64.60	$355.29	$4,083.60	$0.0000	4,438.89	5,699.50	6,977.87
Power stablizer, annualized	4	2.50	$43.91	$157.37	$0.0000	201.28	252.88	306.68
Uninterrupted power system, up to 200 KVA, annualized	4	91.70	$1,013.97	$5,776.80	$0.0000	6,790.77	8,625.20	10,510.34
Uninterrupted power system, 200 KVA to 800 KVA, annualized	4	312.23	$1,057.88	$19,720.80	$0.0000	20,778.68	26,800.71	32,875.63
Battery system and charger, annualized	4	34.93	$87.82	$2,211.12	$0.0000	2,298.94	2,971.06	3,647.57
Light, emergency, hardwired system, annualized	65	16.25	$590.32	$1,026.13	$0.0000	1,616.45	1,983.32	2,379.70
Light, emergency, wet cell, annualized	65	25.35	$2,432.62	$1,618.50	$0.0000	4,051.12	4,779.94	5,630.38
Hoist / winch, chain / cable, electric, annualized	2	3.30	$452.48	$128.19	$0.0000	580.67	664.37	770.70
Dishwasher, electric, annualized	2	9.42	$337.34	$359.40	$0.0000	696.74	838.29	996.71
Oven, convection, gas / electric, annualized	2	22.48	$105.04	$856.57	$0.0000	961.61	1,229.08	1,501.81
Refrigerator freezer, walk-in box w/external condenser, annually	2	1.47	$430.26	$55.71	$0.0000	485.97	545.71	626.96
Water flow meter, turbine, annualized	2	1.18	$39.73	$64.05	$0.0000	103.78	126.97	152.14
Pump, centrifugal ejector, annualized	3	3.59	$57.95	$194.71	$0.0000	252.66	316.87	383.98
Water softner, annualized	4	21.74	$115.08	$1,178.52	$0.0000	1,293.60	1,658.66	2,029.48
Fuel oil storage tank, above ground, annualized	4	13.10	$96.45	$710.53	$0.0000	806.98	1,029.78	1,257.40
						$187,172.97	$233,513.61	$282,306.99

FAC 6200 Administrative Building, Underground

FY25 SUC:	$4.55 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 6201 Alternate Joint Communications Center

FY25 SUC:	$13.92 / SF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Classified model originally calculated using R.S. Means Cost Works; developed in FY 11

FAC 6900 Administrative Structure, Other Than Buildings

FY25 SUC:	$258.97 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7110 Family Housing Dwelling

FY25 SUC:	$2.95 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7113 Family Housing High Rise Building

FY25 SUC:	$5.05 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7130 Family Housing Individual Trailer Site

FY25 SUC:	$2.97 / SY
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7141 Family Housing Garage

FY25 SUC:	$1.71 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7142 Family Housing Storage Facility

FY25 SUC:	$0.82 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7143 Miscellaneous Family Housing Support Facility

FY25 SUC:	$1.73 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7145 Trailer Court Support Facility

FY25 SUC:	$1.98 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7147 Family Housing Carport

FY25 SUC:	$0.77 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7210 Enlisted Unaccompanied Personnel Housing

FY25 SUC:	$6.14 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7210 Enlisted Unaccompanied Personnel Housing

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $6.14
UM: SF
Expected Service Life: 55
Model Size: 29967

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair concrete stairs	30	340.00 S.F.	$10,838.29	$12,543.98	1.8333	1	1	$12,543.98	$12,543.98
Replace concrete stairs	75	340.00 S.F.	$29,561.05	$36,357.46	0.7333	0	0	$0.00	$0.00
Replace metal hand rail	30	60.00 L.F.	$3,698.03	$4,299.80	1.8333	1	1	$4,299.80	$4,299.80
Refinish metal hand rail	7	60.00 L.F.	$125.76	$155.20	7.8571	7	7	$1,086.41	$1,086.41
Repair clay brick wall, 1st floor	25	476.00 S.F.	$22,672.20	$27,816.27	2.2000	2	2	$55,632.54	$55,632.54
Waterproof clay brick wall, 1st floor	10	47.60 C.S.F.	$9,236.44	$11,130.11	5.5000	5	5	$55,650.56	$55,650.56
Waterproof clay brick wall, 2nd floor	10	47.60 C.S.F.	$38,380.08	$45,847.84	5.5000	5	5	$229,239.22	$229,239.22
Waterproof clay brick wall, 3rd floor	10	47.60 C.S.F.	$38,725.94	$46,244.25	5.5000	5	5	$231,221.27	$231,221.27
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	24.00 S.F.	$327.63	$384.70	55.0000	55	55	$21,158.51	$21,158.51
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	40.00 Ea.	$6,459.92	$7,698.24	2.7500	2	2	$15,396.47	$15,396.47
Replace 2'-0" x 3'-0" aluminum window - 2nd floor	50	40.00 Ea.	$34,915.84	$40,948.68	1.1000	1	1	$40,948.68	$40,948.68
Repair 2'-0" x 3'-0" aluminum window - 3rd floor	20	40.00 Ea.	$10,512.63	$12,739.41	2.7500	2	2	$25,478.83	$25,478.83
Replace 2'-0" x 3'-0" aluminum window - 3rd floor	50	40.00 Ea.	$36,923.26	$43,445.71	1.1000	1	1	$43,445.71	$43,445.71
Repair aluminum storefront door	12	2.00 Ea.	$1,099.17	$1,310.67	4.5833	4	4	$5,242.68	$5,242.68
Replace 3'-0" x 7'-0" aluminum storefront doors	50	2.00 Ea.	$5,728.92	$6,718.40	1.1000	1	1	$6,718.40	$6,718.40
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	3.9286	3	3	$11,049.22	$11,049.22
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.00 Ea.	$191.97	$235.01	13.7500	13	13	$3,055.13	$3,055.13
Replace 3'-0" x 7'-0" steel, painted, door	45	4.00 Ea.	$2,943.44	$3,426.28	1.2222	1	1	$3,426.28	$3,426.28
Debris removal, by hand and visual inspection, metal panel roofing	1	10.10 M.S.F.	$248.21	$303.13	55.0000	55	55	$16,672.41	$16,672.41
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	202.00 S.F.	$979.35	$1,162.22	11.0000	11	11	$12,784.45	$12,784.45
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	200.00 S.F.	$5,651.73	$6,725.66	55.0000	55	55	$369,911.48	$369,911.48
Minor metal roof panel replacement, 2.5% of roof area	20	252.00 S.F.	$3,485.35	$4,122.74	2.7500	2	2	$8,245.48	$8,245.48
Total metal roof panel replacement	30	10.10 Sq.	$9,708.27	$11,480.30	1.8333	1	1	$11,480.30	$11,480.30
Repair 8" concrete block wall - (2% of walls) painted	25	28.80 C.S.F.	$35,019.03	$42,063.08	2.2000	2	2	$84,126.15	$84,126.15
Refinish concrete block wall painted	4	62.00 C.S.F.	$8,503.49	$10,222.99	13.7500	13	13	$132,898.86	$132,898.86
Repair steel painted interior door	14	4.00 Ea.	$1,187.40	$1,385.29	3.9286	3	3	$4,155.86	$4,155.86
Refinish 3'-0" x 7'-0" steel painted interior door	4	4.00 Ea.	$240.81	$296.10	13.7500	13	13	$3,849.27	$3,849.27
Replace 3'-0" x 7'-0" hollow core wood door, interior	30	60.00 Ea.	$20,623.09	$24,284.32	1.8333	1	1	$24,284.32	$24,284.32
Repair solid core wood door, interior	11	60.00 Ea.	$17,810.98	$20,779.31	5.0000	5	5	$103,896.53	$103,896.53
Replace 3'-0" x 7'-0" solid core wood door, interior	40	60.00 Ea.	$38,626.65	$44,538.04	1.3750	1	1	$44,538.04	$44,538.04
Replace brass lockset interior	30	60.00 Ea.	$17,598.83	$20,494.35	1.8333	1	1	$20,494.35	$20,494.35
Repair concrete steps	15	720.00 S.F.	$22,207.78	$25,618.02	3.6667	3	3	$76,854.06	$76,854.06
Replace rubber steps	18	24.00 L.F.	$1,137.24	$1,317.84	3.0556	3	3	$3,953.51	$3,953.51
Repair 5/8" drywall - (2% of walls)	20	640.00 S.F.	$1,195.52	$1,454.17	2.7500	2	2	$2,908.34	$2,908.34
Office painting, 10' x 12', 10' high walls	5	60.00 Ea.	$15,640.64	$19,107.31	11.0000	11	11	$210,180.41	$210,180.41
Replace vinyl tile flooring	18	2,010.00 S.Y.	$113,682.13	$139,150.42	3.0556	3	3	$417,451.27	$417,451.27
Replace 2" x 2" thin set ceramic tile floor	50	11.75 C.S.F.	$19,201.13	$22,935.49	1.1000	1	1	$22,935.49	$22,935.49
Replace ceramic trim	50	893.00 L.F.	$15,271.43	$18,402.53	1.1000	1	1	$18,402.53	$18,402.53
Acoustic tile repairs - (2% of ceilings)	9	5.10 C.S.F.	$5,868.63	$6,801.80	6.1111	6	6	$40,810.78	$40,810.78
Replace acoustic tile ceiling, fire-rated	20	160.00 C.S.F.	$99,950.83	$117,541.71	2.7500	2	2	$235,083.42	$235,083.42
Replace flush valve diaphragm tankless water closet	10	60.00 Ea.	$1,655.38	$2,056.57	5.5000	5	5	$10,282.87	$10,282.87
Unplug clogged line tankless water closet	5	60.00 Ea.	$13,786.87	$17,267.27	11.0000	11	11	$189,940.02	$189,940.02
Replace tankless water closet	35	60.00 Ea.	$82,599.39	$95,591.75	1.5714	1	1	$95,591.75	$95,591.75
Replace washer in spud connection lavatory, vitreous china	7	60.00 Ea.	$1,043.58	$1,274.02	7.8571	7	7	$8,918.15	$8,918.15
Replace washer in faucet lavatory, vitreous china	2	60.00 Ea.	$815.86	$1,017.77	27.5000	27	27	$27,479.83	$27,479.83
Replace faucets lavatory, vitreous china	10	60.00 Ea.	$11,917.36	$14,327.01	5.5000	5	5	$71,635.04	$71,635.04
Replace lavatory, vitreous china	35	60.00 Ea.	$45,082.53	$54,053.12	1.5714	1	1	$54,053.12	$54,053.12
Replace faucet washer sink, service/utility	2	2.00 Ea.	$27.01	$33.69	27.5000	27	27	$909.67	$909.67
Replace faucets sink, service/utility	10	2.00 Ea.	$397.25	$477.57	5.5000	5	5	$2,387.83	$2,387.83
Replace sink, P.E.C.I. service/utility	35	2.00 Ea.	$3,318.04	$3,881.20	1.5714	1	1	$3,881.20	$3,881.20
Inspect / clean shower head bathtub, fiberglass	3	60.00 Ea.	$3,123.52	$3,912.03	18.3333	18	18	$70,416.57	$70,416.57
Replace mixing valve bathtub, fiberglass	10	60.00 Ea.	$17,629.45	$21,451.14	5.5000	5	5	$107,255.68	$107,255.68
Replace bathtub, fiberglass	20	60.00 Ea.	$103,655.17	$121,588.66	2.7500	2	2	$243,177.32	$243,177.32
Minor repairs, adjustments water heater, gas / oil, 1150 GPH	2	3.00 Ea.	$310.11	$388.39	27.5000	27	25	$10,486.60	$9,709.82
Replace water heater, gas / oil, 1150 GPH	20	3.00 Ea.	$117,599.23	$135,534.83	2.7500	2	2	$271,069.66	$271,069.66
Insp./chk. pump/mtr. oper., lub., chk. align. circulation pump, 1/2 HP	1	3.00 Ea.	$37.81	$47.35	55.0000	55	55	$2,604.18	$2,604.18
Replace pump / motor assembly, partial circulation pump, 1/2 HP	20	3.00 Ea.	$11,872.77	$13,681.71	2.7500	2	2	$27,363.43	$27,363.43
Repair boiler, gas, 2000 MBH	7	1.00 Ea.	$5,513.06	$6,436.35	7.8571	7	6	$45,054.46	$38,618.11
Replace boiler, gas, 2000 MBH	30	1.00 Ea.	$47,742.79	$55,703.30	1.8333	1	1	$55,703.30	$55,703.30
Replace metal flue, all fuel SS, 6" diameter metal flue / chimney	15	1.00 L.F.	$185.43	$213.70	3.6667	3	3	$641.10	$641.10
Replace roof mounted exhaust fan, 2000 CFM exhaust fan	20	2.00 Ea.	$6,030.30	$7,006.64	2.7500	2	2	$14,013.27	$14,013.27
Repair circulator pump, 1 H.P.	5	3.00 Ea.	$315.16	$371.80	11.0000	11	8	$4,089.79	$2,974.39
Replace circulator. pump, 1 H.P.	15	3.00 Ea.	$16,383.39	$18,807.06	3.6667	3	3	$56,421.18	$56,421.18
Repair single zone rooftop unit, 60 ton	10	3.00 Ea.	$241,030.43	$281,576.92	5.5000	5	4	$1,407,884.59	$1,126,307.67
Replace single zone rooftop unit, 60 ton	15	3.00 Ea.	$286,021.56	$334,647.86	3.6667	3	3	$1,003,943.58	$1,003,943.58
Repair central station A.H.U., 16,000 CFM	10	3.00 Ea.	$6,393.46	$7,389.92	5.5000	5	4	$36,949.62	$29,559.70
Replace central station A.H.U., 16,000 CFM	15	3.00 Ea.	$225,397.13	$259,280.59	3.6667	3	3	$777,841.76	$777,841.76
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	5.5000	5	5	$5,873.21	$5,873.21
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	55.0000	55	55	$2,497.55	$2,497.55
Replace sprinkler head	20	88.00 Ea.	$8,068.78	$9,943.76	2.7500	2	2	$19,887.51	$19,887.51
Replace fire pump / electric motor assembly 100 H.P.	25	1.00 Ea.	$46,050.08	$53,152.38	2.2000	2	2	$106,304.77	$106,304.77
Replace fuse	25	84.00 Ea.	$51,047.68	$58,483.40	2.2000	2	2	$116,966.79	$116,966.79
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	5.5000	5	5	$7,769.55	$7,769.55
Replace switchboard meter	20	1.00 Ea.	$4,602.43	$5,251.74	2.7500	2	2	$10,503.49	$10,503.49
Maintenance and repair motor starter, 600 V	3	2.00 Ea.	$1,489.46	$1,831.18	18.3333	18	18	$32,961.25	$32,961.25
Maintenance and inspection motor starter, 600 V	0.25	2.00 Ea.	$116.84	$146.58	220.0000	220	220	$32,247.45	$32,247.45
Maintenance and inspection lighting panel, indoor	3	5.00 Ea.	$219.08	$274.84	18.3333	18	18	$4,947.05	$4,947.05
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	28.00 Ea.	$2,164.03	$2,714.77	2.7500	2	2	$5,429.54	$5,429.54
Replace circuit breaker molded case, 480 V, 1 pole circuit breaker	50	12.00 Ea.	$10,829.43	$12,511.68	1.1000	1	1	$12,511.68	$12,511.68
Maintenance and repair receptacles and plugs	20	237.00 Ea.	$10,844.92	$13,550.55	2.7500	2	2	$27,101.10	$27,101.10
Maintenance and repair wiring devices, switches	10	94.00 Ea.	$4,301.36	$5,374.48	5.5000	5	5	$26,872.40	$26,872.40
Replace wiring devices, switches	15	94.00 Ea.	$6,536.25	$8,138.90	3.6667	3	3	$24,416.71	$24,416.71
Replace fluorescent light fixture ballast, 80 W	10	210.00 Ea.	$22,875.72	$28,208.74	5.5000	5	5	$141,043.68	$141,043.68
Replace lamps (2 lamps), 4', 34 W energy saver	10	210.00 Ea.	$5,701.84	$7,149.70	5.5000	5	5	$35,748.48	$35,748.48
Repair smoke detector	10	82.00 Ea.	$4,982.73	$6,166.83	5.5000	5	4	$30,834.13	$24,667.31
Replace smoke detector	15	82.00 Ea.	$27,668.55	$32,923.60	3.6667	3	3	$98,770.80	$98,770.80
Check and repair manual pull station	10	8.00 Ea.	$759.91	$935.25	5.5000	5	4	$4,676.27	$3,741.02
Replace manual pull station	15	8.00 Ea.	$1,840.61	$2,212.03	3.6667	3	3	$6,636.10	$6,636.10
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.6667	3	3	$8,524.19	$8,524.19
Minor repairs to annunciation panel	5	3.00 Ea.	$480.83	$586.28	11.0000	11	11	$6,449.03	$6,449.03
Maintenance and inspection annunciation panel	0.5	3.00 Ea.	$138.75	$174.06	110.0000	110	110	$19,146.92	$19,146.92
Replace fire alarm bell, 6"	20	6.00 Ea.	$1,202.61	$1,456.93	2.7500	2	2	$2,913.86	$2,913.86
Maintenance and repair building structure ground	7	0.80 M.L.F.	$76.37	$95.47	7.8571	7	7	$668.26	$668.26
Replace building structure ground	50	0.80 M.L.F.	$4,662.74	$5,639.58	1.1000	1	1	$5,639.58	$5,639.58
Maintenance and repair of general wiring lightning protection system	1	1.20 M.L.F.	$133.59	$164.83	55.0000	55	55	$9,065.71	$9,065.71
Replace lightning protection general wiring system	25	1.20 M.L.F.	$16,109.13	$19,074.77	2.2000	2	2	$38,149.54	$38,149.54
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	55.0000	55	53	$13,126.62	$12,649.29
Replace lightning ground rod	25	2.00 Ea.	$515.56	$637.11	2.2000	2	2	$1,274.23	$1,274.23
Replace lamp emergency lighting fixture	2	8.00 Ea.	$458.52	$553.43	27.5000	27	27	$14,942.63	$14,942.63
Replace emergency lighting fixture	20	8.00 Ea.	$4,990.25	$5,891.96	2.7500	2	2	$11,783.91	$11,783.91
Maintenance and repair exit light	20	8.00 Ea.	$319.32	$395.25	2.7500	2	2	$790.50	$790.50
Replace lamp exit light	5	8.00 Ea.	$146.39	$173.53	11.0000	11	11	$1,908.79	$1,908.79
Replace lighting fixture exit light	20	8.00 Ea.	$1,491.53	$1,806.28	2.7500	2	2	$3,612.56	$3,612.56
Maintenance and repair voice/data outlet	10	6.00 Ea.	$334.16	$417.69	5.5000	5	5	$2,088.44	$2,088.44
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	110.0000	110	110	$12,764.62	$12,764.62
			$2,205,526.77	$2,595,451.22				MR Subtotal:	$7,842,012.69
								MR Per Year:	$142,582.05
								PM Total:	$41,273.04
								Subtotal:	$183,855.09
								Total Per Unit:	$6.14

FAC 7210 Enlisted Unaccompanied Personnel Housing

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $6.14
UM: SF
Expected Service Life: 55
Model Size: 29967

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Fire doors, swinging, annualized	4	1.57	$57.96	$64.30	$0.0000	122.26	147.34	175.32
Elevator, cable, electric, passenger / freight, annualized	1	47.90	$3,787.50	$4,430.40	$0.0000	8,217.90	9,925.77	11,823.02
Toilet (vacuum breaker type), annualized	60	10.62	$551.03	$573.59	$0.0000	1,124.62	1,351.80	1,606.53
Lavatories, annualized	60	20.88	$463.10	$1,319.76	$0.0000	1,782.86	2,225.10	2,690.49
Showers, annualized	60	13.68	$841.20	$865.46	$0.0000	1,706.65	2,050.41	2,436.23
Drink fountain, annualized	4	2.48	$144.60	$133.67	$0.0000	278.26	332.82	394.61
Water heater, steam 2500 gal., annualized	3	4.65	$466.03	$249.99	$0.0000	716.02	837.62	982.53
Boiler, hot water, oil, gas, or comb. fired, over 1000 MBH, annualized	1	19.70	$90.37	$1,269.00	$0.0000	1,359.37	1,749.11	2,143.37
Deaerator tank, annualized	1	1.51	$25.40	$96.44	$0.0000	121.85	153.32	186.06
Air handling unit, 3 thru 24 tons, annualized	3	6.18	$489.48	$332.48	$0.0000	821.96	970.65	1,143.81
VAV Boxes, annualized	32	29.89	$304.82	$1,908.58	$0.0000	2,213.40	2,816.46	3,434.75
Package unit, air cooled, 25 thru 50 ton, annualized	3	9.75	$495.34	$624.35	$0.0000	1,119.69	1,356.53	1,618.13
Controls, central system, electro/pneumatic, annually	6	11.53	$1,078.61	$736.02	$0.0000	1,814.63	2,143.29	2,525.89
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Fire pump, electric motor driven, annualized	1	47.75	$61.55	$3,003.30	$0.0000	3,064.85	3,972.00	4,882.22
Panelboard, 225 A and above, annualized	4	1.76	$103.79	$125.50	$0.0000	229.29	277.32	330.53
Motor control center, over 400 A, annualized	2	0.78	$51.90	$55.78	$0.0000	107.67	129.59	154.11
Fire alarm annuciator system, annualized	2	22.10	$391.22	$1,394.40	$0.0000	1,785.62	2,243.06	2,720.06
Light, emergency, hardwired system, annualized	18	4.50	$163.47	$284.16	$0.0000	447.63	549.23	658.99
						$27,914.33	$34,351.56	$41,273.04

FAC 7212 Enlisted Unaccompanied Personnel Housing, Transient

FY25 SUC:	$6.99 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7213 Student Barracks

FY25 SUC:	$4.75 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7214 Annual Training/Mobilization Barracks

FY25 SUC:	$4.64 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7215 Unaccompanied Housing for Wounded Warriors

FY25 SUC:	$4.12 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7218 Recruit/Trainee Barracks

FY25 SUC:	$5.53 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7218 Recruit/Trainee Barracks

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $5.53
UM: SF
Expected Service Life: 55
Model Size: 63605

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair concrete stairs	30	4,620.00 S.F.	$147,273.21	$170,450.59	1.8333	1	1	$170,450.59	$170,450.59
Replace precast concrete coping, 12" wide	50	490.00 L.F.	$35,879.44	$44,064.85	1.1000	1	1	$44,064.85	$44,064.85
Repair 8" concrete block wall, 1st floor	25	5,200.00 S.F.	$139,221.67	$170,315.96	2.2000	2	2	$340,631.93	$340,631.93
Waterproof concrete block wall, 1st floor	10	152.00 C.S.F.	$29,494.53	$35,541.54	5.5000	5	5	$177,707.68	$177,707.68
Waterproof concrete block wall, 2nd floor	10	52.00 C.S.F.	$41,927.82	$50,085.88	5.5000	5	5	$250,429.40	$250,429.40
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	14.50 S.F.	$197.94	$232.42	55.0000	55	55	$12,783.27	$12,783.27
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	128.00 Ea.	$20,671.75	$24,634.36	2.7500	2	2	$49,268.71	$49,268.71
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	128.00 Ea.	$105,185.75	$122,894.50	1.1000	1	1	$122,894.50	$122,894.50
Replace glass - 2nd floor (1% of glass) - alum. window fixed	1	28.40 S.F.	$3,292.01	$4,067.91	55.0000	55	55	$223,735.31	$223,735.31
Repair 2'-0" x 3'-0" aluminum window - 2nd floor	20	144.00 Ea.	$30,618.77	$36,872.57	2.7500	2	2	$73,745.14	$73,745.14
Replace 2'-0" x 3'-0" aluminum window - 2nd floor	50	144.00 Ea.	$125,697.02	$147,415.24	1.1000	1	1	$147,415.24	$147,415.24
Repair aluminum storefront door	12	3.00 Ea.	$1,648.76	$1,966.00	4.5833	4	4	$7,864.02	$7,864.02
Replace 3'-0" x 7'-0" aluminum storefront doors	50	3.00 Ea.	$8,593.38	$10,077.60	1.1000	1	1	$10,077.60	$10,077.60
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	3.9286	3	3	$8,286.91	$8,286.91
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.20 Ea.	$201.57	$246.76	13.7500	13	13	$3,207.89	$3,207.89
Replace 3'-0" x 7'-0" steel, painted, door	45	8.00 Ea.	$5,886.87	$6,852.55	1.2222	1	1	$6,852.55	$6,852.55
Replace tempered glass - (3% of glass) steel painted door	1	8.00 S.F.	$263.58	$311.15	55.0000	55	55	$17,113.29	$17,113.29
Prepare and refinish 3'-0" x 7'-0" steel painted. door	4	4.00 Ea.	$358.66	$442.61	13.7500	13	13	$5,753.99	$5,753.99
Debris removal and visual inspection of built-up roofing	0.5	32.00 M.S.F.	$1,301.19	$1,589.11	110.0000	110	110	$174,801.86	$174,801.86
Non-destructive moisture inspection of built-up roofing	5	32.00 M.S.F.	$4,045.06	$4,940.12	11.0000	11	11	$54,341.28	$54,341.28
Minor BUR membrane repairs, 2% of roof area	1	12.80 Sq.	$7,476.23	$8,837.67	55.0000	55	55	$486,071.72	$486,071.72
BUR flashing repairs, 2 S.F. per sq. repaired	1	48.50 S.F.	$186.17	$226.14	55.0000	55	55	$12,437.93	$12,437.93
Minor BUR membrane replacement, 25% of roof area	15	80.00 Sq.	$80,556.65	$95,094.09	3.6667	3	3	$285,282.26	$285,282.26
Place new BUR membrane over existing	20	320.00 Sq.	$190,049.13	$223,192.78	2.7500	2	2	$446,385.56	$446,385.56
Total BUR roof replacement	28	320.00 Sq.	$311,150.04	$366,197.01	1.9643	1	1	$366,197.01	$366,197.01
Repair 8" concrete block wall - (2% of walls) painted	25	126.00 C.S.F.	$153,208.26	$184,025.95	2.2000	2	2	$368,051.91	$368,051.91
Refinish concrete block wall painted	4	1,233.00 C.S.F.	$169,109.67	$203,305.58	13.7500	13	13	$2,642,972.52	$2,642,972.52
Repair steel painted interior door	14	4.00 Ea.	$1,187.40	$1,385.29	3.9286	3	3	$4,155.86	$4,155.86
Refinish 3'-0" x 7'-0" steel painted interior door	4	4.00 Ea.	$240.81	$296.10	13.7500	13	13	$3,849.27	$3,849.27
Repair solid core wood door, interior	11	85.00 Ea.	$25,232.23	$29,437.35	5.0000	5	5	$147,186.75	$147,186.75
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	85.00 Ea.	$4,647.92	$5,654.38	13.7500	13	12	$73,506.88	$67,852.50
Replace 3'-0" x 7'-0" solid core wood door, interior	40	85.00 Ea.	$54,721.08	$63,095.55	1.3750	1	1	$63,095.55	$63,095.55
Repair concrete steps	15	860.00 S.F.	$26,525.96	$30,599.30	3.6667	3	3	$91,797.91	$91,797.91
Refinish metal stair railing, interior	7	284.00 S.F.	$469.44	$578.03	7.8571	7	7	$4,046.18	$4,046.18
Replace metal stair railing, interior	45	284.00 L.F.	$13,597.62	$15,919.71	1.2222	1	1	$15,919.71	$15,919.71
Repair 5/8" drywall - (2% of walls)	20	6,564.00 S.F.	$12,261.59	$14,914.33	2.7500	2	2	$29,828.67	$29,828.67
Refinish drywall	4	16,480.00 S.F.	$11,899.50	$14,591.46	13.7500	13	13	$189,688.95	$189,688.95
Repair 4" x 4" thin set ceramic tile - (2% of walls)	10	6.40 C.S.F.	$5,894.64	$7,094.55	5.5000	5	5	$35,472.73	$35,472.73
Refinish concrete floor finished	25	57.90 C.S.F.	$26,547.88	$31,895.60	2.2000	2	2	$63,791.20	$63,791.20
Replace vinyl tile flooring	18	6,555.00 S.Y.	$370,739.48	$453,796.53	3.0556	3	3	$1,361,389.58	$1,361,389.58
Replace carpet	8	116.60 S.Y.	$6,494.45	$7,510.30	6.8750	6	6	$45,061.81	$45,061.81
Acoustic tile repairs - (2% of ceilings)	9	14.90 C.S.F.	$17,145.61	$19,871.92	6.1111	6	6	$119,231.49	$119,231.49
Replace acoustic tile ceiling, fire-rated	20	590.00 C.S.F.	$368,568.70	$433,435.05	2.7500	2	2	$866,870.10	$866,870.10
Replace flush valve diaphragm tankless water closet	10	62.00 Ea.	$1,710.56	$2,125.13	5.5000	5	5	$10,625.63	$10,625.63
Rebuild flush valve tankless water closet	20	62.00 Ea.	$11,982.80	$14,443.16	2.7500	2	2	$28,886.31	$28,886.31
Unplug clogged line tankless water closet	5	62.00 Ea.	$14,246.44	$17,842.85	11.0000	11	11	$196,271.36	$196,271.36
Replace tankless water closet	35	62.00 Ea.	$85,352.70	$98,778.14	1.5714	1	1	$98,778.14	$98,778.14
Replace tankless flush valve	25	62.00 Ea.	$16,904.62	$19,841.74	2.2000	2	2	$39,683.48	$39,683.48
Replace wax ring gasket for tankless water closet	5	62.00 Ea.	$9,284.79	$11,617.68	11.0000	11	11	$127,794.50	$127,794.50
Replace flush valve diaphragm for a urinal	7	38.00 Ea.	$1,048.41	$1,302.50	7.8571	7	7	$9,117.48	$9,117.48
Rebuild flush valve for a urinal	20	38.00 Ea.	$7,344.30	$8,852.26	2.7500	2	2	$17,704.51	$17,704.51
Unplug line urinal	5	38.00 Ea.	$5,810.33	$7,277.11	11.0000	11	11	$80,048.24	$80,048.24
Replace wall-hung urinal	35	38.00 Ea.	$41,507.01	$49,946.74	1.5714	1	1	$49,946.74	$49,946.74
Replace washer in spud connection lavatory, vitreous china	7	48.00 Ea.	$834.87	$1,019.22	7.8571	7	7	$7,134.52	$7,134.52
Replace washer in faucet lavatory, vitreous china	2	48.00 Ea.	$652.69	$814.22	27.5000	27	27	$21,983.87	$21,983.87
Replace faucets lavatory, vitreous china	10	48.00 Ea.	$9,533.89	$11,461.61	5.5000	5	5	$57,308.03	$57,308.03
Clean out strainer and P trap lavatory, vitreous china	2	48.00 Ea.	$1,780.24	$2,229.65	27.5000	27	27	$60,200.47	$60,200.47
Replace lavatory, vitreous china	35	48.00 Ea.	$36,066.03	$43,242.50	1.5714	1	1	$43,242.50	$43,242.50
Replace faucet washer sink, iron enamel	2	16.00 Ea.	$216.07	$269.53	27.5000	27	27	$7,277.37	$7,277.37
Clean trap sink, iron enamel	3	16.00 Ea.	$144.28	$180.70	18.3333	18	18	$3,252.66	$3,252.66
Replace faucets sink, iron enamel	10	16.00 Ea.	$3,177.96	$3,820.54	5.5000	5	5	$19,102.68	$19,102.68
Unstop sink, iron enamel	2	16.00 Ea.	$706.44	$884.78	27.5000	27	27	$23,889.08	$23,889.08
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	8.00 Ea.	$7,281.37	$8,565.61	5.5000	5	5	$42,828.06	$42,828.06
Inspect / clean shower head	3	80.00 Ea.	$4,164.69	$5,216.04	18.3333	18	18	$93,888.76	$93,888.76
Replace shower surface, ceramic tile	30	80.00 Ea.	$77,149.11	$93,462.62	1.8333	1	1	$93,462.62	$93,462.62
Check / minor repairs drinking fountain	1	6.00 Ea.	$311.67	$390.34	55.0000	55	55	$21,468.94	$21,468.94
Repair internal leaks drinking fountain	4	6.00 Ea.	$286.73	$359.12	13.7500	13	13	$4,668.52	$4,668.52
Correct water pressure drinking fountain	2	6.00 Ea.	$264.92	$331.79	27.5000	27	27	$8,958.40	$8,958.40
Replace refrigerant drinking fountain	2	6.00 Ea.	$220.63	$257.98	27.5000	27	27	$6,965.54	$6,965.54
Replace fountain drinking fountain	10	6.00 Ea.	$9,140.36	$10,766.64	5.5000	5	5	$53,833.21	$53,833.21
Resolder joint pipe & fittings, copper	10	168.00 Ea.	$8,551.63	$10,548.00	5.5000	5	5	$52,740.02	$52,740.02
Replace pipe and fittings, copper 3/4"	20	448.00 L.F.	$10,796.14	$13,121.95	2.7500	2	2	$26,243.91	$26,243.91
Replace pipe and fittings, copper 2"	25	366.00 L.F.	$20,701.62	$24,808.96	2.2000	2	2	$49,617.91	$49,617.91
Minor repairs, adjustments water heater, gas / oil, 1150 GPH	2	2.00 Ea.	$206.74	$258.93	27.5000	27	25	$6,991.07	$6,473.21
Clean & service water heater, gas / oil, 1150 GPH	2	2.00 Ea.	$1,236.28	$1,548.37	27.5000	27	27	$41,805.89	$41,805.89
Replace water heater, gas / oil, 1150 GPH	20	2.00 Ea.	$78,399.48	$90,356.55	2.7500	2	2	$180,713.11	$180,713.11
Insp/chk pump/mtr oper, lub, chk align circulation pump, CI 1-1/2 HP	0.5	3.00 Ea.	$37.81	$47.35	110.0000	110	110	$5,208.37	$5,208.37
Replace pump / motor assembly circulation pump, CI 1-1/2 HP	20	3.00 Ea.	$9,857.70	$11,391.87	2.7500	2	2	$22,783.74	$22,783.74
Replace pipe, 4" pipe and fittings, PVC	30	720.00 L.F.	$67,462.91	$82,562.31	1.8333	1	1	$82,562.31	$82,562.31
General maintenance & repair drain: roof, scupper, area	1	16.00 Ea.	$627.49	$785.89	55.0000	55	55	$43,224.14	$43,224.14
Replace drain: roof, scupper, area	40	16.00 Ea.	$17,541.71	$20,243.45	1.3750	1	1	$20,243.45	$20,243.45
Repair boiler, gas, 2000 MBH	7	2.00 Ea.	$11,026.11	$12,872.70	7.8571	7	6	$90,108.92	$77,236.22
Replace boiler, gas, 2000 MBH	30	2.00 Ea.	$95,485.58	$111,406.61	1.8333	1	1	$111,406.61	$111,406.61
Repair fan coil unit, 1 ton	10	12.00 Ea.	$5,465.74	$6,544.63	5.5000	5	4	$32,723.15	$26,178.52
Replace fan coil unit, 1 ton	15	12.00 Ea.	$16,277.88	$19,009.88	3.6667	3	3	$57,029.63	$57,029.63
Repair circulator pump, 1/12 - 3/4 H.P.	5	4.00 Ea.	$419.30	$494.59	11.0000	11	8	$5,440.45	$3,956.69
Replace circulator pump, 1/12 - 3/4 H.P.	15	4.00 Ea.	$14,751.50	$17,015.83	3.6667	3	3	$51,047.49	$51,047.49
Refill expansion tank	5	1.00 Ea.	$15.69	$19.65	11.0000	11	11	$216.12	$216.12
Replace expansion tank, 60 gal capacity	50	1.00 Ea.	$2,962.57	$3,398.58	1.1000	1	1	$3,398.58	$3,398.58
Repair damaged pipe insulation, fiberglass 3/4"	5	16.00 Ea.	$367.26	$447.82	11.0000	11	11	$4,926.06	$4,926.06
Repair damaged pipe insulation, fiberglass 2"	5	16.00 Ea.	$439.95	$535.12	11.0000	11	11	$5,886.35	$5,886.35
Replace pipe insulation, fiberglass 3/4"	5	2.70 M.L.F.	$25,559.83	$31,025.92	11.0000	11	11	$341,285.08	$341,285.08
Replace pipe insulation, fiberglass 2"	5	2.70 M.L.F.	$30,798.15	$37,277.22	11.0000	11	11	$410,049.46	$410,049.46
Repair multi-zone variable volume, 50 ton	10	2.00 Ea.	$134,043.46	$156,632.66	5.5000	5	4	$783,163.30	$626,530.64
Replace multi-zone variable volume, 50 ton	15	2.00 Ea.	$283,484.98	$328,726.43	3.6667	3	3	$986,179.29	$986,179.29
Repair central station A.H.U., 16,000 CFM	10	4.00 Ea.	$8,524.61	$9,853.23	5.5000	5	4	$49,266.16	$39,412.93
Replace central station A.H.U., 16,000 CFM	15	4.00 Ea.	$300,529.50	$345,707.45	3.6667	3	3	$1,037,122.35	$1,037,122.35
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	55.0000	55	55	$2,497.55	$2,497.55
Replace sprinkler head	20	95.00 Ea.	$8,710.61	$10,734.74	2.7500	2	2	$21,469.48	$21,469.48
Replace fuse	25	78.00 Ea.	$47,401.42	$54,306.01	2.2000	2	2	$108,612.02	$108,612.02
Repair switchboard meter	10	2.00 Ea.	$2,643.78	$3,107.82	5.5000	5	5	$15,539.10	$15,539.10
Maintenance and repair secondary transformer, dry	10	3.00 Ea.	$886.53	$1,053.79	5.5000	5	5	$5,268.95	$5,268.95
Maintenance and inspection secondary transformer, dry	0.5	3.00 Ea.	$261.07	$327.51	110.0000	110	110	$36,026.45	$36,026.45
Maintenance and inspection lighting panel, indoor	3	4.00 Ea.	$175.26	$219.87	18.3333	18	18	$3,957.64	$3,957.64
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	34.00 Ea.	$2,627.74	$3,296.51	2.7500	2	2	$6,593.02	$6,593.02
Maintenance and repair breaker, enclosed, 240 V, 1 pole	25	48.00 Ea.	$3,709.76	$4,653.89	2.2000	2	2	$9,307.79	$9,307.79
Maintenance and inspection circuit breaker, enclosed, 240 V, 1 pole	1	48.00 Ea.	$1,665.01	$2,088.76	55.0000	55	55	$114,881.55	$114,881.55
Maintenance and repair safety switch general, 2 pole	8	16.00 Ea.	$701.06	$879.48	6.8750	6	6	$5,276.86	$5,276.86
Maintenance and repair receptacles and plugs	20	255.00 Ea.	$11,668.58	$14,579.71	2.7500	2	2	$29,159.41	$29,159.41
Replace receptacle/plug receptacles and plugs	20	255.00 Ea.	$20,589.51	$25,326.87	2.7500	2	2	$50,653.74	$50,653.74
Maintenance and repair wiring devices, switches	10	62.00 Ea.	$2,837.07	$3,544.87	5.5000	5	5	$17,724.35	$17,724.35
Replace wiring devices, switches	15	62.00 Ea.	$4,311.15	$5,368.21	3.6667	3	3	$16,104.64	$16,104.64
Maintenance and repair incandescent lighting fixtures	10	31.00 Ea.	$2,304.27	$2,743.97	5.5000	5	3	$13,719.84	$8,231.90
Replace incandescent lighting fixture lamp	5	31.00 Ea.	$422.61	$508.06	11.0000	11	11	$5,588.62	$5,588.62
Replace incandescent lighting fixture	20	31.00 Ea.	$4,584.50	$5,554.26	2.7500	2	2	$11,108.52	$11,108.52
Replace fluorescent light fixture ballast, 80 W	10	212.00 Ea.	$23,093.58	$28,477.39	5.5000	5	5	$142,386.96	$142,386.96
Replace lamps (2 lamps), 4', 34 W energy saver	10	212.00 Ea.	$5,756.14	$7,217.79	5.5000	5	5	$36,088.94	$36,088.94
Repair smoke detector	10	86.00 Ea.	$5,225.79	$6,467.65	5.5000	5	4	$32,338.24	$25,870.59
Check operation smoke detector	1	86.00 Ea.	$1,502.04	$1,884.31	55.0000	55	55	$103,636.93	$103,636.93
Replace smoke detector	15	86.00 Ea.	$29,018.24	$34,529.63	3.6667	3	3	$103,588.89	$103,588.89
Check and repair manual pull station	10	12.00 Ea.	$1,139.86	$1,402.88	5.5000	5	4	$7,014.40	$5,611.52
Replace manual pull station	15	12.00 Ea.	$2,760.91	$3,318.05	3.6667	3	3	$9,954.16	$9,954.16
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.6667	3	3	$8,524.19	$8,524.19
Minor repairs to annunciation panel	5	3.00 Ea.	$480.83	$586.28	11.0000	11	11	$6,449.03	$6,449.03
Maintenance and inspection annunciation panel	0.5	3.00 Ea.	$138.75	$174.06	110.0000	110	110	$19,146.92	$19,146.92
Replace annunciation panel	15	3.00 Ea.	$3,751.22	$4,507.48	3.6667	3	3	$13,522.44	$13,522.44
Replace fire alarm bell, 6"	20	8.00 Ea.	$1,603.48	$1,942.57	2.7500	2	2	$3,885.15	$3,885.15

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Maintenance and repair building structure ground	7	6.50 M.L.F.	$620.49	$775.66	7.8571	7	7	$5,429.65	$5,429.65
Replace building structure ground	50	6.50 M.L.F.	$37,884.79	$45,821.55	1.1000	1	1	$45,821.55	$45,821.55
Maintenance and repair of general wiring lightning protection system	1	12.60 M.L.F.	$1,402.67	$1,730.73	55.0000	55	55	$95,189.98	$95,189.98
Replace lightning protection general wiring system	25	12.60 M.L.F.	$169,145.89	$200,285.11	2.2000	2	2	$400,570.22	$400,570.22
Maintenance and repair lightning ground rod	1	12.00 Ea.	$1,145.52	$1,431.99	55.0000	55	53	$78,759.72	$75,895.73
Replace lightning ground rod	25	12.00 Ea.	$3,093.39	$3,822.69	2.2000	2	2	$7,645.37	$7,645.37
Replace lamp emergency lighting fixture	2	60.00 Ea.	$3,438.93	$4,150.73	27.5000	27	27	$112,069.71	$112,069.71
Replace emergency lighting fixture	20	60.00 Ea.	$37,426.91	$44,189.67	2.7500	2	2	$88,379.34	$88,379.34
Maintenance and repair exit light	20	60.00 Ea.	$2,394.92	$2,964.36	2.7500	2	2	$5,928.72	$5,928.72
Replace lamp exit light	5	60.00 Ea.	$1,097.90	$1,301.45	11.0000	11	11	$14,315.92	$14,315.92
Replace lighting fixture exit light	20	60.00 Ea.	$11,186.47	$13,547.09	2.7500	2	2	$27,094.18	$27,094.18
Replace voice/data outlet	20	22.00 Ea.	$622.98	$758.70	2.7500	2	2	$1,517.39	$1,517.39
Replace patch panel	15	2.00 Ea.	$1,894.36	$2,276.61	3.6667	3	3	$6,829.84	$6,829.84
			$4,518,601.69	$5,353,659.86				MR Subtotal:	$17,001,749.78
								MR Per Year:	$309,122.72
								PM Total:	$42,874.01
								Subtotal:	$351,996.73
								Total Per Unit:	$5.53

FAC 7218 Recruit/Trainee Barracks

Release:	2024 Qtr 3	FY25 SUC:	$5.53
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	55
		Model Size:	63605

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	5	1.30	$79.11	$58.67	$0.0000	137.78	163.29	192.76
Fire doors, swinging, annualized	8	3.14	$115.91	$128.60	$0.0000	244.51	294.68	350.65
Urinals, annualized	38	8.66	$259.88	$466.15	$0.0000	726.03	891.86	1,070.69
Toilet (vacuum breaker type), annualized	62	10.97	$569.40	$592.71	$0.0000	1,162.10	1,396.86	1,660.08
Lavatories, annualized	48	16.70	$370.48	$1,055.81	$0.0000	1,426.29	1,780.08	2,152.39
Showers, annualized	80	18.24	$1,121.60	$1,153.94	$0.0000	2,275.54	2,733.88	3,248.31
Drink fountain, annualized	6	3.72	$216.89	$200.50	$0.0000	417.40	499.24	591.92
Valve, butterfly, above 4", annualized	6	1.00	$41.33	$53.55	$0.0000	94.88	115.08	137.34
Valve, diaphragm, above 4", annualized	2	0.24	$13.78	$13.11	$0.0000	26.89	32.20	38.20
Valve, OS&Y, above 4", annualized	1	0.16	$6.89	$8.54	$0.0000	15.43	18.68	22.28
Water heater, steam 2500 gal., annualized	2	3.10	$310.69	$166.66	$0.0000	477.35	558.42	655.02
Boiler, hot water, oil, gas, or comb. fired, over 1000 MBH, annualized	2	39.40	$180.74	$2,538.00	$0.0000	2,718.74	3,498.22	4,286.73
Pump, condensate return, over 1 H.P., annualized	2	2.25	$137.76	$143.82	$0.0000	281.58	338.50	402.31
Air handling unit, 3 thru 24 tons, annualized	4	8.24	$652.64	$443.30	$0.0000	1,095.94	1,294.19	1,525.08
Air handling unit, over 50 tons, annualized	4	13.10	$1,012.17	$703.87	$0.0000	1,716.04	2,028.42	2,391.41
Fan coil unit, annualized	18	60.08	$1,547.57	$3,228.34	$0.0000	4,775.90	5,899.16	7,099.80
VAV Boxes, annualized	58	54.17	$552.49	$3,459.29	$0.0000	4,011.79	5,104.83	6,225.49
Fire dampers, annualized	8	9.26	$67.22	$592.20	$0.0000	659.42	843.80	1,031.54
Package unit, air cooled, 25 thru 50 ton, annualized	2	6.50	$330.23	$416.23	$0.0000	746.46	904.35	1,078.75
Controls, central system, electro/pneumatic, annualized	4	7.68	$719.07	$490.68	$0.0000	1,209.75	1,428.86	1,683.93
Backflow prevention device, up to 4", annualized	2	0.67	$29.11	$42.30	$0.0000	71.41	87.02	104.07
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Circuit breaker, high voltage air, annualized	12	5.64	$198.20	$400.39	$0.0000	598.59	738.53	888.38
Transformer, dry type 500 KVA and over, annualized	4	3.08	$66.07	$219.12	$0.0000	285.19	357.53	433.18
Panelboard, 225 A and above, annualized	4	1.76	$103.79	$125.50	$0.0000	229.29	277.32	330.53
Fire alarm annuciator system, annualized	1	11.05	$195.61	$697.20	$0.0000	892.81	1,121.53	1,360.03
Light, emergency, hardwired system, annualized	1	0.25	$9.08	$15.79	$0.0000	24.87	30.51	36.61
Light, emergency, dry cell, annualized	32	11.39	$1,213.57	$717.12	$0.0000	1,930.69	2,267.18	2,664.35
						$29,022.25	$35,693.73	$42,874.01

FAC 7220 Dining Facility

FY25 SUC: $6.17 / SF

Source:

FAC 7220 Dining Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $6.17
UM: SF
Expected Service Life: 40
Model Size: 11145

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	420.00 S.F.	$17,087.44	$20,811.14	2.6667	2	2	$41,622.29	$41,622.29
Replace steel decking	30	120.00 S.F.	$720.44	$837.25	1.3333	1	1	$837.25	$837.25
Repair 8" concrete block wall, 1st floor	25	1,260.00 S.F.	$33,734.48	$41,268.87	1.6000	1	1	$41,268.87	$41,268.87
Refinish steel louver, 1st floor	5	4.00 Ea.	$441.94	$546.87	8.0000	8	8	$4,374.93	$4,374.93
Repair 3' x 4' aluminum window - 1st floor	20	32.00 Ea.	$9,645.12	$11,335.71	2.0000	2	2	$22,671.42	$22,671.42
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	26.60 S.F.	$363.13	$426.38	40.0000	40	40	$17,055.04	$17,055.04
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	54.00 Ea.	$8,720.89	$10,392.62	2.0000	2	2	$20,785.24	$20,785.24
Repair aluminum storefront door	12	4.00 Ea.	$2,198.35	$2,621.34	3.3333	3	3	$7,864.02	$7,864.02
Replace insulating glass - (3% of glass) aluminum storefront door	1	2.50 S.F.	$169.01	$196.81	40.0000	40	40	$7,872.57	$7,872.57
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	2.8571	2	2	$7,366.14	$7,366.14
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.00 Ea.	$191.97	$235.01	10.0000	10	10	$2,350.10	$2,350.10
Debris removal, by hand and visual inspection, metal panel roofing	1	11.20 M.S.F.	$275.25	$336.15	40.0000	40	40	$13,445.97	$13,445.97
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	224.00 S.F.	$1,086.01	$1,288.80	8.0000	8	8	$10,310.41	$10,310.41
Minor metal roof panel replacement, 2.5% of roof area	20	280.00 S.F.	$3,872.61	$4,580.82	2.0000	2	2	$9,161.64	$9,161.64
Total metal roof panel replacement	30	112.00 Sq.	$107,656.10	$127,306.27	1.3333	1	1	$127,306.27	$127,306.27
Repair steel painted interior door	14	3.00 Ea.	$890.55	$1,038.97	2.8571	2	2	$2,077.93	$2,077.93
Refinish 3'-0" x 7'-0" steel painted interior door	4	3.00 Ea.	$180.61	$222.07	10.0000	10	10	$2,220.73	$2,220.73
Repair 5/8" drywall - (2% of walls)	20	54.60 S.F.	$101.99	$124.06	2.0000	2	2	$248.12	$248.12
Refinish drywall	4	1,730.00 S.F.	$1,249.16	$1,531.75	10.0000	10	10	$15,317.49	$15,317.49
Repair 4" x 4" thin set ceramic tile - (2% of walls)	10	0.78 C.S.F.	$718.41	$864.65	4.0000	4	4	$3,458.59	$3,458.59
Refinish concrete floor finished	25	13.30 C.S.F.	$6,098.22	$7,326.62	1.6000	1	1	$7,326.62	$7,326.62
Replace vinyl sheet flooring	18	260.00 S.Y.	$20,741.03	$25,151.50	2.2222	2	2	$50,303.00	$50,303.00
Ceramic tile floor repairs - (2% of floors)	15	0.40 C.S.F.	$278.65	$347.42	2.6667	2	2	$694.83	$694.83
Replace acoustic tile ceiling, non fire-rated	20	4.60 C.S.F.	$2,827.26	$3,324.17	2.0000	2	2	$6,648.34	$6,648.34
Refinish acoustic tile ceiling and grid (occupied area)	5	40.60 C.S.F.	$1,091.09	$1,357.35	8.0000	8	8	$10,858.81	$10,858.81
Replace flush valve diaphragm tankless water closet	10	8.00 Ea.	$220.72	$274.21	4.0000	4	4	$1,096.84	$1,096.84
Rebuild flush valve tankless water closet	20	8.00 Ea.	$1,546.17	$1,863.63	2.0000	2	2	$3,727.27	$3,727.27
Unplug clogged line tankless water closet	5	8.00 Ea.	$1,838.25	$2,302.30	8.0000	8	8	$18,418.43	$18,418.43
Replace tankless water closet	35	8.00 Ea.	$11,013.25	$12,745.57	1.1429	1	1	$12,745.57	$12,745.57
Replace tankless flush valve	25	8.00 Ea.	$2,181.24	$2,560.22	1.6000	1	1	$2,560.22	$2,560.22
Replace wax ring gasket for tankless water closet	5	8.00 Ea.	$1,198.04	$1,499.06	8.0000	8	8	$11,992.45	$11,992.45
Replace flush valve diaphragm for a urinal	7	6.00 Ea.	$165.54	$205.66	5.7143	5	5	$1,028.29	$1,028.29
Rebuild flush valve for a urinal	20	6.00 Ea.	$1,159.63	$1,397.72	2.0000	2	2	$2,795.45	$2,795.45
Unplug line urinal	5	6.00 Ea.	$917.42	$1,149.02	8.0000	8	8	$9,192.14	$9,192.14
Replace wall-hung urinal	35	6.00 Ea.	$6,553.74	$7,886.33	1.1429	1	1	$7,886.33	$7,886.33
Replace washer in spud connection lavatory, vitreous china	7	8.00 Ea.	$139.14	$169.87	5.7143	5	5	$849.35	$849.35
Replace washer in faucet lavatory, vitreous china	2	8.00 Ea.	$108.78	$135.70	20.0000	20	20	$2,714.06	$2,714.06
Replace faucets lavatory, vitreous china	10	8.00 Ea.	$1,588.98	$1,910.27	4.0000	4	4	$7,641.07	$7,641.07
Clean out strainer and P trap lavatory, vitreous china	2	8.00 Ea.	$296.71	$371.61	20.0000	20	20	$7,432.16	$7,432.16
Replace lavatory, vitreous china	35	8.00 Ea.	$6,011.00	$7,207.08	1.1429	1	1	$7,207.08	$7,207.08
Replace faucet washer sink, stainless steel	2	5.00 Ea.	$67.52	$84.23	20.0000	20	20	$1,684.58	$1,684.58
Clean trap sink, stainless steel	3	5.00 Ea.	$45.09	$56.47	13.3333	13	13	$734.11	$734.11
Replace faucets sink, stainless steel	10	5.00 Ea.	$993.11	$1,193.92	4.0000	4	4	$4,775.67	$4,775.67
Unstop sink, stainless steel	2	5.00 Ea.	$220.76	$276.49	20.0000	20	20	$5,529.88	$5,529.88
Replace sink, stainless steel	40	5.00 Ea.	$5,948.66	$6,976.31	1.0000	1	1	$6,976.31	$6,976.31
Replace faucet washer sink, service/utility	2	1.00 Ea.	$13.50	$16.85	20.0000	20	20	$336.92	$336.92
Clean trap	3	1.00 Ea.	$9.02	$11.29	13.3333	13	13	$146.82	$146.82
Replace faucets sink, service/utility	10	1.00 Ea.	$198.62	$238.78	4.0000	4	4	$955.13	$955.13
Unstop sink	2	5.00 Ea.	$220.76	$276.49	20.0000	20	20	$5,529.88	$5,529.88
Check / minor repairs drinking fountain	1	2.00 Ea.	$103.89	$130.11	40.0000	40	40	$5,204.59	$5,204.59
Repair internal leaks drinking fountain	4	2.00 Ea.	$95.58	$119.71	10.0000	10	10	$1,197.06	$1,197.06
Repair drain leak drinking fountain	4	2.00 Ea.	$61.02	$73.62	10.0000	10	10	$736.17	$736.17
Replace pipe and fittings, copper 3/4"	20	264.00 L.F.	$6,362.01	$7,732.58	2.0000	2	2	$15,465.16	$15,465.16
Remove old insulation & replace with new, pipe 3/4", wall 3/4"	15	100.00 L.F.	$1,252.75	$1,540.56	2.6667	2	2	$3,081.12	$3,081.12
Remove old insulation & replace with new, pipe 1-1/2", wall 3/4"	15	100.00 L.F.	$1,475.75	$1,795.78	2.6667	2	2	$3,591.55	$3,591.55
Overhaul water heater, gas / oil, 70 gallon	5	2.00 Ea.	$346.43	$433.88	8.0000	8	8	$3,471.05	$3,471.05
Clean & service water heater, gas / oil, 70 gallon	1	1.00 Ea.	$206.74	$258.93	40.0000	40	40	$10,357.14	$10,357.14
Replace water heater, gas / oil, 70 gallon	12	1.00 Ea.	$5,470.45	$6,302.52	3.3333	3	3	$18,907.56	$18,907.56
Insp/chk pump/mtr oper, lub, chk align circulation pump, CI 1-1/2 HP	0.5	1.00 Ea.	$12.60	$15.78	80.0000	80	80	$1,262.63	$1,262.63
Replace pump / motor assembly circulation pump, CI 1-1/2 HP	20	1.00 Ea.	$3,285.90	$3,797.29	2.0000	2	2	$7,594.58	$7,594.58
Unclog main drain pipe & fittings, cast iron	10	2.00 Ea.	$97.66	$122.31	4.0000	4	4	$489.23	$489.23
Replace pipe & fittings, cast iron, 4"	40	10.00 L.F.	$609.65	$738.85	1.0000	1	1	$738.85	$738.85
Replace pipe, 4" pipe and fittings, PVC	30	30.00 L.F.	$2,810.95	$3,440.10	1.3333	1	1	$3,440.10	$3,440.10
General maintenance & repair drain: roof, scupper, area	1	4.00 Ea.	$156.87	$196.47	40.0000	40	40	$7,858.93	$7,858.93
Replace drain: roof, scupper, area	40	4.00 Ea.	$4,385.43	$5,060.86	1.0000	1	1	$5,060.86	$5,060.86
Repair boiler, gas, 250 MBH	7	1.00 Ea.	$2,552.63	$2,989.56	5.7143	5	4	$14,947.80	$11,958.24
Replace boiler, gas, 250 MBH	30	1.00 Ea.	$1,636.25	$2,049.31	1.3333	1	1	$2,049.31	$2,049.31
Replace unit ventilator, 750 CFM, heat/cool coils	15	2.00 Ea.	$15,894.85	$18,460.29	2.6667	2	2	$36,920.58	$36,920.58
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	3.00 Ea.	$13,033.08	$15,118.96	2.0000	2	2	$30,237.91	$30,237.91
Repair circulator pump, 1 H.P.	5	2.00 Ea.	$210.11	$247.87	8.0000	8	6	$1,982.93	$1,487.19
Replace circulator. pump, 1 H.P.	15	2.00 Ea.	$10,922.26	$12,538.04	2.6667	2	2	$25,076.08	$25,076.08
Maintenance and repair standard suspended heater	2	2.00 Ea.	$237.88	$280.77	20.0000	20	20	$5,615.40	$5,615.40
Replace terminal reheat, 18" x 24" coil	15	6.00 Ea.	$13,887.83	$15,971.56	2.6667	2	2	$31,943.12	$31,943.12
Repair terminal reheat, 36" x 36" coil	10	6.00 Ea.	$1,034.73	$1,295.94	4.0000	4	4	$5,183.77	$5,183.77
Repair multi-zone rooftop unit, 15 ton	10	2.00 Ea.	$73,268.08	$84,506.36	4.0000	4	3	$338,025.42	$253,519.07
Replace multi-zone rooftop unit, 15 ton	15	2.00 Ea.	$180,401.20	$207,853.40	2.6667	2	2	$415,706.80	$415,706.80
Repair central station A.H.U., 16,000 CFM	10	2.00 Ea.	$4,262.30	$4,926.62	4.0000	4	3	$19,706.46	$14,779.85
Replace central station A.H.U., 16,000 CFM	15	2.00 Ea.	$150,264.75	$172,853.73	2.6667	2	2	$345,707.45	$345,707.45
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	4.0000	4	4	$4,698.57	$4,698.57
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	40.0000	40	40	$1,816.40	$1,816.40
Replace sprinkler head	20	58.00 Ea.	$5,318.06	$6,553.84	2.0000	2	2	$13,107.68	$13,107.68
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	40.0000	40	40	$36,122.11	$36,122.11
Repair 15 KV primary transformer, dry	15	1.00 Ea.	$245.95	$300.05	2.6667	2	2	$600.11	$600.11
Maintenance and inspection primary transformer, dry	0.5	1.00 Ea.	$43.82	$54.97	80.0000	80	80	$4,397.38	$4,397.38
Maintenance and inspection lighting panel, indoor	3	1.00 Ea.	$43.82	$54.97	13.3333	13	13	$714.57	$714.57
Repair failed breaker, molded case, 600 V, 3 pole	10	2.00 Ea.	$808.88	$962.61	4.0000	4	4	$3,850.44	$3,850.44
Maintenance and repair receptacles and plugs	20	16.00 Ea.	$732.15	$914.81	2.0000	2	2	$1,829.61	$1,829.61
Replace receptacle/plug receptacles and plugs	20	16.00 Ea.	$1,291.89	$1,589.14	2.0000	2	2	$3,178.27	$3,178.27
Maintenance and repair wiring devices, switches	10	18.00 Ea.	$823.66	$1,029.16	4.0000	4	4	$4,116.62	$4,116.62
Replace wiring devices, switches	15	18.00 Ea.	$1,251.62	$1,558.51	2.6667	2	2	$3,117.03	$3,117.03
Replace fluorescent light fixture ballast, 80 W	10	58.00 Ea.	$6,318.06	$7,790.98	4.0000	4	4	$31,163.94	$31,163.94
Replace lamps (2 lamps), 4', 34 W energy saver	10	58.00 Ea.	$1,574.79	$1,974.68	4.0000	4	4	$7,898.71	$7,898.71
Replace high pressure sodium ballast, 250 W	10	8.00 Ea.	$1,627.18	$1,933.40	4.0000	4	4	$7,733.59	$7,733.59
Replace high pressure sodium fixture lamp, 250 W	10	8.00 Ea.	$552.58	$666.24	4.0000	4	4	$2,664.95	$2,664.95
Repair smoke detector	10	12.00 Ea.	$729.18	$902.46	4.0000	4	3	$3,609.85	$2,707.39
Check operation smoke detector	1	12.00 Ea.	$209.59	$262.93	40.0000	40	40	$10,517.07	$10,517.07
Replace smoke detector	15	12.00 Ea.	$4,049.06	$4,818.09	2.6667	2	2	$9,636.18	$9,636.18
Repair heat detector	10	8.00 Ea.	$530.03	$651.54	4.0000	4	4	$2,606.17	$2,606.17
Check operation heat detector	1	8.00 Ea.	$139.72	$175.28	40.0000	40	40	$7,011.38	$7,011.38
Replace heat detector	15	8.00 Ea.	$1,518.43	$1,854.55	2.6667	2	2	$3,709.09	$3,709.09
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	4.0000	4	3	$2,805.76	$2,104.32
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	2.6667	2	2	$3,318.05	$3,318.05
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	80.0000	80	80	$4,641.68	$4,641.68
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	2.6667	2	2	$5,682.79	$5,682.79
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	8.0000	8	8	$1,563.40	$1,563.40
Maintenance and inspection annunciation panel	0.5	1.00 Ea.	$46.25	$58.02	80.0000	80	80	$4,641.68	$4,641.68
Replace annunciation panel	15	1.00 Ea.	$1,250.41	$1,502.49	2.6667	2	2	$3,004.99	$3,004.99
Replace fire alarm bell, 6"	20	4.00 Ea.	$801.74	$971.29	2.0000	2	2	$1,942.57	$1,942.57
Replace lamp emergency lighting fixture	2	4.00 Ea.	$229.26	$276.72	20.0000	20	20	$5,534.31	$5,534.31
Replace emergency lighting fixture	20	4.00 Ea.	$2,495.13	$2,945.98	2.0000	2	2	$5,891.96	$5,891.96
Maintenance and repair exit light	20	4.00 Ea.	$159.66	$197.62	2.0000	2	2	$395.25	$395.25
Replace lamp exit light	5	4.00 Ea.	$73.19	$86.76	8.0000	8	8	$694.11	$694.11
Replace lighting fixture exit light	20	4.00 Ea.	$745.76	$903.14	2.0000	2	2	$1,806.28	$1,806.28
Replace fume hood sash	20	2.00 Ea.	$2,510.93	$2,884.67	2.0000	2	2	$5,769.35	$5,769.35
Replace commercial dishwasher, 10 to 12 racks per hour	10	1.00 Ea.	$43,744.46	$49,822.32	4.0000	4	4	$199,289.26	$199,289.26
Unstop disposal waste, residential	1	2.00 Ea.	$97.83	$122.53	40.0000	40	40	$4,901.11	$4,901.11
			$846,700.75	$990,214.68				MR Subtotal:	$2,240,422.35
								MR Per Year:	$56,010.56
								PM Total:	$12,799.48
								Subtotal:	$68,810.04
								Total Per Unit:	$6.17

FAC 7220 Dining Facility

Release:	2024 Qtr 3	FY25 SUC:	$6.17
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	40
		Model Size:	11145

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Urinals, annualized	6	1.37	$41.03	$73.60	$0.0000	114.64	140.82	169.06
Toilet (vacuum breaker type), annually	8	0.46	$36.74	$24.50	$0.0000	61.24	72.26	85.12
Lavatories, annualized	8	2.78	$61.75	$175.97	$0.0000	237.71	296.68	358.73
Drink fountain, annualized	2	1.24	$72.30	$66.83	$0.0000	139.13	166.41	197.31
Water heater, gas, to 120 gal., annualized	1	1.72	$88.42	$92.21	$0.0000	180.63	217.14	258.07
Boiler, hot water, oil, gas, or comb. fired, 120 - 500 MBH, annualized	1	15.88	$90.37	$1,015.20	$0.0000	1,105.57	1,419.17	1,737.29
Air handling unit, 3 thru 24 tons, annualized	2	4.12	$326.32	$221.65	$0.0000	547.97	647.10	762.54
Fan, axial, 5,000 to 10,000 CFM, annualized	3	3.87	$106.98	$208.12	$0.0000	315.10	388.23	466.71
Hood and blower, annualized	4	9.27	$238.39	$497.45	$0.0000	735.84	908.91	1,093.90
Package unit, air cooled, 3 thru 24 ton, annually	2	2.00	$230.57	$127.75	$0.0000	358.32	419.70	492.61
Backflow prevention device, up to 4", annualized	4	1.33	$58.23	$84.60	$0.0000	142.83	174.03	208.15
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Extinguishing system, CO2, annualized	1	9.47	$727.86	$507.60	$0.0000	1,235.46	1,460.53	1,721.99
Panelboard, 225 A and above, annualized	4	1.76	$103.79	$125.50	$0.0000	229.29	277.32	330.53
Fire alarm annuciator system, annualized	1	11.05	$195.61	$697.20	$0.0000	892.81	1,121.53	1,360.03
Light, emergency, hardwired system, annualized	4	1.00	$36.33	$63.15	$0.0000	99.47	122.05	146.44
Deep fat fryer, conventional type, gas / electric, annualized	1	2.58	$24.74	$98.24	$0.0000	122.98	154.93	188.11
Grill, gas / electric, annualized	1	3.28	$137.36	$124.59	$0.0000	261.95	313.07	371.05
Oven, convection, gas / electric, annualized	1	11.24	$52.52	$428.28	$0.0000	480.80	614.54	750.91
Refrigerator freezer, walk-in box w/external condenser, annually	2	1.47	$430.26	$55.71	$0.0000	485.97	545.71	626.96
Vacuum, annualized	1	1.23	$26.26	$46.72	$0.0000	72.98	89.62	107.58
						$8,700.49	$10,669.89	$12,799.48

FAC 7231 Miscellaneous UPH Support Building

FY25 SUC:	$3.10 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7232 Unaccompanied Personnel Housing Garage

FY25 SUC:	$1.61 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7233 Dining Support Facility

FY25 SUC:	$7.10 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7234 Latrine/Shower Facility

FY25 SUC:	$8.60 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7235 Miscellaneous UPH Support Facility

FY25 SUC:	$294.43 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7236 Unaccompanied Personnel Housing Carport

FY25 SUC:	$0.41 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7240 Officer Unaccompanied Personnel Housing

FY25 SUC:	$6.54 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7240 Officer Unaccompanied Personnel Housing

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $6.54
UM: SF
Expected Service Life: 55
Model Size: 16063

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair concrete stairs	30	90.00 S.F.	$2,868.96	$3,320.47	1.8333	1	1	$3,320.47	$3,320.47
Repair clay brick wall, 1st floor	25	720.00 S.F.	$34,294.09	$42,075.03	2.2000	2	2	$84,150.05	$84,150.05
Point clay brick wall, 1st floor	25	72.00 C.S.F.	$62,994.12	$77,884.30	2.2000	2	2	$155,768.60	$155,768.60
Point clay brick wall, 2nd floor	25	72.00 C.S.F.	$66,024.57	$81,646.40	2.2000	2	2	$163,292.79	$163,292.79
Replace glass - 1st floor. (1% of glass) - alum. window	1	3.80 S.F.	$51.88	$60.91	55.0000	55	55	$3,350.10	$3,350.10
Repair 3' x 4' aluminum window - 1st floor	20	64.00 Ea.	$19,290.24	$22,671.42	2.7500	2	2	$45,342.84	$45,342.84
Replace 3' x 4' aluminum window - 1st floor	50	64.00 Ea.	$68,939.75	$80,023.25	1.1000	1	1	$80,023.25	$80,023.25
Replace glass - 2nd floor. (1% of glass) - alum. window	1	3.80 S.F.	$71.31	$85.08	55.0000	55	55	$4,679.41	$4,679.41
Repair 3' x 4' aluminum window - 2nd floor	20	64.00 Ea.	$22,562.71	$26,742.05	2.7500	2	2	$53,484.11	$53,484.11
Replace 3' x 4' aluminum window - 2nd floor	50	64.00 Ea.	$72,212.22	$84,093.88	1.1000	1	1	$84,093.88	$84,093.88
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	0.50 S.F.	$6.83	$8.01	55.0000	55	55	$440.80	$440.80
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	8.00 Ea.	$1,291.98	$1,539.65	2.7500	2	2	$3,079.29	$3,079.29
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	8.00 Ea.	$6,574.11	$7,680.91	1.1000	1	1	$7,680.91	$7,680.91
Repair aluminum storefront door	12	4.00 Ea.	$2,198.35	$2,621.34	4.5833	4	4	$10,485.36	$10,485.36
Replace 3'-0" x 7'-0" aluminum storefront doors	50	4.00 Ea.	$11,457.85	$13,436.80	1.1000	1	1	$13,436.80	$13,436.80
Replace insulating glass - (3% of glass) aluminum storefront door	1	1.40 S.F.	$94.64	$110.22	55.0000	55	55	$6,061.88	$6,061.88
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	3.9286	3	3	$11,049.22	$11,049.22
Refinish 3'-0" x 7'-0" steel, painted, door	4	4.00 Ea.	$191.97	$235.01	13.7500	13	13	$3,055.13	$3,055.13
Replace 3'-0" x 7'-0" steel, painted, door	45	4.00 Ea.	$2,943.44	$3,426.28	1.2222	1	1	$3,426.28	$3,426.28
Replace tempered glass - (3% of glass) steel painted door	1	1.40 S.F.	$46.13	$54.45	55.0000	55	55	$2,994.83	$2,994.83
Debris removal and visual inspection of built-up roofing	0.5	8.10 M.S.F.	$329.36	$402.24	110.0000	110	110	$44,246.72	$44,246.72
Minor BUR membrane repairs, 2% of roof area	1	1.60 Sq.	$934.53	$1,104.71	55.0000	55	55	$60,758.96	$60,758.96
BUR flashing repairs, 2 S.F. per sq. repaired	1	160.00 S.F.	$614.18	$746.04	55.0000	55	55	$41,032.34	$41,032.34
Minor BUR membrane replacement, 25% of roof area	15	20.10 Sq.	$20,239.86	$23,892.39	3.6667	3	3	$71,677.17	$71,677.17
Total BUR roof replacement	28	80.30 Sq.	$78,079.21	$91,892.56	1.9643	1	1	$91,892.56	$91,892.56
Repair solid core wood door, interior	11	32.00 Ea.	$9,499.19	$11,082.30	5.0000	5	5	$55,411.48	$55,411.48
Replace 3'-0" x 7'-0" solid core wood door, interior	40	32.00 Ea.	$20,600.88	$23,753.62	1.3750	1	1	$23,753.62	$23,753.62
Repair masonry steps, painted	20	264.00 S.F.	$8,027.22	$9,518.95	2.7500	2	2	$19,037.90	$19,037.90
Replace masonry steps, painted	50	264.00 S.F.	$58,083.44	$71,641.67	1.1000	1	1	$71,641.67	$71,641.67
Replace metal stair railing, interior	45	96.00 L.F.	$4,596.38	$5,381.31	1.2222	1	1	$5,381.31	$5,381.31
Repair medium weight vinyl wall covering - (2% of walls)	1	1.20 C.S.F.	$635.02	$741.08	55.0000	55	55	$40,759.56	$40,759.56
Replace medium weight vinyl wall covering	15	32.00 C.S.F.	$19,304.44	$22,711.27	3.6667	3	3	$68,133.80	$68,133.80
Repair 5/8" drywall - (2% of walls)	20	373.40 S.F.	$697.51	$848.42	2.7500	2	2	$1,696.83	$1,696.83
Refinish drywall	4	8,670.00 S.F.	$6,260.24	$7,676.45	13.7500	13	13	$99,793.88	$99,793.88
Repair 4" x 4" thin set ceramic tile - (2% of walls)	10	0.90 C.S.F.	$828.93	$997.67	5.5000	5	5	$4,988.35	$4,988.35
Refinish concrete floor finished	25	1.40 C.S.F.	$641.92	$771.22	2.2000	2	2	$1,542.45	$1,542.45
Ceramic tile floor repairs - (2% of floors)	15	0.20 C.S.F.	$139.33	$173.71	3.6667	3	3	$521.12	$521.12
Replace 2" x 2" thin set ceramic tile floor	50	8.20 C.S.F.	$13,399.94	$16,006.04	1.1000	1	1	$16,006.04	$16,006.04
Replace carpet	8	1,420.00 S.Y.	$79,091.89	$91,463.36	6.8750	6	6	$548,780.13	$548,780.13
Repair gypsum board ceiling - (2% of ceilings)	20	1.10 C.S.F.	$449.52	$551.18	2.7500	2	2	$1,102.36	$1,102.36
Refinish gypsum board ceiling, up to 12' high	20	54.00 C.S.F.	$8,215.41	$10,100.37	2.7500	2	1	$20,200.73	$10,100.37
Replace gypsum board ceiling, up to 12' high	40	54.00 C.S.F.	$22,618.90	$27,744.02	1.3750	1	1	$27,744.02	$27,744.02
Unplug clogged line flush-tank water closet	5	28.00 Ea.	$6,433.87	$8,058.06	11.0000	11	11	$88,638.68	$88,638.68
Replace valve and ball cock assembly flush-tank water closet	15	28.00 Ea.	$2,720.98	$3,366.30	3.6667	3	3	$10,098.91	$10,098.91
Install gasket between tank and bowl flush-tank water closet	20	28.00 Ea.	$1,229.95	$1,529.05	2.7500	2	2	$3,058.10	$3,058.10
Replace two piece water closet flush-tank	35	28.00 Ea.	$15,676.06	$18,756.62	1.5714	1	1	$18,756.62	$18,756.62
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	7.8571	7	7	$479.87	$479.87
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.7500	2	2	$931.82	$931.82
Replace wall-hung urinal	35	2.00 Ea.	$2,184.58	$2,628.78	1.5714	1	1	$2,628.78	$2,628.78
Replace washer in spud connection lavatory, vitreous china	7	28.00 Ea.	$487.01	$594.54	7.8571	7	7	$4,161.80	$4,161.80
Replace washer in faucet lavatory, vitreous china	2	28.00 Ea.	$380.73	$474.96	27.5000	27	27	$12,823.92	$12,823.92
Replace faucets lavatory, vitreous china	10	28.00 Ea.	$5,561.43	$6,685.94	5.5000	5	5	$33,429.69	$33,429.69
Clean out strainer and P trap lavatory, vitreous china	2	28.00 Ea.	$1,038.47	$1,300.63	27.5000	27	27	$35,116.94	$35,116.94
Replace lavatory, vitreous china	35	28.00 Ea.	$21,038.52	$25,224.79	1.5714	1	1	$25,224.79	$25,224.79
Replace faucet washer sink, iron enamel	2	2.00 Ea.	$27.01	$33.69	27.5000	27	27	$909.67	$909.67
Clean trap sink, iron enamel	3	2.00 Ea.	$18.04	$22.59	18.3333	18	18	$406.58	$406.58
Replace faucets sink, iron enamel	10	2.00 Ea.	$397.25	$477.57	5.5000	5	5	$2,387.83	$2,387.83
Unstop sink, iron enamel	2	2.00 Ea.	$88.31	$110.60	27.5000	27	27	$2,986.13	$2,986.13
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	2.00 Ea.	$1,820.34	$2,141.40	5.5000	5	5	$10,707.01	$10,707.01
Inspect / clean shower head bathtub, fiberglass	3	26.00 Ea.	$1,353.53	$1,695.21	18.3333	18	18	$30,513.85	$30,513.85
Replace mixing valve bathtub, fiberglass	10	26.00 Ea.	$7,639.43	$9,295.49	5.5000	5	5	$46,477.46	$46,477.46
Check / minor repairs drinking fountain	1	1.00 Ea.	$51.94	$65.06	55.0000	55	55	$3,578.16	$3,578.16
Repair internal leaks drinking fountain	4	1.00 Ea.	$47.79	$59.85	13.7500	13	13	$778.09	$778.09
Correct water pressure drinking fountain	2	1.00 Ea.	$44.15	$55.30	27.5000	27	27	$1,493.07	$1,493.07
Replace refrigerant drinking fountain	2	1.00 Ea.	$36.77	$43.00	27.5000	27	27	$1,160.92	$1,160.92
Repair drain leak drinking fountain	4	1.00 Ea.	$30.51	$36.81	13.7500	13	11	$478.51	$404.89
Replace fountain drinking fountain	10	1.00 Ea.	$1,523.39	$1,794.44	5.5000	5	5	$8,972.20	$8,972.20
Resolder joint pipe & fittings, copper	10	2.00 Ea.	$101.81	$125.57	5.5000	5	5	$627.86	$627.86
Replace pipe and fittings, copper 3/4"	20	36.00 L.F.	$867.55	$1,054.44	2.7500	2	2	$2,108.89	$2,108.89
Replace pipe and fittings, copper 2"	25	18.00 L.F.	$1,018.11	$1,220.11	2.2000	2	2	$2,440.23	$2,440.23
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	4,500.00 L.F.	$46,411.29	$56,701.60	3.6667	3	3	$170,104.80	$170,104.80
Minor repairs, adjustments water heater, gas / oil, 1150 GPH	2	1.00 Ea.	$103.37	$129.46	27.5000	27	25	$3,495.53	$3,236.61
Replace water heater, gas / oil, 1150 GPH	20	1.00 Ea.	$39,199.74	$45,178.28	2.7500	2	2	$90,356.55	$90,356.55
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	1.00 Ea.	$8.47	$10.60	110.0000	110	110	$1,166.48	$1,166.48
Replace pump / motor assembly circulation pump, 1/12 HP	10	1.00 Ea.	$1,265.32	$1,479.95	5.5000	5	5	$7,399.75	$7,399.75
Insp./chk. pump/mtr. oper., lub., chk. align. circulation pump, 1/2 HP	1	1.00 Ea.	$12.60	$15.78	55.0000	55	55	$868.06	$868.06
Replace pump / motor assembly, partial circulation pump, 1/2 HP	20	1.00 Ea.	$3,957.59	$4,560.57	2.7500	2	2	$9,121.14	$9,121.14
Remove old meter, install new water meter 4"	25	1.00 Ea.	$5,533.11	$6,455.85	2.2000	2	2	$12,911.70	$12,911.70
Unclog main drain pipe & fittings, cast iron	10	2.00 Ea.	$97.66	$122.31	5.5000	5	5	$611.54	$611.54
Replace pipe & fittings, cast iron, 4"	40	900.00 L.F.	$54,868.12	$66,496.14	1.3750	1	1	$66,496.14	$66,496.14
Unclog floor drain, PVC	20	3.00 Ea.	$151.16	$189.32	2.7500	2	2	$378.63	$378.63
Unclog 4" - 12" diameter PVC main drain per L.F.	10	26.00 L.F.	$103.99	$130.24	5.5000	5	5	$651.22	$651.22
Repair joint pipe and fittings, PVC	10	1.00 Ea.	$157.21	$195.91	5.5000	5	5	$979.56	$979.56
Replace pipe, 4" pipe and fittings, PVC	30	400.00 L.F.	$37,479.40	$45,867.95	1.8333	1	1	$45,867.95	$45,867.95
General maintenance & repair drain: roof, scupper, area	1	8.00 Ea.	$313.74	$392.95	55.0000	55	55	$21,612.07	$21,612.07
Replace drain: roof, scupper, area	40	8.00 Ea.	$8,770.86	$10,121.72	1.3750	1	1	$10,121.72	$10,121.72
Repair fan coil unit, 5 ton	10	6.00 Ea.	$3,855.72	$4,567.09	5.5000	5	4	$22,835.46	$18,268.37
Replace fan coil unit, 5 ton	15	6.00 Ea.	$17,620.60	$20,422.10	3.6667	3	3	$61,266.29	$61,266.29
Repair multi - zone rooftop unit, 25 ton	10	2.00 Ea.	$110,223.59	$126,905.43	5.5000	5	4	$634,527.13	$507,621.71
Replace multi-zone rooftop unit, 25 ton	15	2.00 Ea.	$200,310.10	$231,291.15	3.6667	3	3	$693,873.45	$693,873.45
Repair central station A.H.U., 1900 CFM	10	2.00 Ea.	$1,331.99	$1,580.92	5.5000	5	4	$7,904.58	$6,323.66
Replace central station A.H.U., 1900 CFM	15	2.00 Ea.	$31,286.71	$36,016.16	3.6667	3	3	$108,048.47	$108,048.47
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	55.0000	55	55	$2,497.55	$2,497.55
Replace sprinkler head	20	104.00 Ea.	$9,535.83	$11,751.71	2.7500	2	2	$23,503.43	$23,503.43
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	55.0000	55	55	$49,667.91	$49,667.91
Repair 500 kva transformer, primary, liquid filled	10	1.00 Ea.	$3,062.11	$3,520.43	5.5000	5	5	$17,602.15	$17,602.15
Replace transformer 500 KVA, liquid filled	30	1.00 Ea.	$77,020.30	$88,152.84	1.8333	1	1	$88,152.84	$88,152.84
Replace switchgear 1200 A mainframe	20	1.00 Ea.	$4,508.06	$5,431.65	2.7500	2	2	$10,863.30	$10,863.30
Replace fuse	25	48.00 Ea.	$29,170.10	$33,419.08	2.2000	2	2	$66,838.17	$66,838.17
Repair switchboard meter	10	2.00 Ea.	$2,643.78	$3,107.82	5.5000	5	5	$15,539.10	$15,539.10
Maintenance and repair safety switch general, 2 pole	8	1.00 Ea.	$43.82	$54.97	6.8750	6	6	$329.80	$329.80
Maintenance and inspection safety switch, 2 pole	1	1.00 Ea.	$43.82	$54.97	55.0000	55	55	$3,023.20	$3,023.20
Replace safety switch, 240 V, 2 pole	25	1.00 Ea.	$489.95	$592.21	2.2000	2	2	$1,184.41	$1,184.41
Replace low voltage cartridge safety switch	50	1.00 Ea.	$61.71	$74.17	1.1000	1	1	$74.17	$74.17
Replace plug fuse safety switch	25	1.00 Ea.	$27.58	$33.81	2.2000	2	2	$67.62	$67.62
Maintenance and repair receptacles and plugs	20	164.00 Ea.	$7,504.50	$9,376.75	2.7500	2	2	$18,753.51	$18,753.51
Replace receptacle/plug receptacles and plugs	20	164.00 Ea.	$13,241.88	$16,288.65	2.7500	2	2	$32,577.31	$32,577.31
Maintenance and repair wiring devices, switches	10	80.00 Ea.	$3,660.73	$4,574.03	5.5000	5	5	$22,870.13	$22,870.13
Replace wiring devices, switches	15	80.00 Ea.	$5,562.77	$6,926.73	3.6667	3	3	$20,780.18	$20,780.18
Maintenance and repair incandescent lighting fixtures	10	78.00 Ea.	$5,797.85	$6,904.18	5.5000	5	3	$34,520.88	$20,712.53
Replace incandescent lighting fixture lamp	5	78.00 Ea.	$1,063.35	$1,278.33	11.0000	11	11	$14,061.68	$14,061.68
Replace incandescent lighting fixture	20	78.00 Ea.	$11,535.20	$13,975.23	2.7500	2	2	$27,950.47	$27,950.47
Replace fluorescent light fixture ballast, 80 W	10	46.00 Ea.	$5,010.87	$6,179.06	5.5000	5	3	$30,895.28	$18,537.17
Replace lamps (2 lamps), 4', 34 W energy saver	10	46.00 Ea.	$1,248.97	$1,566.12	5.5000	5	5	$7,830.62	$7,830.62
Replace fluorescent fixture, lay-in, recess mtd, 2' x 4', two 40 W	20	46.00 Ea.	$12,447.65	$15,099.55	2.7500	2	2	$30,199.10	$30,199.10
Replace metal halide ballast, 175 W	10	8.00 Ea.	$1,372.49	$1,643.98	5.5000	5	3	$8,219.89	$4,931.93
Replace metal halide fixture lamp, 175 W	5	8.00 Ea.	$486.71	$591.39	11.0000	11	11	$6,505.26	$6,505.26
Replace metal halide fixture, 175 W	20	8.00 Ea.	$6,477.63	$7,622.99	2.7500	2	2	$15,245.97	$15,245.97
Repair smoke detector	10	36.00 Ea.	$2,187.54	$2,707.39	5.5000	5	4	$13,536.94	$10,829.55
Check operation smoke detector	1	36.00 Ea.	$628.76	$788.78	55.0000	55	55	$43,382.90	$43,382.90
Replace smoke detector	15	36.00 Ea.	$12,147.17	$14,454.26	3.6667	3	3	$43,362.79	$43,362.79
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	5.5000	5	4	$3,507.20	$2,805.76
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	3.6667	3	3	$4,977.08	$4,977.08
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.6667	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.7500	2	2	$971.29	$971.29
Replace lamp emergency lighting fixture	2	7.00 Ea.	$401.21	$484.25	27.5000	27	27	$13,074.80	$13,074.80
Replace emergency lighting fixture	20	7.00 Ea.	$4,366.47	$5,155.46	2.7500	2	2	$10,310.92	$10,310.92
Maintenance and repair exit light	20	4.00 Ea.	$159.66	$197.62	2.7500	2	2	$395.25	$395.25

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Replace lamp exit light	5	4.00 Ea.	$73.19	$86.76	11.0000	11	11	$954.39	$954.39
Replace lighting fixture exit light	20	4.00 Ea.	$745.76	$903.14	2.7500	2	2	$1,806.28	$1,806.28
Maintenance and repair voice/data outlet	10	6.00 Ea.	$334.16	$417.69	5.5000	5	5	$2,088.44	$2,088.44
Replace voice/data outlet	20	6.00 Ea.	$169.90	$206.92	2.7500	2	2	$413.83	$413.83
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	110.0000	110	110	$12,764.62	$12,764.62
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	3.6667	3	3	$3,414.92	$3,414.92
			$1,595,788.15	$1,888,582.54				MR Subtotal:	$4,922,715.78
								MR Per Year:	$89,503.92
								PM Total:	$15,538.37
								Subtotal:	$105,042.29
								Total Per Unit:	$6.54

FAC 7240 Officer Unaccompanied Personnel Housing

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $6.54
UM: SF
Expected Service Life: 55
Model Size: 16063

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (tank type), annualized	28	10.86	$232.53	$580.36	$0.0000	812.88	1,010.24	1,219.23
Lavatories, annually	28	2.44	$216.11	$153.97	$0.0000	370.08	437.89	516.50
Showers, annually	26	1.48	$364.52	$93.70	$0.0000	458.22	522.78	605.57
Drink fountain, annualized	1	0.62	$36.15	$33.42	$0.0000	69.57	83.21	98.65
Valve, check, above 4", annualized	2	0.51	$13.78	$27.58	$0.0000	41.36	51.01	61.35
Valve, gate, above 4", annualized	2	0.32	$13.78	$17.09	$0.0000	30.86	37.37	44.56
Water heater, steam 2500 gal., annualized	1	1.55	$155.34	$83.33	$0.0000	238.67	279.21	327.51
Air handling unit, 3 thru 24 tons, annualized	2	4.12	$326.32	$221.65	$0.0000	547.97	647.10	762.54
VAV Boxes, annualized	14	13.08	$133.36	$835.00	$0.0000	968.36	1,232.20	1,502.70
Fire dampers, annualized	2	2.31	$16.80	$148.05	$0.0000	164.85	210.95	257.89
Package unit, air cooled, 25 thru 50 ton, annualized	2	6.50	$330.23	$416.23	$0.0000	746.46	904.35	1,078.75
Controls, central system, electro/pneumatic, annualized	1	1.92	$179.77	$122.67	$0.0000	302.44	357.22	420.98
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Switchboard, annualized	2	1.40	$9.50	$100.60	$0.0000	110.10	141.23	172.83
Circuit breaker, high voltage air, annualized	4	1.88	$66.07	$133.46	$0.0000	199.53	246.18	296.13
Transformer, dry type 500 KVA and over, annualized	2	1.54	$33.03	$109.56	$0.0000	142.59	178.77	216.59
Fire alarm annuciator system, annualized	1	11.05	$195.61	$697.20	$0.0000	892.81	1,121.53	1,360.03
Light, emergency, hardwired system, annualized	7	1.75	$63.57	$110.51	$0.0000	174.08	213.59	256.28
Disposal, garbage, electric, annualized	26	39.62	$384.71	$1,502.89	$0.0000	1,887.60	2,376.94	2,885.51
Oven, convection, gas / electric, annualized	2	22.48	$105.04	$856.57	$0.0000	961.61	1,229.08	1,501.81
Refrigerator, domestic, annualized	26	6.08	$128.15	$231.27	$0.0000	359.42	441.62	530.22
						$10,397.47	$12,889.55	$15,538.37

FAC 7241 Officer UPH, Transient

FY25 SUC:	$8.22 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7242 Service Academy Unaccompanied Personnel Housing

FY25 SUC:	$4.95 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7250 Emergency Unaccompanied Personnel Housing

FY25 SUC:	$2.59 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7251 EUPH Tent Pad

FY25 SUC:	$0.19 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7311 Fire Station Facility

FY25 SUC:	$6.29 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7312 Prison/Confinement Facility

FY25 SUC:	$8.09 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7313 Police Station

FY25 SUC:	$7.59 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7314 Drug and Alcohol Abuse Center

FY25 SUC:	$4.54 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7321 Bread/Pastry Kitchen

FY25 SUC:	$5.05 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7322 Ice/Dairy Products Plant

FY25 SUC:	$8.76 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7323 Greenhouse

FY25 SUC:	$3.35 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7331 Exchange Eating Facility

FY25 SUC:	$7.39 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7332 Non-Exchange Eating Facility

FY25 SUC:	$4.67 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7333 Open Mess and Club Facility

FY25 SUC:	$7.50 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7333 Open Mess and Club Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $7.50
UM: SF
Expected Service Life: 45
Model Size: 13988

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair clay brick wall, 1st floor	25	2.00 S.F.	$95.26	$116.88	1.8000	1	1	$116.88	$116.88
Replace glass - 1st floor (1% of glass) - steel frame window	1	5.70 S.F.	$77.81	$91.37	45.0000	45	45	$4,111.48	$4,111.48
Repair 3'-9" x 5'-5" steel frame window - 1st floor.	20	29.00 Ea.	$9,949.20	$11,669.90	2.2500	2	2	$23,339.79	$23,339.79
Refinish 3'-9" x 5'-5" steel frame window - 1st floor.	5	29.00 Ea.	$2,635.35	$3,259.28	9.0000	9	9	$29,333.55	$29,333.55
Replace 3'-9" x 5'-5" steel frame window - 1st floor.	45	29.00 Ea.	$55,322.24	$63,665.48	1.0000	1	1	$63,665.48	$63,665.48
Finish new 3'-9" x 5'-5" steel frame window - 1st floor.	45	29.00 Ea.	$2,300.29	$2,842.44	1.0000	1	1	$2,842.44	$2,842.44
Repair solid core, painted, door	12	1.00 Ea.	$394.00	$472.79	3.7500	3	3	$1,418.38	$1,418.38
Prepare and refinish solid core, painted, door	4	1.00 Ea.	$72.68	$87.24	11.2500	11	11	$959.63	$959.63
Replace 3'-0" x 7'-0" solid core, painted, door	40	1.00 Ea.	$1,478.07	$1,736.45	1.1250	1	1	$1,736.45	$1,736.45
Repair steel, painted, door	14	2.00 Ea.	$1,555.12	$1,841.54	3.2143	3	3	$5,524.61	$5,524.61
Refinish 3'-0" x 7'-0" steel, painted, door	4	2.00 Ea.	$95.98	$117.51	11.2500	11	11	$1,292.56	$1,292.56
Replace 3'-0" x 7'-0" steel, painted, door	45	2.00 Ea.	$1,471.72	$1,713.14	1.0000	1	1	$1,713.14	$1,713.14
Debris removal and visual inspection of built-up roofing	0.5	6.30 M.S.F.	$256.17	$312.86	90.0000	90	90	$28,157.00	$28,157.00
Non-destructive moisture inspection of built-up roofing	5	6.30 M.S.F.	$796.37	$972.59	9.0000	9	9	$8,753.27	$8,753.27
Minor BUR membrane repairs, 2% of roof area	1	1.20 Sq.	$700.90	$828.53	45.0000	45	45	$37,283.91	$37,283.91
BUR flashing repairs, 2 S.F. per sq. repaired	1	2.50 S.F.	$9.60	$11.66	45.0000	45	45	$524.56	$524.56
Minor BUR membrane replacement, 25% of roof area	15	15.80 Sq.	$15,909.94	$18,781.08	3.0000	3	3	$56,343.25	$56,343.25
Place new BUR membrane over existing	20	63.50 Sq.	$37,712.87	$44,289.82	2.2500	2	2	$88,579.64	$88,579.64
Total BUR roof replacement	28	63.50 Sq.	$61,743.84	$72,667.22	1.6071	1	1	$72,667.22	$72,667.22
Repair solid core wood door, interior	11	16.00 Ea.	$4,749.60	$5,541.15	4.0909	4	4	$22,164.59	$22,164.59
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	16.00 Ea.	$874.90	$1,064.35	11.2500	11	10	$11,707.88	$10,643.53
Replace 3'-0" x 7'-0" solid core wood door, interior	40	16.00 Ea.	$10,300.44	$11,876.81	1.1250	1	1	$11,876.81	$11,876.81
Repair wallpaper - (2% of walls)	8	3.50 S.Y.	$77.95	$93.03	5.6250	5	5	$465.14	$465.14
Replace wallpaper	20	177.70 S.Y.	$6,228.79	$7,548.56	2.2500	2	2	$15,097.13	$15,097.13
Repair 5/8" drywall - (2% of walls)	20	144.00 S.F.	$268.99	$327.19	2.2500	2	2	$654.38	$654.38
Refinish drywall	4	5.00 S.F.	$3.61	$4.43	11.2500	11	11	$48.70	$48.70
Replace 5/8" drywall	75	5.00 S.F.	$12.90	$15.78	0.6000	0	0	$0.00	$0.00
Repair 4" x 4" thin set ceramic tile - (2% of walls)	10	0.10 C.S.F.	$92.10	$110.85	4.5000	4	4	$443.41	$443.41
Replace 4" x 4" thin set ceramic tile	75	8.00 C.S.F.	$7,951.56	$9,596.08	0.6000	0	0	$0.00	$0.00
Repair plywood paneling - (2% of walls)	10	0.60 C.S.F.	$283.41	$340.88	4.5000	4	4	$1,363.53	$1,363.53
Refinish plywood paneling	10	30.00 C.S.F.	$3,721.59	$4,563.14	4.5000	4	4	$18,252.58	$18,252.58
Replace plywood paneling	30	30.00 C.S.F.	$16,401.62	$19,819.40	1.5000	1	1	$19,819.40	$19,819.40
Refinish concrete floor finished	25	3.20 C.S.F.	$1,467.24	$1,762.80	1.8000	1	1	$1,762.80	$1,762.80
Quarry tile floor repairs - (2% of floors)	15	19.00 S.F.	$132.36	$165.02	3.0000	3	3	$495.07	$495.07
Replace quarry tile floor	50	950.00 S.F.	$15,524.32	$18,543.59	0.9000	0	0	$0.00	$0.00
Replace carpet	8	850.00 S.Y.	$47,343.74	$54,749.19	5.6250	5	5	$273,745.96	$273,745.96
Repair plaster ceiling - (2% of ceilings)	12	14.10 S.Y.	$859.53	$1,052.55	3.7500	3	3	$3,157.64	$3,157.64
Refinish plaster ceiling	10	505.00 S.Y.	$6,756.37	$8,304.24	4.5000	4	4	$33,216.97	$33,216.97
Replace plaster ceiling	75	505.00 S.Y.	$34,024.23	$41,730.11	0.6000	0	0	$0.00	$0.00
Replace flush valve diaphragm tankless water closet	10	11.00 Ea.	$303.49	$377.04	4.5000	4	4	$1,508.15	$1,508.15
Rebuild flush valve tankless water closet	20	11.00 Ea.	$2,125.98	$2,562.50	2.2500	2	2	$5,124.99	$5,124.99
Unplug clogged line tankless water closet	5	11.00 Ea.	$2,527.59	$3,165.67	9.0000	9	9	$28,491.00	$28,491.00
Replace tankless water closet	35	11.00 Ea.	$15,143.22	$17,525.15	1.2857	1	1	$17,525.15	$17,525.15
Replace tankless flush valve	25	11.00 Ea.	$2,999.21	$3,520.31	1.8000	1	1	$3,520.31	$3,520.31
Replace wax ring gasket for tankless water closet	5	11.00 Ea.	$1,647.30	$2,061.20	9.0000	9	9	$18,550.82	$18,550.82
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	6.4286	6	6	$411.31	$411.31
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.2500	2	2	$931.82	$931.82
Unplug line urinal	5	2.00 Ea.	$305.81	$383.01	9.0000	9	9	$3,447.05	$3,447.05
Replace wall-hung urinal	35	2.00 Ea.	$2,184.58	$2,628.78	1.2857	1	1	$2,628.78	$2,628.78
Replace washer in spud connection lavatory, vitreous china	7	10.00 Ea.	$173.93	$212.34	6.4286	6	6	$1,274.02	$1,274.02
Replace washer in faucet lavatory, vitreous china	2	10.00 Ea.	$135.98	$169.63	22.5000	22	22	$3,731.83	$3,731.83
Replace faucets lavatory, vitreous china	10	10.00 Ea.	$1,986.23	$2,387.83	4.5000	4	4	$9,551.34	$9,551.34
Clean out strainer and P trap lavatory, vitreous china	2	10.00 Ea.	$370.88	$464.51	22.5000	22	22	$10,219.22	$10,219.22
Replace lavatory, vitreous china	35	10.00 Ea.	$7,513.76	$9,008.85	1.2857	1	1	$9,008.85	$9,008.85
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	22.5000	22	22	$370.61	$370.61
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	15.0000	15	15	$169.41	$169.41
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	4.5000	4	4	$955.13	$955.13
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	22.5000	22	22	$1,216.57	$1,216.57
Replace sink, P.E.C.I. sink, iron enamel kitchen	35	1.00 Ea.	$910.17	$1,070.70	1.2857	1	1	$1,070.70	$1,070.70
Replace faucet washer sink, stainless steel	2	4.00 Ea.	$54.02	$67.38	22.5000	22	22	$1,482.43	$1,482.43
Clean trap sink, stainless steel	3	4.00 Ea.	$36.07	$45.18	15.0000	15	15	$677.64	$677.64
Replace faucets sink, stainless steel	10	4.00 Ea.	$794.49	$955.13	4.5000	4	4	$3,820.54	$3,820.54
Unstop sink, stainless steel	2	4.00 Ea.	$176.61	$221.20	22.5000	22	22	$4,866.29	$4,866.29
Replace sink, stainless steel	40	4.00 Ea.	$4,758.93	$5,581.05	1.1250	1	1	$5,581.05	$5,581.05
Check / minor repairs drinking fountain	1	1.00 Ea.	$51.94	$65.06	45.0000	45	45	$2,927.58	$2,927.58
Repair internal leaks drinking fountain	4	1.00 Ea.	$47.79	$59.85	11.2500	11	11	$658.38	$658.38
Correct water pressure drinking fountain	2	1.00 Ea.	$44.15	$55.30	22.5000	22	22	$1,216.57	$1,216.57
Replace refrigerant drinking fountain	2	1.00 Ea.	$36.77	$43.00	22.5000	22	22	$945.94	$945.94
Repair drain leak drinking fountain	4	1.00 Ea.	$30.51	$36.81	11.2500	11	9	$404.89	$331.28
Replace fountain drinking fountain	10	1.00 Ea.	$1,523.39	$1,794.44	4.5000	4	4	$7,177.76	$7,177.76
Replace pipe and fittings, copper 3/4"	20	32.00 L.F.	$771.15	$937.28	2.2500	2	2	$1,874.56	$1,874.56
Replace pipe and fittings, copper 2"	25	16.00 L.F.	$904.99	$1,084.54	1.8000	1	1	$1,084.54	$1,084.54
Replace threaded steel pipe and fittings, 4"	75	150.00 L.F.	$19,901.39	$23,671.62	0.6000	0	0	$0.00	$0.00
Minor repairs, adjustments water heater, gas / oil, 1150 GPH	2	1.00 Ea.	$103.37	$129.46	22.5000	22	20	$2,848.21	$2,589.28
Clean & service water heater, gas / oil, 1150 GPH	2	1.00 Ea.	$618.14	$774.18	22.5000	22	22	$17,032.03	$17,032.03
Replace water heater, gas / oil, 1150 GPH	20	1.00 Ea.	$39,199.74	$45,178.28	2.2500	2	2	$90,356.55	$90,356.55
Replace storage tank, glass lined, P.E., 80 gal.	50	2.00 Ea.	$10,048.84	$11,450.37	0.9000	0	0	$0.00	$0.00
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.2500	2	2	$126.21	$126.21
Unclog 4" - 12" diameter PVC main drain per L.F.	10	1.00 L.F.	$4.00	$5.01	4.5000	4	4	$20.04	$20.04
Repair joint pipe and fittings, PVC	10	2.00 Ea.	$314.41	$391.82	4.5000	4	4	$1,567.29	$1,567.29
Replace pipe, 4" pipe and fittings, PVC	30	1.00 L.F.	$93.70	$114.67	1.5000	1	1	$114.67	$114.67
General maintenance & repair drain: roof, scupper, area	1	3.00 Ea.	$117.65	$147.36	45.0000	45	45	$6,630.98	$6,630.98
Replace drain: roof, scupper, area	40	3.00 Ea.	$3,289.07	$3,795.65	1.1250	1	1	$3,795.65	$3,795.65
Repair boiler, gas/oil, 2000 MBH	7	2.00 Ea.	$12,167.01	$14,231.08	6.4286	6	6	$85,386.51	$85,386.51
Replace boiler, gas/oil, 2000 MBH	30	2.00 Ea.	$118,077.57	$137,181.84	1.5000	1	1	$137,181.84	$137,181.84
Replace metal flue, all fuel SS, 6" diameter metal flue / chimney	15	1.00 L.F.	$185.43	$213.70	3.0000	3	3	$641.10	$641.10
Replace roof mounted exhaust fan, 20,300 CFM exhaust fan	20	1.00 Ea.	$12,416.18	$14,418.05	2.2500	2	2	$28,836.10	$28,836.10
Repair circulator pump, 1/12 - 3/4 H.P.	5	2.00 Ea.	$209.65	$247.29	9.0000	9	6	$2,225.64	$1,483.76
Replace circulator pump, 1/12 - 3/4 H.P.	15	2.00 Ea.	$7,375.75	$8,507.92	3.0000	3	3	$25,523.75	$25,523.75
Repair damaged pipe insulation, fiberglass 3/4"	5	2.00 Ea.	$45.91	$55.98	9.0000	9	9	$503.80	$503.80
Replace pipe insulation, fiberglass 3/4"	5	0.50 M.L.F.	$4,733.30	$5,745.54	9.0000	9	9	$51,709.86	$51,709.86
Repair terminal reheat, 36" x 36" coil	10	1.00 Ea.	$172.46	$215.99	4.5000	4	4	$863.96	$863.96
Replace terminal reheat, 36" x 36" coil	15	1.00 Ea.	$3,907.37	$4,535.10	3.0000	3	3	$13,605.29	$13,605.29
Repair single zone rooftop unit, 25 ton	10	2.00 Ea.	$110,145.67	$126,807.84	4.5000	4	3	$507,231.36	$380,423.52
Replace single zone rooftop unit, 25 ton	15	2.00 Ea.	$103,991.80	$120,837.62	3.0000	3	3	$362,512.86	$362,512.86
Repair central station A.H.U., 33,500 CFM	10	1.00 Ea.	$6,189.44	$7,103.21	4.5000	4	3	$28,412.86	$21,309.64
Replace central station A.H.U., 33,500 CFM	15	1.00 Ea.	$158,862.35	$182,623.73	3.0000	3	3	$547,871.18	$547,871.18
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	4.5000	4	4	$4,698.57	$4,698.57
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	45.0000	45	45	$2,043.45	$2,043.45
Replace sprinkler head	20	32.00 Ea.	$2,934.10	$3,615.91	2.2500	2	2	$7,231.82	$7,231.82
Replace fire pump / electric motor assembly 100 H.P.	25	1.00 Ea.	$46,050.08	$53,152.38	1.8000	1	1	$53,152.38	$53,152.38
Maintenance and repair motor starter, up to 600 V	5	2.00 Ea.	$699.10	$837.86	9.0000	9	9	$7,540.73	$7,540.73
Maintenance and inspection motor starter, up to 600 V	0.5	2.00 Ea.	$116.84	$146.58	90.0000	90	90	$13,192.14	$13,192.14
Replace starter motor starter, up to 600 V	18	2.00 Ea.	$1,637.91	$1,954.90	2.5000	2	2	$3,909.80	$3,909.80
Maintenance and repair secondary transformer, dry	10	1.00 Ea.	$295.51	$351.26	4.5000	4	4	$1,405.05	$1,405.05
Maintenance and inspection secondary transformer, dry	0.5	1.00 Ea.	$87.02	$109.17	90.0000	90	90	$9,825.40	$9,825.40
Replace transformer 112.5 KVA	30	1.00 Ea.	$7,946.28	$9,315.02	1.5000	1	1	$9,315.02	$9,315.02
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	15.0000	15	15	$1,649.02	$1,649.02
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	44.00 Ea.	$3,400.61	$4,266.07	2.2500	2	2	$8,532.14	$8,532.14
Maintenance and inspection circuit breaker, molded case, 480 V, 1 pole	0.5	44.00 Ea.	$1,526.26	$1,914.69	90.0000	90	90	$172,322.32	$172,322.32
Replace circuit breaker molded case, 480 V, 1 pole circuit breaker	50	44.00 Ea.	$39,707.90	$45,876.17	0.9000	0	0	$0.00	$0.00
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	3.00 Ea.	$131.45	$164.90	5.6250	5	5	$824.51	$824.51
Maintenance and inspection safety switch, 3 pole, heavy duty	1	3.00 Ea.	$131.45	$164.90	45.0000	45	45	$7,420.58	$7,420.58
Replace safety switch, heavy duty 30 A	25	3.00 Ea.	$2,302.71	$2,733.12	1.8000	1	1	$2,733.12	$2,733.12
Maintenance and repair receptacles and plugs	20	60.00 Ea.	$2,745.55	$3,430.52	2.2500	2	2	$6,861.04	$6,861.04
Replace receptacle/plug receptacles and plugs	20	60.00 Ea.	$4,844.59	$5,959.26	2.2500	2	2	$11,918.53	$11,918.53
Maintenance and repair wiring devices, switches	10	13.00 Ea.	$594.87	$743.28	4.5000	4	4	$2,973.12	$2,973.12
Replace wiring devices, switches	15	13.00 Ea.	$903.95	$1,125.59	3.0000	3	3	$3,376.78	$3,376.78
Replace fluorescent light fixture ballast, 80 W	10	134.00 Ea.	$14,596.89	$17,999.86	4.5000	4	2	$71,999.44	$35,999.72
Replace lamps (2 lamps), 4', 34 W energy saver	10	134.00 Ea.	$3,638.32	$4,562.19	4.5000	4	4	$18,248.75	$18,248.75
Replace fluorescent fixture, lay-in, recess mtd, 2' x 4', two 40 W	20	134.00 Ea.	$36,260.55	$43,985.64	2.2500	2	2	$87,971.29	$87,971.29
Repair smoke detector	10	25.00 Ea.	$1,519.13	$1,880.13	4.5000	4	3	$7,520.52	$5,640.39
Check operation smoke detector	1	25.00 Ea.	$436.64	$547.76	45.0000	45	45	$24,649.38	$24,649.38
Replace smoke detector	15	25.00 Ea.	$8,435.53	$10,037.68	3.0000	3	3	$30,113.05	$30,113.05
Repair heat detector	10	25.00 Ea.	$1,656.35	$2,036.07	4.5000	4	4	$8,144.27	$8,144.27
Check operation heat detector	1	25.00 Ea.	$436.64	$547.76	45.0000	45	45	$24,649.38	$24,649.38
Replace heat detector	15	25.00 Ea.	$4,745.08	$5,795.46	3.0000	3	3	$17,386.38	$17,386.38
Check and repair manual pull station	10	8.00 Ea.	$759.91	$935.25	4.5000	4	3	$3,741.02	$2,805.76
Replace manual pull station	15	8.00 Ea.	$1,840.61	$2,212.03	3.0000	3	3	$6,636.10	$6,636.10
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	9.0000	9	9	$1,758.83	$1,758.83
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	90.0000	90	90	$5,221.89	$5,221.89

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.0000	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	12.00 Ea.	$2,405.22	$2,913.86	2.2500	2	2	$5,827.72	$5,827.72
Maintenance and repair of general wiring lightning protection system	1	1.00 M.L.F.	$111.32	$137.36	45.0000	45	45	$6,181.17	$6,181.17
Replace lightning protection general wiring system	25	1.00 M.L.F.	$13,424.28	$15,895.64	1.8000	1	1	$15,895.64	$15,895.64
Maintenance and repair lightning ground rod	1	8.00 Ea.	$763.68	$954.66	45.0000	45	44	$42,959.85	$42,005.18
Replace lightning ground rod	25	8.00 Ea.	$2,062.26	$2,548.46	1.8000	1	1	$2,548.46	$2,548.46
Replace lamp emergency lighting fixture	2	20.00 Ea.	$1,146.31	$1,383.58	22.5000	22	22	$30,438.69	$30,438.69
Replace emergency lighting fixture	20	20.00 Ea.	$12,475.64	$14,729.89	2.2500	2	2	$29,459.78	$29,459.78
Maintenance and repair exit light	20	20.00 Ea.	$798.31	$988.12	2.2500	2	2	$1,976.24	$1,976.24
Replace lamp exit light	5	20.00 Ea.	$365.97	$433.82	9.0000	9	9	$3,904.34	$3,904.34
Replace lighting fixture exit light	20	20.00 Ea.	$3,728.82	$4,515.70	2.2500	2	2	$9,031.39	$9,031.39
			$1,241,479.11	$1,453,801.10				MR Subtotal:	$3,529,951.88
								MR Per Year:	$78,443.38
								PM Total:	$26,464.09
								Subtotal:	$104,907.47
								Total Per Unit:	$7.50

FAC 7333 Open Mess and Club Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $7.50
UM: SF
Expected Service Life: 45
Model Size: 13988

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	6	1.56	$94.93	$70.40	$0.0000	165.33	195.95	231.31
Fire doors, swinging, annualized	8	3.14	$115.91	$128.60	$0.0000	244.51	294.68	350.65
Wheelchair lift, annualized	2	2.42	$56.56	$223.37	$0.0000	279.93	352.59	428.09
Urinals, annualized	8	1.82	$54.71	$98.14	$0.0000	152.85	187.76	225.41
Toilet (vacuum breaker type), annualized	12	2.12	$110.21	$114.72	$0.0000	224.92	270.36	321.31
Lavatories, annualized	12	4.18	$92.62	$263.95	$0.0000	356.57	445.02	538.10
Drink fountain, annualized	2	1.24	$72.30	$66.83	$0.0000	139.13	166.41	197.31
Water heater, gas, to 120 gal., annualized	3	5.16	$265.26	$276.64	$0.0000	541.90	651.42	774.20
Boiler, hot water, oil, gas, or comb. fired, 120 - 500 MBH, annualized	2	31.76	$180.74	$2,030.40	$0.0000	2,211.14	2,838.34	3,474.57
Chiller, recip., air cooled, up to 25 tons, annualized	2	19.45	$214.94	$1,243.62	$0.0000	1,458.56	1,853.14	2,258.47
Air handling unit, 25 thru 50 tons, annualized	1	1.94	$228.62	$104.06	$0.0000	332.68	386.76	452.27
VAV Boxes, annualized	6	5.60	$57.15	$357.86	$0.0000	415.01	528.09	644.02
Hood and blower, annualized	2	4.64	$119.19	$248.72	$0.0000	367.92	454.45	546.95
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Fire pump, electric motor driven, annualized	1	47.75	$61.55	$3,003.30	$0.0000	3,064.85	3,972.00	4,882.22
Extinguishing system, dry chemical, annualized	2	11.21	$8.36	$600.66	$0.0000	609.02	790.06	971.51
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Emergency diesel or gas generator, over 15 KVA, annualized	1	16.15	$88.82	$1,020.90	$0.0000	1,109.72	1,424.87	1,744.47
Battery system and charger, annualized	4	34.93	$87.82	$2,211.12	$0.0000	2,298.94	2,971.06	3,647.57
Light, emergency, hardwired system, annualized	20	5.00	$181.64	$315.73	$0.0000	497.37	610.25	732.22
Refrigerator display, walk-in w/ external condenser case, annualized	2	4.75	$858.50	$180.90	$0.0000	1,039.40	1,179.52	1,362.56
Refrigerator freezer, walk-in box w/external condenser, annualized	2	2.93	$858.50	$111.41	$0.0000	969.91	1,089.19	1,251.39
						$17,399.59	$21,833.60	$26,464.09

FAC 7340 Thrift Shop

FY25 SUC:	$5.67 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7341 Bus Station

FY25 SUC:	$3.35 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7342 Laundry/Dry Cleaning Facility

FY25 SUC:	$4.45 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7342 Laundry/Dry Cleaning Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.45
UM: SF
Expected Service Life: 45
Model Size: 4172

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	85.00 S.F.	$3,458.17	$4,211.78	3.0000	3	3	$12,635.34	$12,635.34
Replace metal floor grating	30	46.00 S.F.	$1,323.43	$1,526.98	1.5000	1	1	$1,526.98	$1,526.98
Repair 8" concrete block wall, 1st floor	25	392.00 S.F.	$10,495.17	$12,839.20	1.8000	1	1	$12,839.20	$12,839.20
Repair clay brick wall, 1st floor	25	190.00 S.F.	$9,049.83	$11,103.13	1.8000	1	1	$11,103.13	$11,103.13
Repair 3'-9" x 5'-5" steel frame window - 1st floor.	20	9.00 Ea.	$3,087.68	$3,621.69	2.2500	2	2	$7,243.38	$7,243.38
Refinish 3'-9" x 5'-5" steel frame window - 1st floor.	5	9.00 Ea.	$817.87	$1,011.50	9.0000	9	9	$9,103.52	$9,103.52
Replace 3'-9" x 5'-5" steel frame window - 1st floor.	45	9.00 Ea.	$17,168.97	$19,758.25	1.0000	1	1	$19,758.25	$19,758.25
Replace glass - 1st floor. (1% of glass) - alum. window	1	4.56 S.F.	$62.25	$73.09	45.0000	45	45	$3,289.19	$3,289.19
Repair aluminum storefront door	12	2.00 Ea.	$1,099.17	$1,310.67	3.7500	3	3	$3,932.01	$3,932.01
Replace insulating glass - (3% of glass) aluminum storefront door	1	0.63 S.F.	$42.59	$49.60	45.0000	45	45	$2,231.87	$2,231.87
Repair steel, painted, door	14	2.00 Ea.	$1,555.12	$1,841.54	3.2143	3	3	$5,524.61	$5,524.61
Refinish 3'-0" x 7'-0" steel, painted, door	4	2.00 Ea.	$95.98	$117.51	11.2500	11	11	$1,292.56	$1,292.56
Replace 3'-0" x 7'-0" steel, painted, door	45	2.00 Ea.	$1,471.72	$1,713.14	1.0000	1	1	$1,713.14	$1,713.14
Repair 12' x 12' steel roll-up door	10	1.00 Ea.	$902.17	$1,063.12	4.5000	4	4	$4,252.49	$4,252.49
Refinish 12' x 12' steel roll-up door	5	1.00 Ea.	$256.05	$310.64	9.0000	9	9	$2,795.79	$2,795.79
Replace 12' x 12' steel roll-up door	35	1.00 Ea.	$3,608.67	$4,252.49	1.2857	1	1	$4,252.49	$4,252.49
Debris removal and visual inspection of built-up roofing	0.5	4.20 M.S.F.	$170.78	$208.57	90.0000	90	90	$18,771.34	$18,771.34
BUR flashing repairs, 2 S.F. per sq. repaired	1	83.00 S.F.	$318.61	$387.01	45.0000	45	45	$17,415.43	$17,415.43
Total BUR roof replacement	28	41.70 Sq.	$40,546.74	$47,720.05	1.6071	1	1	$47,720.05	$47,720.05
Repair steel painted interior door	14	2.00 Ea.	$593.70	$692.64	3.2143	3	3	$2,077.93	$2,077.93
Refinish 3'-0" x 7'-0" steel painted interior door	4	2.00 Ea.	$120.41	$148.05	11.2500	11	11	$1,628.54	$1,628.54
Repair solid core wood door, interior	11	4.00 Ea.	$1,187.40	$1,385.29	4.0909	4	4	$5,541.15	$5,541.15
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	4.00 Ea.	$218.73	$266.09	11.2500	11	10	$2,926.97	$2,660.88
Replace 3'-0" x 7'-0" solid core wood door, interior	40	4.00 Ea.	$2,575.11	$2,969.20	1.1250	1	1	$2,969.20	$2,969.20
Repair 5/8" drywall - (2% of walls)	20	25.48 S.F.	$47.60	$57.89	2.2500	2	2	$115.79	$115.79
Refinish drywall	4	1,172.00 S.F.	$846.25	$1,037.69	11.2500	11	11	$11,414.63	$11,414.63
Repair gypsum board ceiling - (2% of ceilings)	20	2.60 C.S.F.	$1,062.50	$1,302.78	2.2500	2	2	$2,605.57	$2,605.57
Refinish gypsum board ceiling, up to 12' high	20	12.10 C.S.F.	$1,840.86	$2,263.23	2.2500	2	2	$4,526.46	$4,526.46
Replace flush valve diaphragm tankless water closet	10	3.00 Ea.	$82.77	$102.83	4.5000	4	4	$411.31	$411.31
Rebuild flush valve tankless water closet	20	3.00 Ea.	$579.81	$698.86	2.2500	2	2	$1,397.72	$1,397.72
Unplug clogged line tankless water closet	5	3.00 Ea.	$689.34	$863.36	9.0000	9	9	$7,770.27	$7,770.27
Replace tankless water closet	35	3.00 Ea.	$4,129.97	$4,779.59	1.2857	1	1	$4,779.59	$4,779.59
Replace tankless flush valve	25	3.00 Ea.	$817.97	$960.08	1.8000	1	1	$960.08	$960.08
Replace wax ring gasket for tankless water closet	5	3.00 Ea.	$449.26	$562.15	9.0000	9	9	$5,059.31	$5,059.31
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	6.4286	6	6	$411.31	$411.31
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.2500	2	2	$931.82	$931.82
Unplug line urinal	5	2.00 Ea.	$305.81	$383.01	9.0000	9	9	$3,447.05	$3,447.05
Replace wall-hung urinal	35	2.00 Ea.	$2,184.58	$2,628.78	1.2857	1	1	$2,628.78	$2,628.78
Replace washer in spud connection lavatory, vitreous china	7	4.00 Ea.	$69.57	$84.93	6.4286	6	6	$509.61	$509.61
Replace washer in faucet lavatory, vitreous china	2	4.00 Ea.	$54.39	$67.85	22.5000	22	22	$1,492.73	$1,492.73
Replace faucets lavatory, vitreous china	10	4.00 Ea.	$794.49	$955.13	4.5000	4	4	$3,820.54	$3,820.54
Clean out strainer and P trap lavatory, vitreous china	2	4.00 Ea.	$148.35	$185.80	22.5000	22	22	$4,087.69	$4,087.69
Replace lavatory, vitreous china	35	4.00 Ea.	$3,005.50	$3,603.54	1.2857	1	1	$3,603.54	$3,603.54
Replace faucet washer sink, iron enamel	2	2.00 Ea.	$27.01	$33.69	22.5000	22	22	$741.21	$741.21
Clean trap sink, iron enamel	3	2.00 Ea.	$18.04	$22.59	15.0000	15	15	$338.82	$338.82
Replace faucets sink, iron enamel	10	2.00 Ea.	$397.25	$477.57	4.5000	4	4	$1,910.27	$1,910.27
Unstop sink, iron enamel	2	2.00 Ea.	$88.31	$110.60	22.5000	22	22	$2,433.15	$2,433.15
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	2.00 Ea.	$1,820.34	$2,141.40	4.5000	4	4	$8,565.61	$8,565.61
Replace faucet washer sink, stainless steel	2	3.00 Ea.	$40.51	$50.54	22.5000	22	22	$1,111.82	$1,111.82
Clean trap sink, stainless steel	3	3.00 Ea.	$27.05	$33.88	15.0000	15	15	$508.23	$508.23
Replace faucets sink, stainless steel	10	3.00 Ea.	$595.87	$716.35	4.5000	4	4	$2,865.40	$2,865.40
Unstop sink, stainless steel	2	3.00 Ea.	$132.46	$165.90	22.5000	22	22	$3,649.72	$3,649.72
Replace sink, stainless steel	40	3.00 Ea.	$3,569.20	$4,185.79	1.1250	1	1	$4,185.79	$4,185.79
Inspect and clean spray heads, emergency eye wash	3	1.00 Ea.	$52.06	$65.20	15.0000	15	15	$978.01	$978.01
Replace eye wash station, emergency eye wash	25	1.00 Ea.	$790.45	$961.55	1.8000	1	1	$961.55	$961.55
Replace threaded steel pipe and fittings, 2"	75	120.00 L.F.	$6,816.01	$8,222.29	0.6000	0	0	$0.00	$0.00
Overhaul water heater, gas / oil, 30 gallon	5	1.00 Ea.	$123.45	$154.62	9.0000	9	9	$1,391.54	$1,391.54
Clean and service water heater, gas / oil, 30 gallon	1	1.00 Ea.	$206.74	$258.93	45.0000	45	45	$11,651.78	$11,651.78
Replace water heater, gas / oil, 30 gallon	10	1.00 Ea.	$1,751.92	$2,063.20	4.5000	4	4	$8,252.79	$8,252.79
Minor repairs, adjustments water heater, gas / oil, 1150 GPH	2	1.00 Ea.	$103.37	$129.46	22.5000	22	22	$2,848.21	$2,848.21
Clean & service water heater, gas / oil, 1150 GPH	2	1.00 Ea.	$618.14	$774.18	22.5000	22	22	$17,032.03	$17,032.03
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	1.00 Ea.	$8.47	$10.60	90.0000	90	90	$954.39	$954.39
Replace pump / motor assembly circulation pump, 1/12 HP	10	1.00 Ea.	$1,265.32	$1,479.95	4.5000	4	4	$5,919.80	$5,919.80
Unclog floor drain, PVC	20	4.00 Ea.	$201.54	$252.42	2.2500	2	2	$504.85	$504.85
General maintenance & repair drain: roof, scupper, area	1	6.00 Ea.	$235.31	$294.71	45.0000	45	45	$13,261.95	$13,261.95
Replace drain: roof, scupper, area	40	6.00 Ea.	$6,578.14	$7,591.29	1.1250	1	1	$7,591.29	$7,591.29
Repair fan coil unit, 10 ton	10	1.00 Ea.	$1,088.60	$1,269.85	4.5000	4	3	$5,079.40	$3,809.55
Replace fan coil unit, 10 ton	15	1.00 Ea.	$6,222.39	$7,284.83	3.0000	3	3	$21,854.49	$21,854.49
Replace roof mounted exhaust fan, 800 CFM exhaust fan	20	2.00 Ea.	$3,451.15	$4,045.26	2.2500	2	2	$8,090.51	$8,090.51
Repair heat pump, 10 ton, air to air split	10	1.00 Ea.	$4,477.94	$5,292.00	4.5000	4	4	$21,167.99	$21,167.99
Replace heat pump, 10 ton, air to air split	20	1.00 Ea.	$12,496.13	$14,824.22	2.2500	2	2	$29,648.44	$29,648.44
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	4.5000	4	4	$4,698.57	$4,698.57
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	45.0000	45	45	$2,043.45	$2,043.45
Replace sprinkler head	20	20.00 Ea.	$1,833.81	$2,259.94	2.2500	2	2	$4,519.89	$4,519.89
Replace fuse	25	36.00 Ea.	$21,877.58	$25,064.31	1.8000	1	1	$25,064.31	$25,064.31
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	4.5000	4	4	$6,215.64	$6,215.64
Maintenance and repair motor starter, up to 600 V	5	1.00 Ea.	$349.55	$418.93	9.0000	9	9	$3,770.37	$3,770.37
Maintenance and inspection motor starter, up to 600 V	0.5	1.00 Ea.	$58.42	$73.29	90.0000	90	90	$6,596.07	$6,596.07
Replace starter motor starter, up to 600 V	18	3.00 Ea.	$2,456.87	$2,932.35	2.5000	2	2	$5,864.71	$5,864.71
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	15.0000	15	15	$1,649.02	$1,649.02
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	4.00 Ea.	$309.15	$387.82	2.2500	2	2	$775.65	$775.65
Maintenance and repair breaker, enclosed, 240 V, 1 pole	25	8.00 Ea.	$618.29	$775.65	1.8000	1	1	$775.65	$775.65
Maintenance and repair breaker, enclosed, 240 V, 3 pole	25	6.00 Ea.	$463.72	$581.74	1.8000	1	1	$581.74	$581.74
Maintenance and inspection safety switch, 3 pole	1	4.00 Ea.	$175.26	$219.87	45.0000	45	45	$9,894.10	$9,894.10
Replace fluorescent light fixture ballast, 80 W	10	20.00 Ea.	$2,178.64	$2,686.55	4.5000	4	4	$10,746.19	$10,746.19
Replace lamps (2 lamps), 4', 34 W energy saver	10	20.00 Ea.	$543.03	$680.92	4.5000	4	4	$2,723.69	$2,723.69
Replace metal halide ballast, 175 W	10	8.00 Ea.	$1,372.49	$1,643.98	4.5000	4	4	$6,575.91	$6,575.91
Replace metal halide fixture lamp, 175 W	5	8.00 Ea.	$486.71	$591.39	9.0000	9	9	$5,322.49	$5,322.49
Repair smoke detector	10	12.00 Ea.	$729.18	$902.46	4.5000	4	3	$3,609.85	$2,707.39
Replace smoke detector	15	12.00 Ea.	$4,049.06	$4,818.09	3.0000	3	3	$14,454.26	$14,454.26
Repair heat detector	10	8.00 Ea.	$530.03	$651.54	4.5000	4	4	$2,606.17	$2,606.17
Check operation heat detector	1	8.00 Ea.	$139.72	$175.28	45.0000	45	45	$7,887.80	$7,887.80
Replace heat detector	15	8.00 Ea.	$1,518.43	$1,854.55	3.0000	3	3	$5,563.64	$5,563.64
Check and repair manual pull station	10	2.00 Ea.	$189.98	$233.81	4.5000	4	3	$935.25	$701.44
Replace manual pull station	15	2.00 Ea.	$460.15	$553.01	3.0000	3	3	$1,659.03	$1,659.03
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	9.0000	9	9	$1,758.83	$1,758.83
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	90.0000	90	90	$5,221.89	$5,221.89
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.0000	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.2500	2	2	$971.29	$971.29
Replace building structure ground	50	0.80 M.L.F.	$4,662.74	$5,639.58	0.9000	0	0	$0.00	$0.00
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	45.0000	45	44	$10,739.96	$10,501.30
Replace lightning ground rod	25	2.00 Ea.	$515.56	$637.11	1.8000	1	1	$637.11	$637.11
Replace lamp emergency lighting fixture	2	6.00 Ea.	$343.89	$415.07	22.5000	22	22	$9,131.61	$9,131.61
Replace emergency lighting fixture	20	6.00 Ea.	$3,742.69	$4,418.97	2.2500	2	2	$8,837.93	$8,837.93
Maintenance and repair exit light	20	8.00 Ea.	$319.32	$395.25	2.2500	2	2	$790.50	$790.50
Replace lamp exit light	5	4.00 Ea.	$73.19	$86.76	9.0000	9	9	$780.87	$780.87
Maintenance and repair voice/data outlet	10	4.00 Ea.	$222.77	$278.46	4.5000	4	4	$1,113.84	$1,113.84
Replace voice/data outlet	20	4.00 Ea.	$113.27	$137.94	2.2500	2	2	$275.89	$275.89
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	90.0000	90	90	$10,443.78	$10,443.78
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	3.0000	3	3	$3,414.92	$3,414.92
			$227,943.36	$270,038.08				MR Subtotal:	$640,282.59
								MR Per Year:	$14,228.50
								PM Total:	$4,327.83
								Subtotal:	$18,556.33
								Total Per Unit:	$4.45

FAC 7342 Laundry/Dry Cleaning Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM
FY25 SUC: $4.45
UM: SF
Expected Service Life: 45
Model Size: 4172

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	2	0.52	$31.64	$23.47	$0.0000	55.11	65.32	77.10
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (vacuum breaker type), annualized	3	0.53	$27.55	$28.68	$0.0000	56.23	67.59	80.33
Lavatories, annualized	4	1.39	$30.87	$87.98	$0.0000	118.86	148.34	179.37
Valve, globe, above 4", annualized	3	0.48	$20.66	$25.63	$0.0000	46.30	56.05	66.84
Valve, OS&Y, above 4", annualized	1	0.16	$6.89	$8.54	$0.0000	15.43	18.68	22.28
Water heater, gas, to 120 gal., annualized	1	1.72	$88.42	$92.21	$0.0000	180.63	217.14	258.07
Valve, pressure relief, above 4", annualized	2	0.30	$12.21	$15.90	$0.0000	28.12	34.11	40.71
Fan coil unit, annualized	1	3.34	$85.98	$179.35	$0.0000	265.33	327.73	394.43
VAV Boxes, annualized	2	1.87	$19.05	$119.29	$0.0000	138.34	176.03	214.67
Fan, axial, up to 5,000 CFM, annualized	2	2.49	$27.55	$133.67	$0.0000	161.22	204.07	248.31
Heat pump, air cooled, over 5 ton, annualized	1	3.59	$171.95	$229.27	$0.0000	401.22	487.19	581.77
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Extinguishing system, foam bottle, annualized	1	3.71	$21.49	$199.66	$0.0000	221.15	283.20	346.32
Transformer, dry type 500 KVA and over, annualized	1	0.77	$16.52	$54.78	$0.0000	71.30	89.38	108.29
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Motor control center, over 400 A, annualized	1	0.39	$25.95	$27.89	$0.0000	53.84	64.80	77.06
Light, emergency, hardwired system, annualized	4	1.00	$36.33	$63.15	$0.0000	99.47	122.05	146.44
						$2,870.69	$3,580.30	$4,327.83

FAC 7343 Clothing Sales Store

FY25 SUC:	$4.33 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7344 Postal Facility

FY25 SUC:	$6.68 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7345 Exchange Automobile Facility

FY25 SUC:	$5.26 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7346 Exchange Sales Facility

FY25 SUC:	$3.99 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7347 Bank and Credit Union

FY25 SUC:	$3.71 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7348 Car Wash Facility

FY25 SUC:	$3.43 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7349 Commissary

FY25 SUC:	$2.50 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7350 Car Wash Structure

FY25 SUC:	$6.95 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7351 Education Center

FY25 SUC:	$5.52 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7352 Dependent School

FY25 SUC:	$5.22 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7353 Dependent School Support Facility

FY25 SUC:	$8.87 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7361 Chapel Facility

FY25 SUC:	$5.36 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7361 Chapel Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $5.36
UM: SF
Expected Service Life: 50
Model Size: 8118

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair masonry steps	4	420.00 S.F.	$10,341.65	$12,570.84	12.5000	12	12	$150,850.04	$150,850.04
Repair wrought iron balustrade	20	64.00 L.F.	$11,529.97	$13,615.98	2.5000	2	2	$27,231.97	$27,231.97
Point and refinish painted concrete block wall, 1st floor	25	9.70 C.S.F.	$5,317.78	$6,535.56	2.0000	2	2	$13,071.12	$13,071.12
Repair clay brick wall, 1st floor	25	204.00 S.F.	$9,716.66	$11,921.26	2.0000	2	2	$23,842.52	$23,842.52
Replace glass - 2nd floor. (1% of glass) - alum. window	1	5.60 S.F.	$105.08	$125.38	50.0000	50	50	$6,269.07	$6,269.07
Repair 3' x 4' aluminum window - 2nd floor	20	62.00 Ea.	$21,857.63	$25,906.36	2.5000	2	2	$51,812.73	$51,812.73
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	9.20 S.F.	$125.59	$147.47	50.0000	50	50	$7,373.42	$7,373.42
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	52.00 Ea.	$8,397.90	$10,007.71	2.5000	2	2	$20,015.41	$20,015.41
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	52.00 Ea.	$42,731.71	$49,925.89	1.0000	1	1	$49,925.89	$49,925.89
Repair window - 1st floor (2% of glass) - fixed glass block	8	28.00 S.F.	$2,297.80	$2,737.75	6.2500	6	6	$16,426.48	$16,426.48
Replace plate glass storefront - 1st floor	50	0.40 C.S.F.	$2,118.74	$2,454.10	1.0000	1	1	$2,454.10	$2,454.10
Replace plate glass storefront - 2nd floor	50	0.40 C.S.F.	$2,187.68	$2,539.84	1.0000	1	1	$2,539.84	$2,539.84
Repair aluminum storefront door	12	4.00 Ea.	$2,198.35	$2,621.34	4.1667	4	4	$10,485.36	$10,485.36
Replace 3'-0" x 7'-0" aluminum storefront doors	50	4.00 Ea.	$11,457.85	$13,436.80	1.0000	1	1	$13,436.80	$13,436.80
Repair solid core, painted, door	12	4.00 Ea.	$1,576.02	$1,891.17	4.1667	4	4	$7,564.68	$7,564.68
Replace 3'-0" x 7'-0" solid core, painted, door	40	4.00 Ea.	$5,912.29	$6,945.80	1.2500	1	1	$6,945.80	$6,945.80
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	3.5714	3	3	$8,286.91	$8,286.91
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	1.1111	1	1	$2,569.71	$2,569.71
Replace tempered glass - (3% of glass) steel painted door	1	28.00 S.F.	$922.54	$1,089.03	50.0000	50	50	$54,451.39	$54,451.39
Prepare and refinish 3'-0" x 7'-0" steel painted. door	4	1.00 Ea.	$89.66	$110.65	12.5000	12	12	$1,327.84	$1,327.84
Replace 3'-0" x 7'-0" steel, with wire glass, door	45	1.00 Ea.	$1,677.90	$1,946.32	1.1111	1	1	$1,946.32	$1,946.32
Debris removal, by hand and visual inspection, metal panel roofing	1	8.30 M.S.F.	$203.98	$249.11	50.0000	50	50	$12,455.53	$12,455.53
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	166.00 S.F.	$804.81	$955.09	10.0000	10	10	$9,550.94	$9,550.94
Minor metal roof panel replacement, 2.5% of roof area	20	207.00 S.F.	$2,862.97	$3,386.53	2.5000	2	2	$6,773.07	$6,773.07
Total metal roof panel replacement	30	83.00 Sq.	$79,780.86	$94,343.04	1.6667	1	1	$94,343.04	$94,343.04
Repair 8" concrete block wall - (2% of walls) painted	25	12.00 C.S.F.	$14,591.26	$17,526.28	2.0000	2	2	$35,052.56	$35,052.56
Refinish concrete block wall painted	4	12.70 C.S.F.	$1,741.84	$2,094.06	12.5000	12	12	$25,128.77	$25,128.77
Repair steel painted interior door	14	1.00 Ea.	$296.85	$346.32	3.5714	3	3	$1,038.97	$1,038.97
Refinish 3'-0" x 7'-0" steel painted interior door	4	1.00 Ea.	$60.20	$74.02	12.5000	12	12	$888.29	$888.29
Repair solid core wood door, interior	11	4.00 Ea.	$1,187.40	$1,385.29	4.5455	4	4	$5,541.15	$5,541.15
Replace 3'-0" x 7'-0" solid core wood door, interior	40	4.00 Ea.	$2,575.11	$2,969.20	1.2500	1	1	$2,969.20	$2,969.20
Replace 3'-0" x 7'-0" solid core, w/ safety glass, door, interior	40	4.00 Ea.	$3,419.32	$3,928.53	1.2500	1	1	$3,928.53	$3,928.53
Repair concrete steps	15	25.00 S.F.	$771.10	$889.51	3.3333	3	3	$2,668.54	$2,668.54
Replace concrete steps	100	25.00 S.F.	$1,475.92	$1,799.68	0.5000	0	0	$0.00	$0.00
Repair 5/8" drywall - (2% of walls)	20	331.60 S.F.	$619.43	$753.44	2.5000	2	2	$1,506.88	$1,506.88
Replace vinyl tile flooring	18	260.00 S.Y.	$14,705.15	$17,999.56	2.7778	2	2	$35,999.11	$35,999.11
Ceramic tile floor repairs - (2% of floors)	15	0.09 C.S.F.	$62.70	$78.17	3.3333	3	3	$234.51	$234.51
Replace 2" x 2" thin set ceramic tile floor	50	4.60 C.S.F.	$7,517.04	$8,979.00	1.0000	1	1	$8,979.00	$8,979.00
Replace carpet	8	149.00 S.Y.	$8,299.08	$9,597.21	6.2500	6	6	$57,583.27	$57,583.27
Acoustic tile repairs - (2% of ceilings)	9	4.80 C.S.F.	$5,523.42	$6,401.69	5.5556	5	5	$32,008.45	$32,008.45
Replace flush valve diaphragm tankless water closet	10	8.00 Ea.	$220.72	$274.21	5.0000	5	5	$1,371.05	$1,371.05
Rebuild flush valve tankless water closet	20	8.00 Ea.	$1,546.17	$1,863.63	2.5000	2	2	$3,727.27	$3,727.27
Unplug clogged line tankless water closet	5	8.00 Ea.	$1,838.25	$2,302.30	10.0000	10	10	$23,023.03	$23,023.03
Replace tankless water closet	35	8.00 Ea.	$11,013.25	$12,745.57	1.4286	1	1	$12,745.57	$12,745.57
Replace tankless flush valve	25	8.00 Ea.	$2,181.24	$2,560.22	2.0000	2	2	$5,120.45	$5,120.45
Replace wax ring gasket for tankless water closet	5	8.00 Ea.	$1,198.04	$1,499.06	10.0000	10	10	$14,990.56	$14,990.56
Replace flush valve diaphragm for a urinal	7	4.00 Ea.	$110.36	$137.10	7.1429	7	7	$959.73	$959.73
Rebuild flush valve for a urinal	20	4.00 Ea.	$773.08	$931.82	2.5000	2	2	$1,863.63	$1,863.63
Unplug line urinal	5	4.00 Ea.	$611.61	$766.01	10.0000	10	10	$7,660.12	$7,660.12
Replace wall-hung urinal	35	4.00 Ea.	$4,369.16	$5,257.55	1.4286	1	1	$5,257.55	$5,257.55
Replace washer in spud connection lavatory, vitreous china	7	8.00 Ea.	$139.14	$169.87	7.1429	7	7	$1,189.09	$1,189.09
Replace washer in faucet lavatory, vitreous china	2	8.00 Ea.	$108.78	$135.70	25.0000	25	25	$3,392.57	$3,392.57
Replace faucets lavatory, vitreous china	10	8.00 Ea.	$1,588.98	$1,910.27	5.0000	5	5	$9,551.34	$9,551.34
Clean out strainer and P trap lavatory, vitreous china	2	8.00 Ea.	$296.71	$371.61	25.0000	25	25	$9,290.20	$9,290.20
Replace lavatory, vitreous china	35	8.00 Ea.	$6,011.00	$7,207.08	1.4286	1	1	$7,207.08	$7,207.08
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	25.0000	25	25	$421.14	$421.14
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	16.6667	16	16	$180.70	$180.70
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	5.0000	5	5	$1,193.92	$1,193.92
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	25.0000	25	25	$1,382.47	$1,382.47
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	1.00 Ea.	$910.17	$1,070.70	5.0000	5	5	$5,353.51	$5,353.51
Check / minor repairs drinking fountain	1	3.00 Ea.	$155.83	$195.17	50.0000	50	50	$9,758.61	$9,758.61
Repair internal leaks drinking fountain	4	3.00 Ea.	$143.37	$179.56	12.5000	12	12	$2,154.70	$2,154.70
Correct water pressure drinking fountain	2	3.00 Ea.	$132.46	$165.90	25.0000	25	25	$4,147.41	$4,147.41
Replace refrigerant drinking fountain	2	3.00 Ea.	$110.31	$128.99	25.0000	25	25	$3,224.79	$3,224.79
Repair drain leak drinking fountain	4	3.00 Ea.	$91.53	$110.43	12.5000	12	10	$1,325.10	$1,104.25
Replace fountain drinking fountain	10	3.00 Ea.	$4,570.18	$5,383.32	5.0000	5	5	$26,916.60	$26,916.60
Replace pipe and fittings, copper 3/4"	20	32.00 L.F.	$771.15	$937.28	2.5000	2	2	$1,874.56	$1,874.56
Drain and flush water heater, electric, 120 gallon	7	1.00 Ea.	$310.63	$389.04	7.1429	7	7	$2,723.30	$2,723.30
Check operation water heater, electric, 120 gallon	3	1.00 Ea.	$2.72	$3.41	16.6667	16	16	$54.54	$54.54
Unclog floor drain, PVC	20	3.00 Ea.	$151.16	$189.32	2.5000	2	2	$378.63	$378.63
Replace drain: roof, scupper, area	40	4.00 Ea.	$4,385.43	$5,060.86	1.2500	1	1	$5,060.86	$5,060.86
Repair boiler, gas, 250 MBH	7	1.00 Ea.	$2,552.63	$2,989.56	7.1429	7	6	$20,926.92	$17,937.36
Replace boiler, gas, 250 MBH	30	1.00 Ea.	$1,636.25	$2,049.31	1.6667	1	1	$2,049.31	$2,049.31
Repair circulator pump, 1/12 - 3/4 H.P.	5	1.00 Ea.	$104.83	$123.65	10.0000	10	7	$1,236.47	$865.53
Replace circulator pump, 1/12 - 3/4 H.P.	15	1.00 Ea.	$3,687.87	$4,253.96	3.3333	3	3	$12,761.87	$12,761.87
Repair damaged pipe insulation, fiberglass 3/4"	5	2.00 Ea.	$45.91	$55.98	10.0000	10	10	$559.78	$559.78
Replace pipe insulation, fiberglass 3/4"	5	0.01 M.L.F.	$94.67	$114.91	10.0000	10	10	$1,149.11	$1,149.11
Repair terminal reheat, 18" x 24" coil	10	4.00 Ea.	$440.49	$551.69	5.0000	5	5	$2,758.43	$2,758.43
Replace terminal reheat, 18" x 24" coil	15	4.00 Ea.	$9,258.55	$10,647.71	3.3333	3	3	$31,943.12	$31,943.12
Repair single zone rooftop unit, 25 ton	10	1.00 Ea.	$55,072.84	$63,403.92	5.0000	5	4	$317,019.60	$253,615.68
Replace single zone rooftop unit, 25 ton	15	1.00 Ea.	$51,995.90	$60,418.81	3.3333	3	3	$181,256.43	$181,256.43
Repair central station A.H.U., 1300 CFM	10	1.00 Ea.	$601.37	$713.88	5.0000	5	4	$3,569.42	$2,855.54
Replace central station A.H.U., 1300 CFM	15	1.00 Ea.	$10,673.04	$12,341.31	3.3333	3	3	$37,023.92	$37,023.92
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	50.0000	50	50	$2,270.50	$2,270.50
Replace sprinkler head	20	28.00 Ea.	$2,567.34	$3,163.92	2.5000	2	2	$6,327.85	$6,327.85
Replace fuse	25	22.00 Ea.	$13,369.63	$15,317.08	2.0000	2	2	$30,634.16	$30,634.16
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	5.0000	5	5	$7,769.55	$7,769.55
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	16.6667	16	16	$1,758.95	$1,758.95
Maintenance and repair breaker, enclosed, 240 V, 3 pole	25	8.00 Ea.	$618.29	$775.65	2.0000	2	2	$1,551.30	$1,551.30
Maintenance and inspection circuit breaker, enclosed, 240 V, 3 pole	1	8.00 Ea.	$277.50	$348.13	50.0000	50	50	$17,406.30	$17,406.30
Repair failed breaker, enclosed, 600 V, 3 pole	4	1.00 Ea.	$1,204.74	$1,390.73	12.5000	12	12	$16,688.78	$16,688.78
Maintenance and inspection circuit breaker, enclosed, 600 V, 3 pole	0.33	1.00 Ea.	$34.69	$43.52	151.5152	151	151	$6,570.88	$6,570.88
Replace circuit breaker enclosed, 600 V, 3 pole circuit breaker	50	1.00 Ea.	$1,110.36	$1,308.65	1.0000	1	1	$1,308.65	$1,308.65
Maintenance and repair receptacles and plugs	20	50.00 Ea.	$2,287.96	$2,858.77	2.5000	2	2	$5,717.53	$5,717.53
Replace receptacle/plug receptacles and plugs	20	50.00 Ea.	$4,037.16	$4,966.05	2.5000	2	2	$9,932.11	$9,932.11
Maintenance and repair wiring devices, switches	10	40.00 Ea.	$1,830.37	$2,287.01	5.0000	5	5	$11,435.06	$11,435.06
Replace wiring devices, switches	15	40.00 Ea.	$2,781.39	$3,463.36	3.3333	3	3	$10,390.09	$10,390.09
Maintenance and repair incandescent lighting fixtures	10	40.00 Ea.	$2,973.26	$3,540.60	5.0000	5	3	$17,703.02	$10,621.81
Replace incandescent lighting fixture lamp	5	40.00 Ea.	$545.31	$655.56	10.0000	10	10	$6,555.56	$6,555.56
Replace incandescent lighting fixture	20	40.00 Ea.	$5,915.49	$7,166.79	2.5000	2	2	$14,333.57	$14,333.57
Replace fluorescent light fixture ballast, 80 W	10	32.00 Ea.	$3,485.82	$4,298.47	5.0000	5	3	$21,492.37	$12,895.42
Replace lamps (2 lamps), 4', 34 W energy saver	10	32.00 Ea.	$868.85	$1,089.48	5.0000	5	5	$5,447.39	$5,447.39
Replace fluorescent fixture, lay-in, recess mtd, 2' x 4', two 40 W	20	32.00 Ea.	$8,659.24	$10,504.03	2.5000	2	2	$21,008.07	$21,008.07
Repair smoke detector	10	14.00 Ea.	$850.71	$1,052.87	5.0000	5	4	$5,264.36	$4,211.49
Check operation smoke detector	1	14.00 Ea.	$244.52	$306.75	50.0000	50	50	$15,337.39	$15,337.39
Replace smoke detector	15	14.00 Ea.	$4,723.90	$5,621.10	3.3333	3	3	$16,863.31	$16,863.31
Check and repair manual pull station	10	4.00 Ea.	$379.95	$467.63	5.0000	5	4	$2,338.13	$1,870.51
Replace manual pull station	15	4.00 Ea.	$920.30	$1,106.02	3.3333	3	3	$3,318.05	$3,318.05
Minor repairs to fire alarm control panel	5	2.00 Ea.	$320.55	$390.85	10.0000	10	10	$3,908.50	$3,908.50
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	100.0000	100	100	$5,802.10	$5,802.10
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	10.0000	10	10	$1,954.25	$1,954.25
Maintenance and inspection annunciation panel	0.5	1.00 Ea.	$46.25	$58.02	100.0000	100	100	$5,802.10	$5,802.10
Replace fire alarm bell, 6"	20	4.00 Ea.	$801.74	$971.29	2.5000	2	2	$1,942.57	$1,942.57
Maintenance and repair of general wiring lightning protection system	1	0.80 M.L.F.	$89.06	$109.89	50.0000	50	50	$5,494.37	$5,494.37
Replace lightning protection general wiring system	25	0.80 M.L.F.	$10,739.42	$12,716.51	2.0000	2	2	$25,433.03	$25,433.03
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	50.0000	50	48	$23,866.58	$22,911.92
Replace lightning ground rod	25	4.00 Ea.	$1,031.13	$1,274.23	2.0000	2	2	$2,548.46	$2,548.46
Replace lamp emergency lighting fixture	2	9.00 Ea.	$515.84	$622.61	25.0000	25	25	$15,565.24	$15,565.24
Replace emergency lighting fixture	20	1.00 Ea.	$623.78	$736.49	2.5000	2	2	$1,472.99	$1,472.99
Maintenance and repair exit light	20	1.00 Ea.	$39.92	$49.41	2.5000	2	2	$98.81	$98.81
Replace lamp exit light	5	1.00 Ea.	$18.30	$21.69	10.0000	10	10	$216.91	$216.91
Replace lighting fixture exit light	20	1.00 Ea.	$186.44	$225.78	2.5000	2	2	$451.57	$451.57
Maintenance and repair voice/data outlet	10	6.00 Ea.	$334.16	$417.69	5.0000	5	5	$2,088.44	$2,088.44
Replace voice/data outlet	20	6.00 Ea.	$169.90	$206.92	2.5000	2	2	$413.83	$413.83
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	100.0000	100	100	$11,604.20	$11,604.20
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	3.3333	3	3	$3,414.92	$3,414.92
			$549,449.67	$648,777.81				MR Subtotal:	$1,886,881.01
								MR Per Year:	$37,737.62
								PM Total:	$5,795.64
								Subtotal:	$43,533.26

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
								Total Per Unit:	$5.36

FAC 7361 Chapel Facility

Release:	2024 Qtr 3	FY25 SUC:	$5.36
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	50
		Model Size:	8118

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	6	1.56	$94.93	$70.40	$0.0000	165.33	195.95	231.31
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (vacuum breaker type), annualized	8	1.42	$73.47	$76.48	$0.0000	149.95	180.24	214.20
Lavatories, annualized	8	2.78	$61.75	$175.97	$0.0000	237.71	296.68	358.73
Drink fountain, annualized	3	1.86	$108.45	$100.25	$0.0000	208.70	249.62	295.96
Water heater, gas, to 120 gal., annualized	1	1.72	$88.42	$92.21	$0.0000	180.63	217.14	258.07
Air handling unit, 3 thru 24 tons, annualized	1	2.06	$163.16	$110.83	$0.0000	273.98	323.55	381.27
VAV Boxes, annualized	4	3.74	$38.10	$238.57	$0.0000	276.68	352.06	429.34
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Controls, central system, electro/pneumatic, annualized	1	1.92	$179.77	$122.67	$0.0000	302.44	357.22	420.98
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Circuit breaker, high voltage air, annualized	8	3.76	$132.14	$266.93	$0.0000	399.06	492.36	592.25
Switch, interrupt, high voltage, w/ aux fuses, air, annualized	2	0.73	$33.03	$51.79	$0.0000	84.83	103.67	124.16
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Light, emergency, hardwired system, annualized	9	2.25	$81.74	$142.08	$0.0000	223.82	274.61	329.50
Dishwasher, electric, annually	1	1.18	$56.06	$44.92	$0.0000	100.98	120.06	141.95
Disposal, garbage, electric, annualized	1	1.52	$14.80	$57.80	$0.0000	72.60	91.42	110.98
Refrigerator, domestic, annualized	1	0.23	$4.93	$8.90	$0.0000	13.82	16.99	20.39
						$3,932.05	$4,828.47	$5,795.64

FAC 7362 Religious Education Facility

FY25 SUC:	$5.47 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7362 Religious Education Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $5.47
UM: SF
Expected Service Life: 50
Model Size: 6395

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	123.00 S.F.	$5,004.18	$6,094.69	3.3333	3	3	$18,284.08	$18,284.08
Repair concrete stairs	30	220.00 S.F.	$7,013.01	$8,116.69	1.6667	1	1	$8,116.69	$8,116.69
Waterproof concrete block wall, 1st floor	10	96.00 C.S.F.	$18,628.12	$22,447.29	5.0000	5	5	$112,236.43	$112,236.43
Point and refinish painted concrete block wall, 1st floor	25	96.00 C.S.F.	$52,629.57	$64,681.82	2.0000	2	2	$129,363.63	$129,363.63
Repair clay brick wall, 1st floor	25	83.00 S.F.	$3,953.35	$4,850.32	2.0000	2	2	$9,700.63	$9,700.63
Replace clay brick wall, 2nd floor	75	8.30 C.S.F.	$21,327.93	$25,902.20	0.6667	0	0	$0.00	$0.00
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	7.20 S.F.	$98.29	$115.41	50.0000	50	50	$5,770.50	$5,770.50
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	32.00 Ea.	$5,167.94	$6,158.59	2.5000	2	2	$12,317.18	$12,317.18
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	32.00 Ea.	$26,296.44	$30,723.63	1.0000	1	1	$30,723.63	$30,723.63
Repair aluminum storefront door	12	2.00 Ea.	$1,099.17	$1,310.67	4.1667	4	4	$5,242.68	$5,242.68
Replace 3'-0" x 7'-0" aluminum storefront doors	50	2.00 Ea.	$5,728.92	$6,718.40	1.0000	1	1	$6,718.40	$6,718.40
Repair steel, painted, door	14	2.00 Ea.	$1,555.12	$1,841.54	3.5714	3	3	$5,524.61	$5,524.61
Refinish 3'-0" x 7'-0" steel, painted, door	4	2.00 Ea.	$95.98	$117.51	12.5000	12	12	$1,410.06	$1,410.06
Replace 3'-0" x 7'-0" steel, painted, door	45	2.00 Ea.	$1,471.72	$1,713.14	1.1111	1	1	$1,713.14	$1,713.14
Replace tempered glass - (3% of glass) steel painted door	1	1.26 S.F.	$41.51	$49.01	50.0000	50	50	$2,450.31	$2,450.31
Prepare and refinish 3'-0" x 7'-0" steel painted. door	4	2.00 Ea.	$179.33	$221.31	12.5000	12	12	$2,655.69	$2,655.69
Replace 3'-0" x 7'-0" steel, with wire glass, door	45	2.00 Ea.	$3,355.81	$3,892.63	1.1111	1	1	$3,892.63	$3,892.63
Debris removal and visual inspection of built-up roofing	0.5	6.40 M.S.F.	$260.24	$317.82	100.0000	100	100	$31,782.16	$31,782.16
Non-destructive moisture inspection of built-up roofing	5	6.40 M.S.F.	$809.01	$988.02	10.0000	10	10	$9,880.23	$9,880.23
Minor BUR membrane repairs, 2% of roof area	1	0.10 Sq.	$58.41	$69.04	50.0000	50	50	$3,452.21	$3,452.21
BUR flashing repairs, 2 S.F. per sq. repaired	1	0.96 S.F.	$3.70	$4.49	50.0000	50	50	$224.75	$224.75
Minor BUR membrane replacement, 25% of roof area	15	8.00 Sq.	$8,055.66	$9,509.41	3.3333	3	3	$28,528.23	$28,528.23
Total BUR roof replacement	28	64.00 Sq.	$62,230.01	$73,239.40	1.7857	1	1	$73,239.40	$73,239.40
Repair 8" concrete block wall - (2% of walls) painted	25	0.26 C.S.F.	$310.06	$372.43	2.0000	2	2	$744.87	$744.87
Refinish concrete block wall painted	4	12.77 C.S.F.	$1,751.44	$2,105.61	12.5000	12	12	$25,267.27	$25,267.27
Replace 8" concrete block wall painted	75	12.77 C.S.F.	$16,486.95	$19,841.94	0.6667	0	0	$0.00	$0.00
Refinish 3'-0" x 7'-0" steel painted interior door	4	1.00 Ea.	$60.20	$74.02	12.5000	12	12	$888.29	$888.29
Replace 3'-0" x 7'-0" steel painted interior door	60	1.00 Ea.	$1,409.52	$1,632.80	0.8333	0	0	$0.00	$0.00
Replace 3'-0" x 7'-0" solid core wood door, interior	40	14.00 Ea.	$9,012.88	$10,392.21	1.2500	1	1	$10,392.21	$10,392.21
Repair solid core sliding wood door, interior	14	14.00 Ea.	$884.19	$1,063.60	3.5714	3	3	$3,190.79	$3,190.79
Replace metal stair railing, interior	45	19.00 L.F.	$909.70	$1,065.05	1.1111	1	1	$1,065.05	$1,065.05
Repair 5/8" drywall - (2% of walls)	20	175.30 S.F.	$327.46	$398.31	2.5000	2	2	$796.61	$796.61
Refinish drywall	4	2,764.00 S.F.	$1,995.77	$2,447.26	12.5000	12	12	$29,367.08	$29,367.08
Replace 5/8" drywall	75	2,764.00 S.F.	$7,128.40	$8,724.75	0.6667	0	0	$0.00	$0.00
Refinish concrete floor finished	25	3.38 C.S.F.	$1,549.77	$1,861.95	2.0000	2	2	$3,723.91	$3,723.91
Replace vinyl tile flooring	18	240.00 S.Y.	$13,573.99	$16,614.98	2.7778	2	2	$33,229.95	$33,229.95
Ceramic tile floor repairs - (2% of floors)	15	2.10 C.S.F.	$1,462.92	$1,823.93	3.3333	3	3	$5,471.79	$5,471.79
Replace 2" x 2" thin set ceramic tile floor	50	9.29 C.S.F.	$15,181.15	$18,133.68	1.0000	1	1	$18,133.68	$18,133.68
Replace carpet	8	86.00 S.Y.	$4,790.07	$5,539.33	6.2500	6	6	$33,235.98	$33,235.98
Repair plaster ceiling - (2% of ceilings)	12	5.36 S.Y.	$326.74	$400.12	4.1667	4	4	$1,600.47	$1,600.47
Repair gypsum board ceiling - (2% of ceilings)	20	0.04 C.S.F.	$17.57	$21.55	2.5000	2	2	$43.09	$43.09
Refinish gypsum board ceiling, up to 12' high	20	2.17 C.S.F.	$330.14	$405.89	2.5000	2	1	$811.77	$405.89
Replace gypsum board ceiling, up to 12' high	40	2.17 C.S.F.	$908.94	$1,114.90	1.2500	1	1	$1,114.90	$1,114.90
Replace acoustic tile ceiling, fire-rated	20	16.40 C.S.F.	$10,244.96	$12,048.03	2.5000	2	2	$24,096.05	$24,096.05
Replace flush valve diaphragm tankless water closet	10	8.00 Ea.	$220.72	$274.21	5.0000	5	5	$1,371.05	$1,371.05
Rebuild flush valve tankless water closet	20	8.00 Ea.	$1,546.17	$1,863.63	2.5000	2	2	$3,727.27	$3,727.27
Replace tankless water closet	35	8.00 Ea.	$11,013.25	$12,745.57	1.4286	1	1	$12,745.57	$12,745.57
Replace tankless flush valve	25	8.00 Ea.	$2,181.24	$2,560.22	2.0000	2	2	$5,120.45	$5,120.45
Replace wax ring gasket for tankless water closet	5	8.00 Ea.	$1,198.04	$1,499.06	10.0000	10	10	$14,990.56	$14,990.56
Replace flush valve diaphragm for a urinal	7	4.00 Ea.	$110.36	$137.10	7.1429	7	7	$959.73	$959.73
Rebuild flush valve for a urinal	20	4.00 Ea.	$773.08	$931.82	2.5000	2	2	$1,863.63	$1,863.63
Unplug line urinal	5	4.00 Ea.	$611.61	$766.01	10.0000	10	10	$7,660.12	$7,660.12
Replace wall-hung urinal	35	4.00 Ea.	$4,369.16	$5,257.55	1.4286	1	1	$5,257.55	$5,257.55
Replace washer in spud connection lavatory, vitreous china	7	6.00 Ea.	$104.36	$127.40	7.1429	7	7	$891.82	$891.82
Replace washer in faucet lavatory, vitreous china	2	6.00 Ea.	$81.59	$101.78	25.0000	25	25	$2,544.43	$2,544.43
Replace faucets lavatory, vitreous china	10	6.00 Ea.	$1,191.74	$1,432.70	5.0000	5	5	$7,163.50	$7,163.50
Clean out strainer and P trap lavatory, vitreous china	2	6.00 Ea.	$222.53	$278.71	25.0000	25	25	$6,967.65	$6,967.65
Replace lavatory, vitreous china	35	6.00 Ea.	$4,508.25	$5,405.31	1.4286	1	1	$5,405.31	$5,405.31
Replace faucet washer sink, iron enamel	2	1.00 Ea.	$13.50	$16.85	25.0000	25	25	$421.14	$421.14
Clean trap sink, iron enamel	3	1.00 Ea.	$9.02	$11.29	16.6667	16	16	$180.70	$180.70
Replace faucets sink, iron enamel	10	1.00 Ea.	$198.62	$238.78	5.0000	5	5	$1,193.92	$1,193.92
Unstop sink, iron enamel	2	1.00 Ea.	$44.15	$55.30	25.0000	25	25	$1,382.47	$1,382.47
Replace sink, P.E.C.I. sink, iron enamel kitchen	10	1.00 Ea.	$910.17	$1,070.70	5.0000	5	5	$5,353.51	$5,353.51
Check / minor repairs drinking fountain	1	2.00 Ea.	$103.89	$130.11	50.0000	50	50	$6,505.74	$6,505.74
Repair internal leaks drinking fountain	4	2.00 Ea.	$95.58	$119.71	12.5000	12	12	$1,436.47	$1,436.47
Correct water pressure drinking fountain	2	2.00 Ea.	$88.31	$110.60	25.0000	25	25	$2,764.94	$2,764.94
Replace refrigerant drinking fountain	2	2.00 Ea.	$73.54	$85.99	25.0000	25	25	$2,149.86	$2,149.86
Repair drain leak drinking fountain	4	2.00 Ea.	$61.02	$73.62	12.5000	12	10	$883.40	$736.17
Replace fountain drinking fountain	10	2.00 Ea.	$3,046.79	$3,588.88	5.0000	5	5	$17,944.40	$17,944.40
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	16.00 L.F.	$165.02	$201.61	3.3333	3	3	$604.82	$604.82
Overhaul water heater, gas / oil, 70 gallon	5	1.00 Ea.	$173.21	$216.94	10.0000	10	10	$2,169.40	$2,169.40
Clean & service water heater, gas / oil, 70 gallon	1	1.00 Ea.	$206.74	$258.93	50.0000	50	50	$12,946.42	$12,946.42
Replace water heater, gas / oil, 70 gallon	12	1.00 Ea.	$5,470.45	$6,302.52	4.1667	4	4	$25,210.08	$25,210.08
Unclog main drain pipe & fittings, cast iron	10	0.50 Ea.	$24.41	$30.58	5.0000	5	5	$152.88	$152.88
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.5000	2	2	$126.21	$126.21
General maintenance & repair drain: roof, scupper, area	1	8.00 Ea.	$313.74	$392.95	50.0000	50	50	$19,647.33	$19,647.33
Replace drain: roof, scupper, area	40	8.00 Ea.	$8,770.86	$10,121.72	1.2500	1	1	$10,121.72	$10,121.72
Repair boiler, gas, 250 MBH	7	1.00 Ea.	$2,552.63	$2,989.56	7.1429	7	6	$20,926.92	$17,937.36
Replace boiler, gas, 250 MBH	30	1.00 Ea.	$1,636.25	$2,049.31	1.6667	1	1	$2,049.31	$2,049.31
Repair circulator pump, 1/12 - 3/4 H.P.	5	1.00 Ea.	$104.83	$123.65	10.0000	10	7	$1,236.47	$865.53
Replace circulator pump, 1/12 - 3/4 H.P.	15	1.00 Ea.	$3,687.87	$4,253.96	3.3333	3	3	$12,761.87	$12,761.87
Repair terminal reheat, 12" x 24" coil	10	3.00 Ea.	$282.06	$353.26	5.0000	5	4	$1,766.31	$1,413.05
Replace terminal reheat, 12" x 24" coil	15	3.00 Ea.	$6,027.94	$6,913.43	3.3333	3	3	$20,740.29	$20,740.29
Repair single zone variable volume, 20 ton	10	1.00 Ea.	$36,712.21	$42,346.59	5.0000	5	4	$211,732.93	$169,386.34
Replace single zone variable volume, 20 ton	15	1.00 Ea.	$37,507.41	$43,805.98	3.3333	3	3	$131,417.95	$131,417.95
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	50.0000	50	50	$2,270.50	$2,270.50
Replace sprinkler head	20	24.00 Ea.	$2,200.58	$2,711.93	2.5000	2	2	$5,423.87	$5,423.87
Rebuild double check 3" backflow preventer sprinkler system	1	0.50 Ea.	$376.70	$451.53	50.0000	50	50	$22,576.32	$22,576.32
Replace fuse	25	13.00 Ea.	$7,900.24	$9,051.00	2.0000	2	2	$18,102.00	$18,102.00
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	16.6667	16	16	$1,758.95	$1,758.95
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	2.00 Ea.	$154.57	$193.91	2.5000	2	2	$387.82	$387.82
Maintenance and repair breaker, enclosed, 240 V, 2 pole	25	8.00 Ea.	$618.29	$775.65	2.0000	2	2	$1,551.30	$1,551.30
Maintenance and repair incandescent lighting fixtures	10	4.00 Ea.	$297.33	$354.06	5.0000	5	5	$1,770.30	$1,770.30
Replace incandescent lighting fixture lamp	5	4.00 Ea.	$54.53	$65.56	10.0000	10	10	$655.56	$655.56
Replace fluorescent light fixture ballast, 80 W	10	34.00 Ea.	$3,703.69	$4,567.13	5.0000	5	5	$22,835.64	$22,835.64
Replace lamps (2 lamps), 4', 34 W energy saver	10	34.00 Ea.	$923.16	$1,157.57	5.0000	5	5	$5,787.85	$5,787.85
Repair smoke detector	10	14.00 Ea.	$850.71	$1,052.87	5.0000	5	4	$5,264.36	$4,211.49
Check operation smoke detector	1	14.00 Ea.	$244.52	$306.75	50.0000	50	50	$15,337.39	$15,337.39
Replace smoke detector	15	14.00 Ea.	$4,723.90	$5,621.10	3.3333	3	3	$16,863.31	$16,863.31
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	5.0000	5	4	$3,507.20	$2,805.76
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	3.3333	3	3	$4,977.08	$4,977.08
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	10.0000	10	10	$1,954.25	$1,954.25
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	100.0000	100	100	$5,802.10	$5,802.10
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.3333	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.5000	2	2	$971.29	$971.29
Maintenance and repair of general wiring lightning protection system	1	0.50 M.L.F.	$55.66	$68.68	50.0000	50	50	$3,433.98	$3,433.98
Replace lightning protection general wiring system	25	0.50 M.L.F.	$6,712.14	$7,947.82	2.0000	2	2	$15,895.64	$15,895.64
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	50.0000	50	48	$11,933.29	$11,455.96
Replace lightning ground rod	25	2.00 Ea.	$515.56	$637.11	2.0000	2	2	$1,274.23	$1,274.23
Replace lamp emergency lighting fixture	2	6.00 Ea.	$343.89	$415.07	25.0000	25	25	$10,376.83	$10,376.83
Replace emergency lighting fixture	20	6.00 Ea.	$3,742.69	$4,418.97	2.5000	2	2	$8,837.93	$8,837.93
Maintenance and repair exit light	20	6.00 Ea.	$239.49	$296.44	2.5000	2	2	$592.87	$592.87
Replace lamp exit light	5	6.00 Ea.	$109.79	$130.14	10.0000	10	10	$1,301.45	$1,301.45
Replace lighting fixture exit light	20	6.00 Ea.	$1,118.65	$1,354.71	2.5000	2	2	$2,709.42	$2,709.42
Maintenance and repair voice/data outlet	10	4.00 Ea.	$222.77	$278.46	5.0000	5	5	$1,392.30	$1,392.30
Replace voice/data outlet	20	4.00 Ea.	$113.27	$137.94	2.5000	2	2	$275.89	$275.89
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	100.0000	100	100	$11,604.20	$11,604.20
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	3.3333	3	3	$3,414.92	$3,414.92
			$491,658.62	$584,056.09				MR Subtotal:	$1,457,416.26
								MR Per Year:	$29,148.33
								PM Total:	$5,818.03
								Subtotal:	$34,966.36
								Total Per Unit:	$5.47

FAC 7362 Religious Education Facility

Release:	2024 Qtr 3	FY25 SUC:	$5.47
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	50
		Model Size:	6395

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Fire doors, swinging, annualized	1	0.39	$14.49	$16.08	$0.0000	30.56	36.84	43.83
Urinals, annualized	4	0.91	$27.36	$49.07	$0.0000	76.42	93.88	112.70
Toilet (vacuum breaker type), annualized	8	1.42	$73.47	$76.48	$0.0000	149.95	180.24	214.20
Lavatories, annualized	6	2.09	$46.31	$131.98	$0.0000	178.29	222.51	269.05
Drink fountain, annualized	2	1.24	$72.30	$66.83	$0.0000	139.13	166.41	197.31
Boiler, hot water, oil, gas, or comb. fired, up to 120 MBH, annualized	1	12.53	$90.37	$799.47	$0.0000	889.84	1,138.72	1,392.12
VAV Boxes, annualized	9	8.41	$85.73	$536.79	$0.0000	622.52	792.13	966.02
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Controls, central system, electro/pneumatic, annualized	1	1.92	$179.77	$122.67	$0.0000	302.44	357.22	420.98
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Light, emergency, hardwired system, annualized	6	1.50	$54.49	$94.72	$0.0000	149.21	183.08	219.66
Disposal, garbage, electric, annualized	1	1.52	$14.80	$57.80	$0.0000	72.60	91.42	110.98
						$3,845.56	$4,807.89	$5,818.03

FAC 7371 Nursery and Child Care Facility

FY25 SUC:	$3.25 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7371 Nursery and Child Care Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $3.25
UM: SF
Expected Service Life: 45
Model Size: 13075

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair clay brick wall, 1st floor	25	487.00 S.F.	$23,196.14	$28,459.08	1.8000	1	1	$28,459.08	$28,459.08
Refinish aluminum louver, 1st floor	5	2.00 Ea.	$220.97	$273.43	9.0000	9	9	$2,460.90	$2,460.90
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	6.96 S.F.	$95.01	$111.56	45.0000	45	45	$5,020.34	$5,020.34
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	48.00 Ea.	$7,751.91	$9,237.88	2.2500	2	2	$18,475.77	$18,475.77
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	48.00 Ea.	$39,444.66	$46,085.44	0.9000	0	0	$0.00	$0.00
Repair aluminum storefront door	12	6.00 Ea.	$3,297.52	$3,932.01	3.7500	3	3	$11,796.03	$11,796.03
Replace 3'-0" x 7'-0" flush aluminum door	50	2.00 Ea.	$5,724.76	$6,546.14	0.9000	0	0	$0.00	$0.00
Replace wire glass - (3% of glass) aluminum door	1	1.26 S.F.	$64.05	$74.44	45.0000	45	45	$3,349.70	$3,349.70
Repair steel, painted, door	14	0.80 Ea.	$622.05	$736.61	3.2143	3	3	$2,209.84	$2,209.84
Refinish 3'-0" x 7'-0" steel, painted, door	4	8.00 Ea.	$383.94	$470.02	11.2500	11	11	$5,170.23	$5,170.23
Replace 3'-0" x 7'-0" steel, painted, door	45	8.00 Ea.	$5,886.87	$6,852.55	1.0000	1	1	$6,852.55	$6,852.55
Replace tempered glass - (3% of glass) steel painted door	1	6.35 S.F.	$209.22	$246.98	45.0000	45	45	$11,113.92	$11,113.92
Replace door panic device	25	6.00 Ea.	$14,225.73	$16,258.16	1.8000	1	1	$16,258.16	$16,258.16
Debris removal, by hand and visual inspection, metal panel roofing	1	0.21 M.S.F.	$5.16	$6.30	45.0000	45	45	$283.63	$283.63
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	237.00 S.F.	$1,149.04	$1,363.60	9.0000	9	9	$12,272.38	$12,272.38
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	14.50 S.F.	$409.75	$487.61	45.0000	45	45	$21,942.48	$21,942.48
Total metal roof panel replacement	30	116.00 Sq.	$111,500.96	$131,852.93	1.5000	1	1	$131,852.93	$131,852.93
Replace Roof edges, aluminum, duranodic, .050" thick, 6" face	25	640.00 L.F.	$19,630.50	$23,184.82	1.8000	1	1	$23,184.82	$23,184.82
Replace aluminum downspout, 2" x 3", .024" thick	25	240.00 L.F.	$1,745.53	$2,112.83	1.8000	1	1	$2,112.83	$2,112.83
Repair glass skylight glazing single unit	6	6.00 S.F.	$545.66	$637.78	7.5000	7	7	$4,464.45	$4,464.45
Replace skylight and structure, double glazed, 10 to 20 S.F.	40	6.00 S.F.	$397.26	$457.29	1.1250	1	1	$457.29	$457.29
Repair solid core wood door, interior	11	2.20 Ea.	$653.07	$761.91	4.0909	4	4	$3,047.63	$3,047.63
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	22.00 Ea.	$1,202.99	$1,463.49	11.2500	11	10	$16,098.34	$14,634.85
Replace 3'-0" x 7'-0" solid core wood door, interior	40	22.00 Ea.	$14,163.10	$16,330.61	1.1250	1	1	$16,330.61	$16,330.61
Repair medium weight vinyl wall covering - (2% of walls)	1	0.50 C.S.F.	$265.12	$309.40	45.0000	45	45	$13,923.10	$13,923.10
Replace medium weight vinyl wall covering	15	14.20 C.S.F.	$8,566.34	$10,078.12	3.0000	3	3	$30,234.37	$30,234.37
Repair fabric wall finish fabric interior	9	64.00 S.Y.	$2,463.88	$2,937.02	5.0000	5	5	$14,685.08	$14,685.08
Replace fabric wall finish fabric interior	50	64.00 S.Y.	$10,643.34	$13,112.88	0.9000	0	0	$0.00	$0.00
Repair 5/8" drywall - (2% of walls)	20	198.90 S.F.	$371.55	$451.93	2.2500	2	2	$903.86	$903.86
Refinish drywall	4	945.00 S.F.	$682.34	$836.71	11.2500	11	11	$9,203.77	$9,203.77
Replace 5/8" drywall	75	145.00 S.F.	$373.96	$457.70	0.6000	0	0	$0.00	$0.00
Replace vinyl tile flooring	18	2.79 S.Y.	$157.80	$193.15	2.5000	2	2	$386.30	$386.30
Replace carpet	8	88.00 S.Y.	$4,901.47	$5,668.15	5.6250	5	5	$28,340.76	$28,340.76
Repair gypsum board ceiling - (2% of ceilings)	20	0.50 C.S.F.	$204.33	$250.54	2.2500	2	2	$501.07	$501.07
Refinish gypsum board ceiling, up to 12' high	20	25.00 C.S.F.	$3,803.43	$4,676.10	2.2500	2	1	$9,352.19	$4,676.10
Replace gypsum board ceiling, up to 12' high	40	25.10 C.S.F.	$10,513.60	$12,895.83	1.1250	1	1	$12,895.83	$12,895.83
Replace acoustic tile ceiling, fire-rated	20	28.40 C.S.F.	$17,741.27	$20,863.65	2.2500	2	2	$41,727.31	$41,727.31
Replace flush valve diaphragm tankless water closet	10	14.00 Ea.	$386.25	$479.87	4.5000	4	4	$1,919.47	$1,919.47
Rebuild flush valve tankless water closet	20	14.00 Ea.	$2,705.79	$3,261.36	2.2500	2	2	$6,522.72	$6,522.72
Unplug clogged line tankless water closet	5	16.00 Ea.	$3,676.50	$4,604.61	9.0000	9	9	$41,441.46	$41,441.46
Replace tankless water closet	35	14.00 Ea.	$19,273.19	$22,304.74	1.2857	1	1	$22,304.74	$22,304.74
Replace tankless flush valve	25	14.00 Ea.	$3,817.17	$4,480.39	1.8000	1	1	$4,480.39	$4,480.39
Replace wax ring gasket for tankless water closet	5	14.00 Ea.	$2,096.56	$2,623.35	9.0000	9	9	$23,610.13	$23,610.13
Replace flush valve diaphragm for a urinal	7	14.00 Ea.	$386.25	$479.87	6.4286	6	6	$2,879.20	$2,879.20
Rebuild flush valve for a urinal	20	3.00 Ea.	$579.81	$698.86	2.2500	2	2	$1,397.72	$1,397.72
Unplug line urinal	5	3.00 Ea.	$458.71	$574.51	9.0000	9	9	$5,170.58	$5,170.58
Replace wall-hung urinal	35	3.00 Ea.	$3,276.87	$3,943.16	1.2857	1	1	$3,943.16	$3,943.16
Replace washer in spud connection lavatory, vitreous china	7	18.00 Ea.	$313.08	$382.21	6.4286	6	6	$2,293.24	$2,293.24
Replace washer in faucet lavatory, vitreous china	2	18.00 Ea.	$244.76	$305.33	22.5000	22	22	$6,717.29	$6,717.29
Replace faucets lavatory, vitreous china	10	18.00 Ea.	$3,575.21	$4,298.10	4.5000	4	4	$17,192.41	$17,192.41
Clean out strainer and P trap lavatory, vitreous china	2	18.00 Ea.	$667.59	$836.12	22.5000	22	22	$18,394.59	$18,394.59
Replace lavatory, vitreous china	35	18.00 Ea.	$13,524.76	$16,215.94	1.2857	1	1	$16,215.94	$16,215.94
Replace faucet washer sink, iron enamel	2	8.00 Ea.	$108.03	$134.77	22.5000	22	22	$2,964.85	$2,964.85
Clean trap sink, iron enamel	3	8.00 Ea.	$72.14	$90.35	15.0000	15	15	$1,355.28	$1,355.28
Replace faucets sink, iron enamel	10	8.00 Ea.	$1,588.98	$1,910.27	4.5000	4	4	$7,641.07	$7,641.07
Unstop sink, iron enamel	2	8.00 Ea.	$353.22	$442.39	22.5000	22	22	$9,732.59	$9,732.59
Replace sink, P.E.C.I. sink, iron enamel kitchen	35	2.00 Ea.	$1,820.34	$2,141.40	1.2857	1	1	$2,141.40	$2,141.40
Replace faucet washer sink, stainless steel	2	2.00 Ea.	$27.01	$33.69	22.5000	22	22	$741.21	$741.21
Clean trap sink, stainless steel	3	2.00 Ea.	$18.04	$22.59	15.0000	15	15	$338.82	$338.82
Replace faucets sink, stainless steel	10	2.00 Ea.	$397.25	$477.57	4.5000	4	4	$1,910.27	$1,910.27
Unstop sink, stainless steel	2	2.00 Ea.	$88.31	$110.60	22.5000	22	22	$2,433.15	$2,433.15
Replace sink, stainless steel	40	2.00 Ea.	$2,379.47	$2,790.52	1.1250	1	1	$2,790.52	$2,790.52
Check / minor repairs drinking fountain	1	3.00 Ea.	$155.83	$195.17	45.0000	45	45	$8,782.75	$8,782.75
Repair internal leaks drinking fountain	4	3.00 Ea.	$143.37	$179.56	11.2500	11	11	$1,975.14	$1,975.14
Correct water pressure drinking fountain	2	3.00 Ea.	$132.46	$165.90	22.5000	22	22	$3,649.72	$3,649.72
Replace refrigerant drinking fountain	2	3.00 Ea.	$110.31	$128.99	22.5000	22	22	$2,837.81	$2,837.81
Repair drain leak drinking fountain	4	3.00 Ea.	$91.53	$110.43	11.2500	11	9	$1,214.68	$993.83
Replace fountain drinking fountain	10	3.00 Ea.	$4,570.18	$5,383.32	4.5000	4	4	$21,533.28	$21,533.28
Resolder joint pipe & fittings, copper	10	2.00 Ea.	$101.81	$125.57	4.5000	4	4	$502.29	$502.29
Replace pipe and fittings, copper 3/4"	20	16.00 L.F.	$385.58	$468.64	2.2500	2	2	$937.28	$937.28
Replace pipe and fittings, copper 2"	25	8.00 L.F.	$452.49	$542.27	1.8000	1	1	$542.27	$542.27
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	16.00 L.F.	$165.02	$201.61	3.0000	3	3	$604.82	$604.82
Drain and flush water heater, electric, 120 gallon	7	0.50 Ea.	$155.31	$194.52	6.4286	6	6	$1,167.13	$1,167.13
Check operation water heater, electric, 120 gallon	3	0.50 Ea.	$1.36	$1.70	15.0000	15	15	$25.57	$25.57
Replace water heater, electric, 120 gallon	15	0.50 Ea.	$7,973.03	$9,118.74	3.0000	3	3	$27,356.23	$27,356.23
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	1.00 Ea.	$8.47	$10.60	90.0000	90	90	$954.39	$954.39
Replace pump / motor assembly circulation pump, 1/12 HP	10	1.00 Ea.	$1,265.32	$1,479.95	4.5000	4	4	$5,919.80	$5,919.80
Unclog main drain pipe & fittings, cast iron	10	1.00 Ea.	$48.83	$61.15	4.5000	4	4	$244.62	$244.62
Replace pipe & fittings, cast iron, 4"	40	8.00 L.F.	$487.72	$591.08	1.1250	1	1	$591.08	$591.08
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.2500	2	2	$126.21	$126.21
Repair joint pipe and fittings, PVC	10	1.00 Ea.	$157.21	$195.91	4.5000	4	4	$783.64	$783.64
Replace pipe, 4" pipe and fittings, PVC	30	8.00 L.F.	$749.59	$917.36	1.5000	1	1	$917.36	$917.36
General maintenance & repair drain: roof, scupper, area	1	8.00 Ea.	$313.74	$392.95	45.0000	45	45	$17,682.60	$17,682.60
Replace drain: roof, scupper, area	40	8.00 Ea.	$8,770.86	$10,121.72	1.1250	1	1	$10,121.72	$10,121.72
Check gas pressure natural gas, pressure reducing valve	5	1.00 Ea.	$10.18	$12.75	9.0000	9	9	$114.76	$114.76
Replace pressure regulator 1" diam. pipe natural gas	14	1.00 Ea.	$218.88	$256.30	3.2143	3	3	$768.90	$768.90
Replace 10' steel pipe 1" diam. per M.L.F. LPG distribution	12	4.00 Ea.	$1,639.16	$2,002.56	3.7500	3	3	$6,007.68	$6,007.68
Repair fan coil unit, 1 ton	10	0.50 Ea.	$227.74	$272.69	4.5000	4	3	$1,090.77	$818.08
Replace fan coil unit, 1 ton	15	1.00 Ea.	$1,356.49	$1,584.16	3.0000	3	3	$4,752.47	$4,752.47
Replace fan coil, DX 1-1/2 ton, with heat	15	3.00 Ea.	$5,587.60	$6,565.89	3.0000	3	3	$19,697.67	$19,697.67
Replace fan coil, DX 2 ton, with heat	15	3.00 Ea.	$5,562.78	$6,545.28	3.0000	3	3	$19,635.83	$19,635.83
Repair unit ventilator, 750 CFM, 2 ton	10	6.00 Ea.	$3,085.68	$3,714.19	4.5000	4	4	$14,856.74	$14,856.74
Repair fan, induced draft, 2000 CFM	10	1.00 Ea.	$320.21	$391.19	4.5000	4	4	$1,564.76	$1,564.76
Replace fan & motor, propeller exhaust, 1000 CFM exhaust fan	15	1.00 Ea.	$930.97	$1,096.55	3.0000	3	3	$3,289.65	$3,289.65
Replace fan & motor, propeller exhaust, 4700 CFM exhaust fan	15	1.00 Ea.	$2,262.92	$2,633.25	3.0000	3	3	$7,899.76	$7,899.76
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	1.00 Ea.	$4,344.36	$5,039.65	2.2500	2	2	$10,079.30	$10,079.30
Repair single zone rooftop unit, 25 ton	10	1.00 Ea.	$55,072.84	$63,403.92	4.5000	4	3	$253,615.68	$190,211.76
Replace single zone rooftop unit, 25 ton	15	1.00 Ea.	$51,995.90	$60,418.81	3.0000	3	3	$181,256.43	$181,256.43
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	4.5000	4	4	$4,698.57	$4,698.57
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	45.0000	45	45	$2,043.45	$2,043.45
Replace sprinkler head	20	62.00 Ea.	$5,684.82	$7,005.83	2.2500	2	2	$14,011.66	$14,011.66
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	45.0000	45	45	$40,637.38	$40,637.38
Replace fuse	25	24.00 Ea.	$14,585.05	$16,709.54	1.8000	1	1	$16,709.54	$16,709.54
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	4.5000	4	4	$6,215.64	$6,215.64
Maintenance and repair secondary transformer, dry	10	1.00 Ea.	$295.51	$351.26	4.5000	4	4	$1,405.05	$1,405.05
Maintenance and inspection secondary transformer, dry	0.5	1.00 Ea.	$87.02	$109.17	90.0000	90	90	$9,825.40	$9,825.40
Maintenance and inspection lighting panel, indoor	3	4.00 Ea.	$175.26	$219.87	15.0000	15	15	$3,298.03	$3,298.03
Replace EMT conduit, 1" diameter	50	1.20 M.L.F.	$13,871.09	$16,718.57	0.9000	0	0	$0.00	$0.00
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	6.00 Ea.	$463.72	$581.74	2.2500	2	2	$1,163.47	$1,163.47
Maintenance and inspection circuit breaker, molded case, 600 V, 3 pole	0.33	1.00 Ea.	$34.69	$43.52	136.3636	136	136	$5,918.14	$5,918.14
Replace circuit breaker molded case, 600 V, 3 pole circuit breaker	50	4.00 Ea.	$20,688.88	$23,697.60	0.9000	0	0	$0.00	$0.00
Maintenance and repair breaker, enclosed, 240 V, 2 pole	25	14.00 Ea.	$1,082.01	$1,357.39	1.8000	1	1	$1,357.39	$1,357.39
Maintenance and repair receptacles and plugs	20	86.00 Ea.	$3,935.29	$4,917.08	2.2500	2	2	$9,834.16	$9,834.16
Replace receptacle/plug receptacles and plugs	20	86.00 Ea.	$6,943.91	$8,541.61	2.2500	2	2	$17,083.22	$17,083.22
Maintenance and repair wiring devices, switches	10	33.00 Ea.	$1,510.05	$1,886.79	4.5000	4	4	$7,547.14	$7,547.14
Replace wiring devices, switches	15	33.00 Ea.	$2,294.64	$2,857.27	3.0000	3	3	$8,571.82	$8,571.82
Replace fluorescent light fixture ballast, 80 W	10	48.00 Ea.	$5,228.74	$6,447.71	4.5000	4	4	$25,790.85	$25,790.85
Replace lamps (2 lamps), 4', 34 W energy saver	10	48.00 Ea.	$1,303.28	$1,634.22	4.5000	4	4	$6,536.86	$6,536.86
Repair smoke detector	10	17.00 Ea.	$1,033.01	$1,278.49	4.5000	4	3	$5,113.95	$3,835.47
Check operation smoke detector	1	17.00 Ea.	$296.91	$372.48	45.0000	45	45	$16,761.58	$16,761.58
Replace smoke detector	15	17.00 Ea.	$5,736.16	$6,825.62	3.0000	3	3	$20,476.87	$20,476.87
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	4.5000	4	3	$2,805.76	$2,104.32
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	3.0000	3	3	$4,977.08	$4,977.08
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	90.0000	90	90	$5,221.89	$5,221.89
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.0000	3	3	$8,524.19	$8,524.19
Replace fire alarm bell, 6"	20	6.00 Ea.	$1,202.61	$1,456.93	2.2500	2	2	$2,913.86	$2,913.86
Maintenance and repair building structure ground	7	1.20 M.L.F.	$114.55	$143.20	6.4286	6	6	$859.20	$859.20
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	45.0000	45	45	$10,739.96	$10,739.96
Replace lamp with exit light L.E.D. retrofit kits	15	12.00 Ea.	$1,236.21	$1,423.98	3.0000	3	3	$4,271.95	$4,271.95
Replace lighting fixture with exit light L.E.D. standard	20	12.00 Ea.	$2,296.86	$2,801.26	2.2500	2	2	$5,602.52	$5,602.52

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Maintenance and repair voice/data outlet	10	2.00 Ea.	$111.39	$139.23	4.5000	4	4	$556.92	$556.92
Replace voice/data outlet	20	2.00 Ea.	$56.63	$68.97	2.2500	2	2	$137.94	$137.94
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	90.0000	90	90	$10,443.78	$10,443.78
			$631,961.44	$745,785.60				MR Subtotal:	$1,555,038.80
								MR Per Year:	$34,556.42
								PM Total:	$7,988.41
								Subtotal:	$42,544.83
								Total Per Unit:	$3.25

FAC 7371 Nursery and Child Care Facility

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $3.25
UM: SF
Expected Service Life: 45
Model Size: 13075

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	8	2.08	$126.58	$93.87	$0.0000	220.45	261.26	308.41
Urinals, annualized	3	0.68	$20.52	$36.80	$0.0000	57.32	70.41	84.53
Toilet (vacuum breaker type), annualized	14	2.48	$128.57	$133.84	$0.0000	262.41	315.42	374.86
Lavatories, annualized	18	6.26	$138.93	$395.93	$0.0000	534.86	667.53	807.15
Drink fountain, annualized	3	1.86	$108.45	$100.25	$0.0000	208.70	249.62	295.96
VAV Boxes, annualized	6	5.60	$57.15	$357.86	$0.0000	415.01	528.09	644.02
Fan, axial, up to 5,000 CFM, annualized	1	1.24	$13.78	$66.83	$0.0000	80.61	102.04	124.15
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Circuit breaker, high voltage air, annualized	6	2.82	$99.10	$200.20	$0.0000	299.30	369.27	444.19
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Dishwasher, electric, annualized	1	4.71	$168.67	$179.70	$0.0000	348.37	419.15	498.36
Disposal, garbage, electric, annualized	1	1.52	$14.80	$57.80	$0.0000	72.60	91.42	110.98
Ice machine, flake or cube, annualized	1	3.58	$611.05	$135.97	$0.0000	747.02	848.92	981.37
Oven, convection, gas / electric, annualized	1	11.24	$52.52	$428.28	$0.0000	480.80	614.54	750.91
Refrigerator display, walk-in w/ external condenser case, annualized	1	2.38	$429.25	$90.45	$0.0000	519.70	589.76	681.28
						$5,486.17	$6,680.90	$7,988.41

FAC 7372 Family Service Center

FY25 SUC:	$6.10 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7380 Homeless Support Facility

FY25 SUC:	$0.00 / SF
Source:	

FAC 7381 Forestry Guard Station

FY25 SUC:	$2.01 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7382 Locker Room

FY25 SUC:	$4.24 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7383 Air Raid/Fallout/Storm Shelter

FY25 SUC:	$6.65 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7384 Personnel/ Equipment Shelter

FY25 SUC:	$0.69 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7385 Public Restroom/Shower

FY25 SUC:	$7.39 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7386 Ceremonial Hall

FY25 SUC:	$3.71 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7387 Exchange Support Facility

FY25 SUC:	$5.50 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7388 Exchange Warehouse

FY25 SUC:	$2.56 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7389 Private Vehicle Inspection Facility

FY25 SUC:	$1.70 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7411 Hobby And Craft Center

FY25 SUC:	$6.88 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7412 Automobile Craft Center

FY25 SUC:	$3.83 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7412 Automobile Craft Center

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $3.83
UM: SF
Expected Service Life: 40
Model Size: 7114

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	226.00 S.F.	$9,194.67	$11,198.38	2.6667	2	2	$22,396.75	$22,396.75
Replace aluminum siding, 1st floor	35	20.79 C.S.F.	$13,235.00	$15,942.46	1.1429	1	1	$15,942.46	$15,942.46
Refinish aluminum siding, 1st floor	20	20.79 C.S.F.	$4,412.08	$5,417.14	2.0000	2	2	$10,834.28	$10,834.28
Replace steel louver, 1st floor	40	2.00 Ea.	$1,288.25	$1,505.87	1.0000	1	1	$1,505.87	$1,505.87
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	7.92 S.F.	$108.12	$126.95	40.0000	40	40	$5,078.04	$5,078.04
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	32.00 Ea.	$5,167.94	$6,158.59	2.0000	2	2	$12,317.18	$12,317.18
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	32.00 Ea.	$26,296.44	$30,723.63	0.8000	0	0	$0.00	$0.00
Repair aluminum storefront door	12	4.00 Ea.	$2,198.35	$2,621.34	3.3333	3	3	$7,864.02	$7,864.02
Replace 3'-0" x 7'-0" aluminum storefront doors	50	4.00 Ea.	$11,457.85	$13,436.80	0.8000	0	0	$0.00	$0.00
Replace insulating glass - (3% of glass) aluminum storefront door	1	2.52 S.F.	$170.36	$198.39	40.0000	40	40	$7,935.55	$7,935.55
Repair steel, painted, door	14	5.00 Ea.	$3,887.79	$4,603.84	2.8571	2	2	$9,207.68	$9,207.68
Refinish 3'-0" x 7'-0" steel, painted, door	4	5.00 Ea.	$239.96	$293.76	10.0000	10	10	$2,937.63	$2,937.63
Replace 3'-0" x 7'-0" steel, painted, door	45	5.00 Ea.	$3,679.29	$4,282.84	0.8889	0	0	$0.00	$0.00
Repair 12' x 12' steel roll-up door	10	6.00 Ea.	$5,413.01	$6,378.73	4.0000	4	4	$25,514.93	$25,514.93
Refinish 12' x 12' steel roll-up door	5	6.00 Ea.	$1,536.29	$1,863.86	8.0000	8	8	$14,910.89	$14,910.89
Replace 12' x 12' steel roll-up door	35	6.00 Ea.	$21,652.04	$25,514.93	1.1429	1	1	$25,514.93	$25,514.93
Debris removal and visual inspection of built-up roofing	0.5	7.10 M.S.F.	$288.70	$352.58	80.0000	80	80	$28,206.66	$28,206.66
Minor BUR membrane repairs, 2% of roof area	1	1.42 Sq.	$829.39	$980.43	40.0000	40	40	$39,217.15	$39,217.15
Minor BUR membrane replacement, 25% of roof area	15	17.80 Sq.	$17,923.85	$21,158.43	2.6667	2	2	$42,316.87	$42,316.87
Total BUR roof replacement	28	72.00 Sq.	$70,008.76	$82,394.33	1.4286	1	1	$82,394.33	$82,394.33
Repair steel painted interior door	14	4.00 Ea.	$1,187.40	$1,385.29	2.8571	2	2	$2,770.57	$2,770.57
Refinish 3'-0" x 7'-0" steel painted interior door	4	4.00 Ea.	$240.81	$296.10	10.0000	10	10	$2,960.98	$2,960.98
Replace 3'-0" x 7'-0" steel painted interior door	60	4.00 Ea.	$5,638.07	$6,531.20	0.6667	0	0	$0.00	$0.00
Refinish concrete floor finished	25	38.50 C.S.F.	$17,652.74	$21,208.64	1.6000	1	1	$21,208.64	$21,208.64
Replace vinyl tile flooring	18	95.56 S.Y.	$5,404.71	$6,615.53	2.2222	2	2	$13,231.06	$13,231.06
Unplug clogged line flush-tank water closet	5	4.00 Ea.	$919.12	$1,151.15	8.0000	8	8	$9,209.21	$9,209.21
Replace washer / diaphragm in ball cock flush-tank water closet	5	4.00 Ea.	$79.00	$97.50	8.0000	8	8	$779.96	$779.96
Replace valve and ball cock assembly flush-tank water closet	15	4.00 Ea.	$388.71	$480.90	2.6667	2	2	$961.80	$961.80
Install gasket between tank and bowl flush-tank water closet	20	4.00 Ea.	$175.71	$218.44	2.0000	2	2	$436.87	$436.87
Replace one piece water closet flush-tank	35	4.00 Ea.	$5,007.86	$5,825.46	1.1429	1	1	$5,825.46	$5,825.46
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	5.7143	5	5	$342.76	$342.76
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.0000	2	2	$931.82	$931.82
Unplug line urinal	5	2.00 Ea.	$305.81	$383.01	8.0000	8	8	$3,064.05	$3,064.05
Replace wall-hung urinal	35	2.00 Ea.	$2,184.58	$2,628.78	1.1429	1	1	$2,628.78	$2,628.78
Replace washer in spud connection lavatory, vitreous china	7	4.00 Ea.	$69.57	$84.93	5.7143	5	5	$424.67	$424.67
Replace faucets lavatory, vitreous china	10	4.00 Ea.	$794.49	$955.13	4.0000	4	4	$3,820.54	$3,820.54
Replace lavatory, vitreous china	35	4.00 Ea.	$3,005.50	$3,603.54	1.1429	1	1	$3,603.54	$3,603.54
Replace faucet washer sink, iron enamel	2	2.00 Ea.	$27.01	$33.69	20.0000	20	20	$673.83	$673.83
Clean trap sink, iron enamel	3	2.00 Ea.	$18.04	$22.59	13.3333	13	13	$293.64	$293.64
Replace faucets sink, iron enamel	10	2.00 Ea.	$397.25	$477.57	4.0000	4	4	$1,910.27	$1,910.27
Unstop sink, iron enamel	2	2.00 Ea.	$88.31	$110.60	20.0000	20	20	$2,211.95	$2,211.95
Inspect and clean spray heads, emergency eye wash	3	3.00 Ea.	$156.18	$195.60	13.3333	13	13	$2,542.82	$2,542.82
Replace eye wash station, emergency eye wash	25	3.00 Ea.	$2,371.34	$2,884.64	1.6000	1	1	$2,884.64	$2,884.64
Resolder joint pipe & fittings, copper	10	2.00 Ea.	$101.81	$125.57	4.0000	4	4	$502.29	$502.29
Remove old insulation & replace with new, pipe 3/4", wall 1"	15	16.00 L.F.	$165.02	$201.61	2.6667	2	2	$403.21	$403.21
Unclog main drain pipe & fittings, cast iron	10	1.00 Ea.	$48.83	$61.15	4.0000	4	4	$244.62	$244.62
Unclog floor drain, PVC	20	4.00 Ea.	$201.54	$252.42	2.0000	2	2	$504.85	$504.85
Repair joint pipe and fittings, PVC	10	1.00 Ea.	$157.21	$195.91	4.0000	4	4	$783.64	$783.64
General maintenance & repair drain: roof, scupper, area	1	4.00 Ea.	$156.87	$196.47	40.0000	40	40	$7,858.93	$7,858.93
Replace drain: roof, scupper, area	40	4.00 Ea.	$4,385.43	$5,060.86	1.0000	1	1	$5,060.86	$5,060.86
Replace fan & motor, propeller exhaust, 4700 CFM exhaust fan	15	1.00 Ea.	$2,262.92	$2,633.25	2.6667	2	2	$5,266.51	$5,266.51
Replace roof mounted exhaust fan, 8500 CFM exhaust fan	20	1.00 Ea.	$4,344.36	$5,039.65	2.0000	2	2	$10,079.30	$10,079.30
Maintenance and repair standard suspended heater	2	6.00 Ea.	$713.63	$842.31	20.0000	20	20	$16,846.20	$16,846.20
Replace heater standard suspended heater	15	6.00 Ea.	$5,500.58	$6,355.81	2.6667	2	2	$12,711.62	$12,711.62
Maintenance and repair explosionproof industrial heater	2	2.00 Ea.	$440.91	$515.28	20.0000	20	19	$10,305.66	$9,790.37
Maintenance and inspection explosionproof industrial heater	0.5	2.00 Ea.	$169.55	$212.69	80.0000	80	80	$17,015.56	$17,015.56
Replace heater explosionproof industrial heater	15	2.00 Ea.	$12,612.52	$14,413.14	2.6667	2	2	$28,826.28	$28,826.28
Repair single zone rooftop unit, 7.5 ton	10	1.00 Ea.	$3,864.50	$4,579.16	4.0000	4	4	$18,316.62	$18,316.62
Replace single zone rooftop unit, 7.5 ton	15	1.00 Ea.	$12,056.40	$14,267.24	2.6667	2	2	$28,534.48	$28,534.48
Repair central station A.H.U., 1300 CFM	10	1.00 Ea.	$601.37	$713.88	4.0000	4	3	$2,855.54	$2,141.65
Replace central station A.H.U., 1300 CFM	15	1.00 Ea.	$10,673.04	$12,341.31	2.6667	2	2	$24,682.61	$24,682.61
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	40.0000	40	40	$1,816.40	$1,816.40
Replace sprinkler head	20	38.00 Ea.	$3,484.24	$4,293.90	2.0000	2	2	$8,587.79	$8,587.79
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	40.0000	40	40	$36,122.11	$36,122.11
Replace fuse	25	14.00 Ea.	$8,507.95	$9,747.23	1.6000	1	1	$9,747.23	$9,747.23
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	4.0000	4	4	$6,215.64	$6,215.64
Maintenance and repair motor starter, up to 600 V	5	2.00 Ea.	$699.10	$837.86	8.0000	8	8	$6,702.87	$6,702.87
Maintenance and inspection motor starter, up to 600 V	0.5	2.00 Ea.	$116.84	$146.58	80.0000	80	80	$11,726.35	$11,726.35
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	13.3333	13	13	$1,429.15	$1,429.15
Maintenance and repair safety switch general, 2 pole	8	2.00 Ea.	$87.63	$109.93	5.0000	5	5	$549.67	$549.67
Maintenance and inspection safety switch, 2 pole	1	2.00 Ea.	$87.63	$109.93	40.0000	40	40	$4,397.38	$4,397.38
Replace safety switch, 240 V, 2 pole	25	7.00 Ea.	$3,429.65	$4,145.44	1.6000	1	1	$4,145.44	$4,145.44
Repair 4-pin receptacle cover	10	12.00 Ea.	$761.20	$940.92	4.0000	4	4	$3,763.67	$3,763.67
Replace 4-pin receptacle	20	12.00 Ea.	$1,919.28	$2,281.68	2.0000	2	2	$4,563.37	$4,563.37
Maintenance and repair wiring devices, switches	10	17.00 Ea.	$777.91	$971.98	4.0000	4	4	$3,887.92	$3,887.92
Replace wiring devices, switches	15	17.00 Ea.	$1,182.09	$1,471.93	2.6667	2	2	$2,943.86	$2,943.86
Replace fluorescent light fixture ballast, 80 W	10	11.00 Ea.	$1,198.25	$1,477.60	4.0000	4	4	$5,910.40	$5,910.40
Replace lamps (2 lamps), 4', 34 W energy saver	10	11.00 Ea.	$298.67	$374.51	4.0000	4	4	$1,498.03	$1,498.03
Replace metal halide ballast, 400 W	10	8.00 Ea.	$1,681.69	$2,002.81	4.0000	4	4	$8,011.26	$8,011.26
Replace metal halide fixture lamp, 400 W	5	8.00 Ea.	$580.39	$698.01	8.0000	8	8	$5,584.08	$5,584.08
Replace metal halide fixture, 400 W	20	8.00 Ea.	$6,343.78	$7,584.77	2.0000	2	2	$15,169.53	$15,169.53
Repair smoke detector	10	8.00 Ea.	$486.12	$601.64	4.0000	4	4	$2,406.57	$2,406.57
Check operation smoke detector	1	8.00 Ea.	$139.72	$175.28	40.0000	40	40	$7,011.38	$7,011.38
Repair heat detector	10	10.00 Ea.	$662.54	$814.43	4.0000	4	4	$3,257.71	$3,257.71
Check operation heat detector	1	10.00 Ea.	$174.66	$219.11	40.0000	40	40	$8,764.22	$8,764.22
Replace heat detector	15	10.00 Ea.	$1,898.03	$2,318.18	2.6667	2	2	$4,636.37	$4,636.37
Check and repair manual pull station	10	3.00 Ea.	$284.97	$350.72	4.0000	4	3	$1,402.88	$1,052.16
Replace manual pull station	15	3.00 Ea.	$690.23	$829.51	2.6667	2	2	$1,659.03	$1,659.03
Maintenance and repair electrical service ground	25	0.20 M.L.F.	$19.09	$23.87	1.6000	1	1	$23.87	$23.87
Replace electrical service ground	50	0.20 M.L.F.	$967.86	$1,177.28	0.8000	0	0	$0.00	$0.00
Remove and replace vehicle lift hydraulic pump	15	2.00 Ea.	$9,828.73	$11,210.81	2.6667	2	2	$22,421.63	$22,421.63
Automotive equipment, compressor, electric, 5 HP, remove and replace motor	10	1.00 Ea.	$715.72	$825.69	4.0000	4	4	$3,302.75	$3,302.75
			$353,221.71	$417,239.64				MR Subtotal:	$823,690.52
								MR Per Year:	$20,592.26
								PM Total:	$6,683.82
								Subtotal:	$27,276.08
								Total Per Unit:	$3.83

FAC 7412 Automobile Craft Center

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM
FY25 SUC: $3.83
UM: SF
Expected Service Life: 40
Model Size: 7114

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, overhead, manual, up to 24' high x 25' wide, annualized	6	13.18	$91.37	$594.51	$0.0000	685.88	873.37	1,065.43
Fire doors, swinging, annualized	2	0.78	$28.98	$32.15	$0.0000	61.13	73.67	87.66
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (tank type), annualized	4	1.55	$33.22	$82.91	$0.0000	116.13	144.32	174.18
Lavatories, annualized	4	1.39	$30.87	$87.98	$0.0000	118.86	148.34	179.37
Fan, axial, up to 5,000 CFM, annualized	2	2.49	$27.55	$133.67	$0.0000	161.22	204.07	248.31
Unit heater, gas infrared, annualized	3	4.52	$199.31	$242.38	$0.0000	441.69	534.33	636.94
Package unit, air cooled, 3 thru 24 ton, annualized	1	2.40	$165.11	$153.97	$0.0000	319.09	381.79	452.75
Air compressor, reciprocating, less than 5 H.P., annualized	1	4.80	$65.46	$308.79	$0.0000	374.25	473.43	575.89
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Hydraulic lift, annualized	2	3.09	$1,403.90	$117.40	$0.0000	1,521.30	1,696.92	1,942.72
						$4,643.05	$5,610.20	$6,683.82

FAC 7413 Golf Club House and Sales

FY25 SUC:	$10.06 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7414 Club and Organization Building

FY25 SUC:	$6.87 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7415 Bowling Center

FY25 SUC:	$5.07 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7416 Library, General Use

FY25 SUC:	$4.97 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7417 Recreation Center

FY25 SUC:	$6.96 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7418 Indoor Skating Rink

FY25 SUC:	$2.97 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7421 Indoor Physical Fitness Facility

FY25 SUC:	$4.82 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7422 Indoor Swimming Pool

FY25 SUC:	$5.77 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7422 Indoor Swimming Pool

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $5.77
UM: SF
Expected Service Life: 40
Model Size: 11994

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	696.00 S.F.	$28,316.32	$34,487.04	2.6667	2	2	$68,974.08	$68,974.08
Repair clay brick wall, 1st floor	25	3,090.00 S.F.	$147,178.81	$180,571.99	1.6000	1	1	$180,571.99	$180,571.99
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	5.40 S.F.	$73.72	$86.56	40.0000	40	40	$3,462.30	$3,462.30
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	24.00 Ea.	$3,875.95	$4,618.94	2.0000	2	2	$9,237.88	$9,237.88
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	24.00 Ea.	$19,722.33	$23,042.72	0.8000	0	0	$0.00	$0.00
Replace plate glass storefront - 1st floor	50	8.20 C.S.F.	$43,434.25	$50,309.00	0.8000	0	0	$0.00	$0.00
Replace plate glass storefront - 2nd floor	50	8.20 C.S.F.	$44,847.40	$52,066.81	0.8000	0	0	$0.00	$0.00
Repair aluminum storefront door	12	4.00 Ea.	$2,198.35	$2,621.34	3.3333	3	3	$7,864.02	$7,864.02
Replace 3'-0" x 7'-0" aluminum storefront doors	50	4.00 Ea.	$11,457.85	$13,436.80	0.8000	0	0	$0.00	$0.00
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	2.8571	2	2	$5,524.61	$5,524.61
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	10.0000	10	10	$1,762.58	$1,762.58
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	0.8889	0	0	$0.00	$0.00
Debris removal, by hand and visual inspection, metal panel roofing	1	12.00 M.S.F.	$294.91	$360.16	40.0000	40	40	$14,406.40	$14,406.40
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	240.00 S.F.	$1,163.58	$1,380.86	8.0000	8	8	$11,046.87	$11,046.87
Minor metal roof panel replacement, 2.5% of roof area	20	300.00 S.F.	$4,149.23	$4,908.02	2.0000	2	2	$9,816.04	$9,816.04
Total metal roof panel replacement	30	120.00 Sq.	$115,345.82	$136,399.58	1.3333	1	1	$136,399.58	$136,399.58
Repair 8" concrete block wall - (2% of walls) painted	25	4.20 C.S.F.	$5,106.94	$6,134.20	1.6000	1	1	$6,134.20	$6,134.20
Refinish concrete block wall painted	4	22.60 C.S.F.	$3,099.66	$3,726.44	10.0000	10	10	$37,264.45	$37,264.45
Replace 8" concrete block wall painted	75	22.60 C.S.F.	$29,178.17	$35,115.73	0.5333	0	0	$0.00	$0.00
Repair steel painted interior door	14	17.00 Ea.	$5,046.45	$5,887.47	2.8571	2	2	$11,774.94	$11,774.94
Refinish 3'-0" x 7'-0" steel painted interior door	4	17.00 Ea.	$1,023.46	$1,258.42	10.0000	10	10	$12,584.16	$12,584.16
Replace 3'-0" x 7'-0" steel painted interior door	60	17.00 Ea.	$23,961.80	$27,757.62	0.6667	0	0	$0.00	$0.00
Replace safety glass (3% of glass) aluminum interior door	1	0.80 S.F.	$20.54	$24.23	40.0000	40	40	$969.31	$969.31
Replace 3'-0" x 7'-0" aluminum door, frame & vision lite, interior	50	7.00 Ea.	$29,392.59	$33,703.41	0.8000	0	0	$0.00	$0.00
Repair 4" x 4" thin set ceramic tile - (2% of walls)	10	1.20 C.S.F.	$1,105.24	$1,330.23	4.0000	4	4	$5,320.91	$5,320.91
Replace 4" x 4" thin set ceramic tile	75	11.30 C.S.F.	$11,231.57	$13,554.47	0.5333	0	0	$0.00	$0.00
Refinish concrete floor finished	25	48.00 C.S.F.	$22,008.60	$26,441.95	1.6000	1	1	$26,441.95	$26,441.95
Replace rubber tile floor	18	422.20 S.Y.	$48,698.93	$59,271.61	2.2222	2	2	$118,543.22	$118,543.22
Ceramic tile floor repairs - (2% of floors)	15	0.30 C.S.F.	$208.99	$260.56	2.6667	2	2	$521.12	$521.12
Replace 2" x 2" thin set ceramic tile floor	50	19.00 C.S.F.	$31,048.64	$37,087.18	0.8000	0	0	$0.00	$0.00
Replace flush valve diaphragm tankless water closet	10	8.00 Ea.	$220.72	$274.21	4.0000	4	4	$1,096.84	$1,096.84
Rebuild flush valve tankless water closet	20	8.00 Ea.	$1,546.17	$1,863.63	2.0000	2	2	$3,727.27	$3,727.27
Unplug clogged line tankless water closet	5	8.00 Ea.	$1,838.25	$2,302.30	8.0000	8	8	$18,418.43	$18,418.43
Replace tankless water closet	35	8.00 Ea.	$11,013.25	$12,745.57	1.1429	1	1	$12,745.57	$12,745.57
Replace tankless flush valve	25	8.00 Ea.	$2,181.24	$2,560.22	1.6000	1	1	$2,560.22	$2,560.22
Replace wax ring gasket for tankless water closet	5	8.00 Ea.	$1,198.04	$1,499.06	8.0000	8	8	$11,992.45	$11,992.45
Replace flush valve diaphragm for a urinal	7	6.00 Ea.	$165.54	$205.66	5.7143	5	5	$1,028.29	$1,028.29
Rebuild flush valve for a urinal	20	6.00 Ea.	$1,159.63	$1,397.72	2.0000	2	2	$2,795.45	$2,795.45
Replace wall-hung urinal	35	6.00 Ea.	$6,553.74	$7,886.33	1.1429	1	1	$7,886.33	$7,886.33
Replace washer in spud connection lavatory, vitreous china	7	8.00 Ea.	$139.14	$169.87	5.7143	5	5	$849.35	$849.35
Replace washer in faucet lavatory, vitreous china	2	8.00 Ea.	$108.78	$135.70	20.0000	20	20	$2,714.06	$2,714.06
Replace faucets lavatory, vitreous china	10	8.00 Ea.	$1,588.98	$1,910.27	4.0000	4	4	$7,641.07	$7,641.07
Clean out strainer and P trap lavatory, vitreous china	2	8.00 Ea.	$296.71	$371.61	20.0000	20	20	$7,432.16	$7,432.16
Replace faucet washer sink, iron enamel	2	2.00 Ea.	$27.01	$33.69	20.0000	20	20	$673.83	$673.83
Clean trap sink, iron enamel	3	2.00 Ea.	$18.04	$22.59	13.3333	13	13	$293.64	$293.64
Replace faucets sink, iron enamel	10	2.00 Ea.	$397.25	$477.57	4.0000	4	4	$1,910.27	$1,910.27
Unstop sink, iron enamel	2	2.00 Ea.	$88.31	$110.60	20.0000	20	20	$2,211.95	$2,211.95
Inspect / clean shower head shower, terrazzo	3	16.00 Ea.	$832.94	$1,043.21	13.3333	13	13	$13,561.71	$13,561.71
Replace terrazzo shower surface	30	16.00 Ea.	$22,432.63	$27,000.78	1.3333	1	1	$27,000.78	$27,000.78
Inspect / clean shower head	3	16.00 Ea.	$832.94	$1,043.21	13.3333	13	13	$13,561.71	$13,561.71
Replace shower surface, ceramic tile	30	16.00 Ea.	$15,429.82	$18,692.52	1.3333	1	1	$18,692.52	$18,692.52
Check / minor repairs drinking fountain	1	3.00 Ea.	$155.83	$195.17	40.0000	40	40	$7,806.89	$7,806.89
Repair internal leaks drinking fountain	4	3.00 Ea.	$143.37	$179.56	10.0000	10	10	$1,795.58	$1,795.58
Correct water pressure drinking fountain	2	3.00 Ea.	$132.46	$165.90	20.0000	20	20	$3,317.93	$3,317.93
Replace refrigerant drinking fountain	2	3.00 Ea.	$110.31	$128.99	20.0000	20	20	$2,579.83	$2,579.83
Repair drain leak drinking fountain	4	3.00 Ea.	$91.53	$110.43	10.0000	10	8	$1,104.25	$883.40
Replace fountain drinking fountain	10	3.00 Ea.	$4,570.18	$5,383.32	4.0000	4	4	$21,533.28	$21,533.28
Replace old valve, non-drain, 4"	10	6.00 Ea.	$24,804.13	$28,801.54	4.0000	4	4	$115,206.17	$115,206.17
Minor repairs, adjustments water heater, gas / oil, 1150 GPH	2	1.00 Ea.	$103.37	$129.46	20.0000	20	18	$2,589.28	$2,330.36
Clean & service water heater, gas / oil, 1150 GPH	2	1.00 Ea.	$618.14	$774.18	20.0000	20	20	$15,483.66	$15,483.66
Replace water heater, gas / oil, 1150 GPH	20	1.00 Ea.	$39,199.74	$45,178.28	2.0000	2	2	$90,356.55	$90,356.55
Replace 1000 gallon solar storage tank	20	1.00 Ea.	$8,261.71	$9,574.74	2.0000	2	2	$19,149.48	$19,149.48
Insp/chk pump/mtr oper, lub, chk align circulation pump, 3 HP	0.5	4.00 Ea.	$54.73	$68.54	80.0000	80	80	$5,483.56	$5,483.56
Remove old meter, install new water meter 4"	25	1.00 Ea.	$5,533.11	$6,455.85	1.6000	1	1	$6,455.85	$6,455.85
Replace water softener	15	1.00 Ea.	$1,208.54	$1,443.77	2.6667	2	2	$2,887.54	$2,887.54
Replace drain: roof, scupper, area	40	4.00 Ea.	$4,385.43	$5,060.86	1.0000	1	1	$5,060.86	$5,060.86
Replace 1000 L.F. of hung 4" diam steel pipe natural gas	75	0.27 M.L.F.	$33,041.10	$39,390.81	0.5333	0	0	$0.00	$0.00
Repair boiler, gas, 2000 MBH	7	1.00 Ea.	$5,513.06	$6,436.35	5.7143	5	4	$32,181.76	$25,745.41
Replace boiler, gas, 2000 MBH	30	1.00 Ea.	$47,742.79	$55,703.30	1.3333	1	1	$55,703.30	$55,703.30
Repair chemical feed system	15	2.00 Ea.	$1,992.90	$2,372.00	2.6667	2	2	$4,743.99	$4,743.99
Replace chemical feed system	15	2.00 Ea.	$1,936.11	$2,245.23	2.6667	2	2	$4,490.46	$4,490.46
Replace metal flue, all fuel SS, 6" diameter metal flue / chimney	15	1.00 L.F.	$185.43	$213.70	2.6667	2	2	$427.40	$427.40
Repair fan coil unit, 1 ton	10	8.00 Ea.	$3,643.83	$4,363.09	4.0000	4	3	$17,452.35	$13,089.26
Replace fan coil unit, 1 ton	15	8.00 Ea.	$10,851.92	$12,673.25	2.6667	2	2	$25,346.50	$25,346.50
Replace axial flow fan, 6400 CFM exhaust fan	10	2.00 Ea.	$7,314.22	$8,532.15	4.0000	4	4	$34,128.62	$34,128.62
Repair circulator pump, 1/12 - 3/4 H.P.	5	2.00 Ea.	$209.65	$247.29	8.0000	8	6	$1,978.35	$1,483.76
Replace circulator pump, 1/12 - 3/4 H.P.	15	2.00 Ea.	$7,375.75	$8,507.92	2.6667	2	2	$17,015.83	$17,015.83
Repair circulator pump, 1 H.P.	5	2.00 Ea.	$210.11	$247.87	8.0000	8	6	$1,982.93	$1,487.19
Replace circulator. pump, 1 H.P.	15	2.00 Ea.	$10,922.26	$12,538.04	2.6667	2	2	$25,076.08	$25,076.08
Maintenance and repair infrared heater suspended, commercial	1	6.00 Ea.	$272.93	$342.39	40.0000	40	40	$13,695.45	$13,695.45
Maintenance and inspection infrared heater suspended, commercial	0.5	6.00 Ea.	$508.64	$638.08	80.0000	80	80	$51,046.69	$51,046.69
Repair single zone rooftop unit, 15 ton	10	2.00 Ea.	$73,865.44	$85,254.52	4.0000	4	4	$341,018.06	$341,018.06
Replace single zone rooftop unit, 15 ton	15	2.00 Ea.	$42,450.82	$50,048.47	2.6667	2	2	$100,096.94	$100,096.94
Repair central station A.H.U., 8000 CFM	10	2.00 Ea.	$3,569.69	$4,134.01	4.0000	4	3	$16,536.05	$12,402.04
Replace central station A.H.U., 8000 CFM	15	2.00 Ea.	$81,713.15	$94,182.38	2.6667	2	2	$188,364.76	$188,364.76
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	40.0000	40	40	$1,816.40	$1,816.40
Replace sprinkler head	20	62.00 Ea.	$5,684.82	$7,005.83	2.0000	2	2	$14,011.66	$14,011.66
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	4.0000	4	4	$6,215.64	$6,215.64
Maintenance and repair secondary transformer, dry	10	2.00 Ea.	$591.02	$702.53	4.0000	4	4	$2,810.11	$2,810.11
Maintenance and inspection secondary transformer, dry	0.5	2.00 Ea.	$174.05	$218.34	80.0000	80	80	$17,467.37	$17,467.37
Maintenance and inspection lighting panel, indoor	3	2.00 Ea.	$87.63	$109.93	13.3333	13	13	$1,429.15	$1,429.15
Maintenance and repair breaker, enclosed, 240 V, 3 pole	25	6.00 Ea.	$463.72	$581.74	1.6000	1	1	$581.74	$581.74
Maintenance and inspection circuit breaker, enclosed, 240 V, 3 pole	1	6.00 Ea.	$208.13	$261.09	40.0000	40	40	$10,443.78	$10,443.78
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	6.00 Ea.	$262.90	$329.80	5.0000	5	5	$1,649.02	$1,649.02
Maintenance and inspection safety switch, 3 pole, heavy duty	1	6.00 Ea.	$262.90	$329.80	40.0000	40	40	$13,192.14	$13,192.14
Replace safety switch, heavy duty 30 A	25	6.00 Ea.	$4,605.42	$5,466.24	1.6000	1	1	$5,466.24	$5,466.24
Replace fluorescent light fixture ballast, 80 W	10	96.00 Ea.	$10,457.47	$12,895.42	4.0000	4	2	$51,581.69	$25,790.85
Replace lamps (2 lamps), 4', 34 W energy saver	10	96.00 Ea.	$2,606.56	$3,268.43	4.0000	4	4	$13,073.73	$13,073.73
Replace fluorescent fixture, lay-in, recess mtd, 2' x 4', two 40 W	20	96.00 Ea.	$25,977.71	$31,512.10	2.0000	2	2	$63,024.21	$63,024.21
Replace metal halide ballast, 175 W	10	14.00 Ea.	$2,401.86	$2,876.96	4.0000	4	2	$11,507.84	$5,753.92
Replace metal halide fixture lamp, 175 W	5	14.00 Ea.	$851.75	$1,034.93	8.0000	8	8	$8,279.43	$8,279.43
Replace metal halide fixture, 175 W	20	14.00 Ea.	$11,335.85	$13,340.23	2.0000	2	2	$26,680.45	$26,680.45
Repair smoke detector	10	25.00 Ea.	$1,519.13	$1,880.13	4.0000	4	3	$7,520.52	$5,640.39
Check operation smoke detector	1	25.00 Ea.	$436.64	$547.76	40.0000	40	40	$21,910.56	$21,910.56
Replace smoke detector	15	25.00 Ea.	$8,435.53	$10,037.68	2.6667	2	2	$20,075.37	$20,075.37
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	4.0000	4	3	$2,805.76	$2,104.32
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	2.6667	2	2	$3,318.05	$3,318.05
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	8.0000	8	8	$1,563.40	$1,563.40
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	80.0000	80	80	$4,641.68	$4,641.68
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	2.6667	2	2	$5,682.79	$5,682.79
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	8.0000	8	8	$1,563.40	$1,563.40
Maintenance and inspection annunciation panel	0.5	1.00 Ea.	$46.25	$58.02	80.0000	80	80	$4,641.68	$4,641.68
Replace annunciation panel	15	1.00 Ea.	$1,250.41	$1,502.49	2.6667	2	2	$3,004.99	$3,004.99
Replace fire alarm bell, 6"	20	2.00 Ea.	$400.87	$485.64	2.0000	2	2	$971.29	$971.29
Maintenance and repair of general wiring lightning protection system	1	2.60 M.L.F.	$289.44	$357.13	40.0000	40	40	$14,285.37	$14,285.37
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	40.0000	40	39	$19,093.27	$18,615.93
Replace lightning ground rod	25	4.00 Ea.	$1,031.13	$1,274.23	1.6000	1	1	$1,274.23	$1,274.23
Replace lamp emergency lighting fixture	2	6.00 Ea.	$343.89	$415.07	20.0000	20	20	$8,301.46	$8,301.46
Replace emergency lighting fixture	20	6.00 Ea.	$3,742.69	$4,418.97	2.0000	2	2	$8,837.93	$8,837.93
Maintenance and repair exit light	20	6.00 Ea.	$239.49	$296.44	2.0000	2	2	$592.87	$592.87
Replace lamp exit light	5	6.00 Ea.	$109.79	$130.14	8.0000	8	8	$1,041.16	$1,041.16
Replace lighting fixture exit light	20	6.00 Ea.	$1,118.65	$1,354.71	2.0000	2	2	$2,709.42	$2,709.42
			$1,219,964.00	$1,445,238.55				MR Subtotal:	$2,391,569.32
								MR Per Year:	$59,789.23
								PM Total:	$9,390.35
								Subtotal:	$69,179.58
								Total Per Unit:	$5.77

FAC 7422 Indoor Swimming Pool

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $5.77
UM: SF
Expected Service Life: 40
Model Size: 11994

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	10	2.60	$158.22	$117.34	$0.0000	275.56	326.58	385.52
Urinals, annualized	6	1.37	$41.03	$73.60	$0.0000	114.64	140.82	169.06
Toilet (vacuum breaker type), annualized	8	1.42	$73.47	$76.48	$0.0000	149.95	180.24	214.20
Lavatories, annualized	8	2.78	$61.75	$175.97	$0.0000	237.71	296.68	358.73
Showers, annualized	20	4.56	$280.40	$288.49	$0.0000	568.88	683.47	812.08
Drink fountain, annualized	4	2.48	$144.60	$133.67	$0.0000	278.26	332.82	394.61
Water heater, steam 2500 gal., annualized	1	1.55	$155.34	$83.33	$0.0000	238.67	279.21	327.51
Boiler, steam, oil, gas, or comb. fired, 500 to 1000 MBH, annualized	1	20.70	$103.56	$1,332.45	$0.0000	1,436.01	1,846.10	2,261.37
Air handling unit, 25 thru 50 tons, annualized	2	3.88	$457.24	$208.12	$0.0000	665.35	773.51	904.53
Fan, axial, 5,000 to 10,000 CFM, annualized	2	2.58	$71.32	$138.74	$0.0000	210.06	258.82	311.14
Centrifugal, over 1 HP, annualized	4	4.78	$55.10	$257.18	$0.0000	312.29	394.95	480.37
Package unit, air cooled, 3 thru 24 ton, annualized	2	4.79	$330.23	$307.94	$0.0000	638.17	763.58	905.49
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Transformer, dry type 500 KVA and over, annualized	2	1.54	$33.03	$109.56	$0.0000	142.59	178.77	216.59
Panelboard, 225 A and above, annualized	2	0.88	$51.90	$62.75	$0.0000	114.64	138.66	165.27
Light, emergency, hardwired system, annualized	6	1.50	$54.49	$94.72	$0.0000	149.21	183.08	219.66
						$6,337.28	$7,810.31	$9,390.35

FAC 7431 Auditorium and Theater Facility

FY25 SUC:	$2.91 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7440 Community Activities/ Conference Center

FY25 SUC:	$4.84 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7441 Transient Lodging

FY25 SUC:	$4.54 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7441 Transient Lodging

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.54
UM: SF
Expected Service Life: 41
Model Size: 18797

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	56.00 S.F.	$2,278.32	$2,774.82	2.7333	2	2	$5,549.64	$5,549.64
Repair masonry steps	4	120.00 S.F.	$2,954.76	$3,591.67	10.2500	10	10	$35,916.68	$35,916.68
Refinish metal hand rail	7	6.00 L.F.	$12.58	$15.52	5.8571	5	5	$77.60	$77.60
Repair clay brick wall, 1st floor	25	120.00 S.F.	$5,715.68	$7,012.50	1.6400	1	1	$7,012.50	$7,012.50
Point clay brick wall, 1st floor	25	87.00 C.S.F.	$76,117.90	$94,110.20	1.6400	1	1	$94,110.20	$94,110.20
Replace hardboard panels, 1st floor	12	95.00 C.S.F.	$37,099.92	$44,765.09	3.4167	3	3	$134,295.26	$134,295.26
Replace hardboard panels, 2nd floor	12	95.00 C.S.F.	$50,647.15	$61,616.52	3.4167	3	3	$184,849.55	$184,849.55
Refinish aluminum louver, 1st floor	5	4.00 Ea.	$441.94	$546.87	8.2000	8	8	$4,374.93	$4,374.93
Replace aluminum louver, 1st floor	60	4.00 Ea.	$2,576.50	$3,011.74	0.6833	0	0	$0.00	$0.00
Repair 3' x 4' aluminum window - 1st floor	20	32.00 Ea.	$9,645.12	$11,335.71	2.0500	2	2	$22,671.42	$22,671.42
Replace 3' x 4' aluminum window - 1st floor	50	32.00 Ea.	$34,469.88	$40,011.63	0.8200	0	0	$0.00	$0.00
Repair 3' x 4' aluminum window - 2nd floor	20	32.00 Ea.	$11,281.36	$13,371.03	2.0500	2	2	$26,742.05	$26,742.05
Replace 3' x 4' aluminum window - 2nd floor	50	32.00 Ea.	$36,106.11	$42,046.94	0.8200	0	0	$0.00	$0.00
Replace plate glass storefront - 1st floor	50	0.80 C.S.F.	$4,237.49	$4,908.19	0.8200	0	0	$0.00	$0.00
Repair aluminum storefront door	12	4.00 Ea.	$2,198.35	$2,621.34	3.4167	3	3	$7,864.02	$7,864.02
Replace 3'-0" x 7'-0" aluminum storefront doors	50	4.00 Ea.	$11,457.85	$13,436.80	0.8200	0	0	$0.00	$0.00
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	2.9286	2	2	$5,524.61	$5,524.61
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	10.2500	10	10	$1,762.58	$1,762.58
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	0.9111	0	0	$0.00	$0.00
Replace door panic device	25	3.00 Ea.	$7,112.86	$8,129.08	1.6400	1	1	$8,129.08	$8,129.08
Debris removal, by hand and visual inspection, thermosetting	1	9.40 M.S.F.	$382.23	$466.80	41.0000	41	41	$19,138.82	$19,138.82
Total EPDM roof replacement	25	86.60 Sq.	$71,020.42	$83,581.24	1.6400	1	1	$83,581.24	$83,581.24
Replace aluminum gutter, enameled, 5" K type, .032 " thick	40	320.00 L.F.	$3,461.80	$4,172.30	1.0250	1	1	$4,172.30	$4,172.30
Replace aluminum downspout, 3" x 4", .024" thick	25	80.00 L.F.	$916.73	$1,092.75	1.6400	1	1	$1,092.75	$1,092.75
Refinish concrete block wall painted	4	14.00 C.S.F.	$1,920.14	$2,308.42	10.2500	10	10	$23,084.17	$23,084.17
Repair hollow core wood door, interior	7	14.00 Ea.	$4,155.90	$4,848.50	5.8571	5	5	$24,242.52	$24,242.52
Refinish 3'-0" x 7'-0" hollow core wood door, interior	4	14.00 Ea.	$765.54	$931.31	10.2500	10	10	$9,313.09	$9,313.09
Replace 3'-0" x 7'-0" solid core wood door, interior	40	24.00 Ea.	$15,450.66	$17,815.21	1.0250	1	1	$17,815.21	$17,815.21
Repair solid core sliding wood door, interior	14	24.00 Ea.	$1,515.75	$1,823.31	2.9286	2	2	$3,646.62	$3,646.62
Repair concrete steps	15	130.00 S.F.	$4,009.74	$4,625.48	2.7333	2	2	$9,250.95	$9,250.95
Refinish metal stair railing, interior	7	60.00 S.F.	$99.18	$122.12	5.8571	5	5	$610.59	$610.59
Refinish drywall	4	1,640.00 S.F.	$1,184.17	$1,452.06	10.2500	10	10	$14,520.63	$14,520.63
Office painting, 10' x 12', 10' high walls	5	3.00 Ea.	$782.03	$955.37	8.2000	8	8	$7,642.92	$7,642.92
Refinish wood surface - fireplace mantle	7	16.00 S.F.	$27.98	$33.82	5.8571	5	5	$169.08	$169.08
Ceramic tile floor repairs - (2% of floors)	15	50.00 C.S.F.	$34,831.42	$43,426.88	2.7333	2	2	$86,853.76	$86,853.76
Replace carpet	8	670.00 S.Y.	$37,318.00	$43,155.25	5.1250	5	5	$215,776.23	$215,776.23
Acoustic tile repairs - (2% of ceilings)	9	2.50 C.S.F.	$2,876.78	$3,334.21	4.5556	4	4	$13,336.86	$13,336.86
Unplug clogged line flush-tank water closet	5	22.00 Ea.	$5,055.19	$6,331.33	8.2000	8	8	$50,650.67	$50,650.67
Replace washer / diaphragm in ball cock flush-tank water closet	5	22.00 Ea.	$434.48	$536.22	8.2000	8	8	$4,289.79	$4,289.79
Replace valve and ball cock assembly flush-tank water closet	15	22.00 Ea.	$2,137.91	$2,644.95	2.7333	2	2	$5,289.91	$5,289.91
Replace flush valve diaphragm for a urinal	7	2.00 Ea.	$55.18	$68.55	5.8571	5	5	$342.76	$342.76
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.0500	2	2	$931.82	$931.82
Unplug line urinal	5	2.00 Ea.	$305.81	$383.01	8.2000	8	8	$3,064.05	$3,064.05
Replace washer in spud connection lavatory, vitreous china	7	22.00 Ea.	$382.65	$467.14	5.8571	5	5	$2,335.71	$2,335.71
Replace washer in faucet lavatory, vitreous china	2	22.00 Ea.	$299.15	$373.18	20.5000	20	20	$7,463.66	$7,463.66
Replace faucets lavatory, vitreous china	10	22.00 Ea.	$4,369.70	$5,253.24	4.1000	4	4	$21,012.95	$21,012.95
Clean out strainer and P trap lavatory, vitreous china	2	22.00 Ea.	$815.94	$1,021.92	20.5000	20	20	$20,438.43	$20,438.43
Replace faucet washer sink, service/utility	2	2.00 Ea.	$27.01	$33.69	20.5000	20	20	$673.83	$673.83
Clean trap	3	2.00 Ea.	$18.04	$22.59	13.6667	13	13	$293.64	$293.64
Unstop sink	2	2.00 Ea.	$88.31	$110.60	20.5000	20	20	$2,211.95	$2,211.95
Inspect / clean shower head fiberglass	3	20.00 Ea.	$1,041.17	$1,304.01	13.6667	13	13	$16,952.14	$16,952.14
Replace mixing valve shower, fiberglass	10	20.00 Ea.	$5,876.48	$7,150.38	4.1000	4	4	$28,601.51	$28,601.51
Replace shower and fittings, fiberglass	20	20.00 Ea.	$23,770.33	$28,249.03	2.0500	2	2	$56,498.06	$56,498.06
Check / minor repairs drinking fountain	1	2.00 Ea.	$103.89	$130.11	41.0000	41	41	$5,334.71	$5,334.71
Repair internal leaks drinking fountain	4	2.00 Ea.	$95.58	$119.71	10.2500	10	10	$1,197.06	$1,197.06
Replace refrigerant drinking fountain	2	2.00 Ea.	$73.54	$85.99	20.5000	20	20	$1,719.89	$1,719.89
Repair drain leak drinking fountain	4	2.00 Ea.	$61.02	$73.62	10.2500	10	8	$736.17	$588.93
Replace fountain drinking fountain	10	2.00 Ea.	$3,046.79	$3,588.88	4.1000	4	4	$14,355.52	$14,355.52
Resolder joint pipe & fittings, copper	10	32.00 Ea.	$1,628.88	$2,009.14	4.1000	4	4	$8,036.57	$8,036.57
Replace pipe and fittings, copper 1"	25	136.00 L.F.	$3,826.23	$4,629.26	1.6400	1	1	$4,629.26	$4,629.26
Replace threaded steel pipe and fittings, 3/4"	75	42.00 L.F.	$1,040.88	$1,264.87	0.5467	0	0	$0.00	$0.00
Replace old valve, non-drain, less than 1-1/2"	10	4.00 Ea.	$2,843.73	$3,274.69	4.1000	4	4	$13,098.74	$13,098.74
Drain and flush water heater, electric, 300 gallon	7	1.00 Ea.	$310.63	$389.04	5.8571	5	5	$1,945.22	$1,945.22
Check operation water heater, electric, 300 gallon	3	1.00 Ea.	$2.72	$3.41	13.6667	13	13	$44.32	$44.32
Refill expansion chamber	5	1.00 Ea.	$3.02	$3.79	8.2000	8	8	$30.29	$30.29
Remove old chamber, install new expansion chamber	10	1.00 Ea.	$1,119.69	$1,280.10	4.1000	4	4	$5,120.39	$5,120.39
Inspect / check pump / motor operation, lubricate circulation pump, 1/12 HP	0.5	1.00 Ea.	$8.47	$10.60	82.0000	82	82	$869.56	$869.56
Replace pump / motor assembly circulation pump, 1/12 HP	10	1.00 Ea.	$1,265.32	$1,479.95	4.1000	4	4	$5,919.80	$5,919.80
Remove old meter, install new water meter 5/8"	25	1.00 Ea.	$307.97	$358.77	1.6400	1	1	$358.77	$358.77
Clean floor drain w/o bucket	4	3.00 Ea.	$370.88	$464.51	10.2500	10	10	$4,645.10	$4,645.10
Replace floor drain w/o bucket	40	3.00 Ea.	$7,932.10	$9,092.44	1.0250	1	1	$9,092.44	$9,092.44
Install new 2" gasket, 1 per M.L.F. natural gas, steel/iron	30	2.00 Ea.	$275.53	$342.35	1.3667	1	1	$342.35	$342.35
Replace fan & motor, propeller exhaust, 1000 CFM exhaust fan	15	1.00 Ea.	$930.97	$1,096.55	2.7333	2	2	$2,193.10	$2,193.10
Repair terminal reheat, 36" x 36" coil	10	6.00 Ea.	$1,034.73	$1,295.94	4.1000	4	4	$5,183.77	$5,183.77
Replace terminal reheat, 36" x 36" coil	15	6.00 Ea.	$23,444.20	$27,210.58	2.7333	2	2	$54,421.17	$54,421.17
Repair multi-zone rooftop unit, 15 ton	10	2.00 Ea.	$73,268.08	$84,506.36	4.1000	4	3	$338,025.42	$253,519.07
Replace multi-zone rooftop unit, 15 ton	15	2.00 Ea.	$180,401.20	$207,853.40	2.7333	2	2	$415,706.80	$415,706.80
Repair central station A.H.U., 1300 CFM	10	2.00 Ea.	$1,202.74	$1,427.77	4.1000	4	3	$5,711.07	$4,283.31
Replace central station A.H.U., 1300 CFM	15	2.00 Ea.	$21,346.09	$24,682.61	2.7333	2	2	$49,365.23	$49,365.23
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	4.1000	4	4	$4,698.57	$4,698.57
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	41.0000	41	41	$1,861.81	$1,861.81
Replace sprinkler head	20	60.00 Ea.	$5,501.44	$6,779.83	2.0500	2	2	$13,559.67	$13,559.67
Replace fuse	25	44.00 Ea.	$26,739.26	$30,634.16	1.6400	1	1	$30,634.16	$30,634.16
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	4.1000	4	4	$6,215.64	$6,215.64
Maintenance and repair motor starter, up to 600 V	5	2.00 Ea.	$699.10	$837.86	8.2000	8	8	$6,702.87	$6,702.87
Maintenance and repair secondary transformer, dry	10	2.00 Ea.	$591.02	$702.53	4.1000	4	4	$2,810.11	$2,810.11
Maintenance and inspection lighting panel, indoor	3	3.00 Ea.	$131.45	$164.90	13.6667	13	13	$2,143.72	$2,143.72
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	4.00 Ea.	$309.15	$387.82	2.0500	2	2	$775.65	$775.65
Replace circuit breaker molded case, 600 V, 3 pole circuit breaker	50	3.00 Ea.	$15,516.66	$17,773.20	0.8200	0	0	$0.00	$0.00
Maintenance and inspection circuit breaker, enclosed, 240 V, 3 pole	1	25.00 Ea.	$867.19	$1,087.89	41.0000	41	41	$44,603.63	$44,603.63
Maintenance and repair safety switch general, 3 pole	8	1.00 Ea.	$43.82	$54.97	5.1250	5	5	$274.84	$274.84
Replace fluorescent light fixture ballast, 80 W	10	84.00 Ea.	$9,150.29	$11,283.49	4.1000	4	4	$45,133.98	$45,133.98
Replace lamps (2 lamps), 4', 34 W energy saver	10	84.00 Ea.	$2,280.74	$2,859.88	4.1000	4	4	$11,439.51	$11,439.51
Replace telephone jack	20	20.00 Ea.	$676.52	$832.62	2.0500	2	2	$1,665.24	$1,665.24
Replace TV cable outlet	20	20.00 Ea.	$1,540.03	$1,917.83	2.0500	2	2	$3,835.66	$3,835.66
Repair smoke detector	10	24.00 Ea.	$1,458.36	$1,804.92	4.1000	4	4	$7,219.70	$7,219.70
Check operation smoke detector	1	24.00 Ea.	$419.17	$525.85	41.0000	41	41	$21,559.99	$21,559.99
Check and repair manual pull station	10	8.00 Ea.	$759.91	$935.25	4.1000	4	4	$3,741.02	$3,741.02
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	8.2000	8	8	$1,563.40	$1,563.40
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	8.2000	8	8	$1,563.40	$1,563.40
Replace fire alarm bell, 6"	20	6.00 Ea.	$1,202.61	$1,456.93	2.0500	2	2	$2,913.86	$2,913.86
Maintenance and repair electrical service ground	25	0.60 M.L.F.	$57.28	$71.60	1.6400	1	1	$71.60	$71.60
Maintenance and repair building structure ground	7	0.60 M.L.F.	$57.28	$71.60	5.8571	5	5	$358.00	$358.00
Replace building structure ground	50	0.90 M.L.F.	$5,245.59	$6,344.52	0.8200	0	0	$0.00	$0.00
Maintenance and repair of general wiring lightning protection system	1	0.90 M.L.F.	$100.19	$123.62	41.0000	41	41	$5,068.56	$5,068.56
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	41.0000	41	41	$9,785.30	$9,785.30
Replace lamp emergency lighting fixture	2	12.00 Ea.	$687.79	$830.15	20.5000	20	20	$16,602.92	$16,602.92
Maintenance and repair exit light	20	12.00 Ea.	$478.98	$592.87	2.0500	2	2	$1,185.74	$1,185.74
Replace lamp exit light	5	12.00 Ea.	$219.58	$260.29	8.2000	8	8	$2,082.32	$2,082.32
Maintenance and repair voice/data outlet	10	6.00 Ea.	$334.16	$417.69	4.1000	4	4	$1,670.76	$1,670.76
Replace voice/data outlet	20	6.00 Ea.	$169.90	$206.92	2.0500	2	2	$413.83	$413.83
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	82.0000	82	82	$9,515.44	$9,515.44
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	2.7333	2	2	$2,276.61	$2,276.61
			$929,922.62	$1,097,666.17				MR Subtotal:	$2,420,127.62
								MR Per Year:	$59,027.50
								PM Total:	$26,266.62
								Subtotal:	$85,294.12
								Total Per Unit:	$4.54

FAC 7441 Transient Lodging

Release:	2024 Qtr 3	FY25 SUC:	$4.54
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	41
		Model Size:	18797

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	2	0.52	$31.64	$23.47	$0.0000	55.11	65.32	77.10
Elevator, cable, electric, passenger / freight, annualized	1	47.90	$3,787.50	$4,430.40	$0.0000	8,217.90	9,925.77	11,823.02
Elevator, hydraulic, passenger / freight, annualized	0.5	5.11	$656.50	$473.04	$0.0000	1,129.54	1,337.10	1,577.48
Urinals, annualized	2	0.46	$13.68	$24.53	$0.0000	38.21	46.94	56.35
Toilet (vacuum breaker type), annually	20	1.14	$91.84	$61.25	$0.0000	153.09	180.65	212.80
Toilet (tank type), annualized	20	7.76	$166.09	$414.54	$0.0000	580.63	721.60	870.88
Showers, annualized	20	4.56	$280.40	$288.49	$0.0000	568.88	683.47	812.08
Drink fountain, annualized	2	1.24	$72.30	$66.83	$0.0000	139.13	166.41	197.31
Air handling unit, 25 thru 50 tons, annualized	2	3.88	$457.24	$208.12	$0.0000	665.35	773.51	904.53
VAV Boxes, annualized	11	10.27	$104.78	$656.07	$0.0000	760.86	968.16	1,180.70
Package unit, air cooled, 3 thru 24 ton, annualized	2	4.79	$330.23	$307.94	$0.0000	638.17	763.58	905.49
Controls, central system, electro/pneumatic, annualized	2	3.84	$359.54	$245.34	$0.0000	604.88	714.43	841.96
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Switchboard, annualized	3	2.10	$14.25	$150.89	$0.0000	165.15	211.84	259.24
Circuit breaker, high voltage air, annualized	14	6.58	$231.24	$467.12	$0.0000	698.36	861.62	1,036.44
Motor control center, over 400 A, annualized	1	0.39	$25.95	$27.89	$0.0000	53.84	64.80	77.06
Fire alarm annuciator system, annualized	1	11.05	$195.61	$697.20	$0.0000	892.81	1,121.53	1,360.03
Light, emergency, hardwired system, annualized	12	3.00	$108.98	$189.44	$0.0000	298.42	366.15	439.33
Ice machine, flake or cube, annualized	2	7.17	$1,222.10	$271.95	$0.0000	1,494.05	1,697.84	1,962.74
Refrigerator, domestic, annualized	20	4.68	$98.58	$177.90	$0.0000	276.48	339.71	407.86
						$18,236.15	$22,043.45	$26,266.62

FAC 7442 Recreational Lodging

FY25 SUC:	$4.97 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7443 Transient And Recreational Lodging Support Facility

FY25 SUC:	$1.59 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7444 Stable

FY25 SUC:	$0.73 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7445 Boathouse

FY25 SUC:	$1.35 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7446 MWR Sales and Rental Building

FY25 SUC:	$5.24 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7447 MWR Storage Building

FY25 SUC:	$3.02 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7448 Recreational Support Building

FY25 SUC:	$2.76 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7449 Retail Kennel

FY25 SUC:	$5.53 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7511 Playground

FY25 SUC:	$4,101.25 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7512 Outdoor Swimming Pool

FY25 SUC:	$16,575.08 / EA
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7512 Outdoor Swimming Pool

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $16,575.08
UM: EA
Expected Service Life: 25
Model Size: 1

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Replace epoxy flooring	15	52.00 C.S.F.	$65,593.57	$78,428.29	1.6667	1	1	$78,428.29	$78,428.29
Check / minor repairs drinking fountain	1	3.00 Ea.	$155.83	$195.17	25.0000	25	25	$4,879.30	$4,879.30
Repair internal leaks drinking fountain	4	3.00 Ea.	$143.37	$179.56	6.2500	6	6	$1,077.35	$1,077.35
Correct water pressure drinking fountain	2	3.00 Ea.	$132.46	$165.90	12.5000	12	12	$1,990.76	$1,990.76
Replace refrigerant drinking fountain	2	3.00 Ea.	$110.31	$128.99	12.5000	12	12	$1,547.90	$1,547.90
Repair drain leak drinking fountain	4	3.00 Ea.	$91.53	$110.43	6.2500	6	5	$662.55	$552.13
Replace fountain drinking fountain	10	3.00 Ea.	$4,570.18	$5,383.32	2.5000	2	2	$10,766.64	$10,766.64
Inspect and clean shower head emergency shower station	3	1.00 Ea.	$52.06	$65.20	8.3333	8	8	$521.60	$521.60
Replace shower emergency shower station	25	1.00 Ea.	$1,055.90	$1,263.20	1.0000	1	1	$1,263.20	$1,263.20
Inspect and clean spray heads, emergency eye wash	3	1.00 Ea.	$52.06	$65.20	8.3333	8	8	$521.60	$521.60
Replace eye wash station, emergency eye wash	25	1.00 Ea.	$790.45	$961.55	1.0000	1	1	$961.55	$961.55
Insp/chk pump/mtr oper, lub, chk align circulation pump, 3 HP	0.5	2.00 Ea.	$27.36	$34.27	50.0000	50	50	$1,713.61	$1,713.61
Replace pump / motor assembly circulation pump, 3 HP	20	2.00 Ea.	$28,718.59	$32,849.64	1.2500	1	1	$32,849.64	$32,849.64
Replace water softener	15	3.00 Ea.	$3,625.63	$4,331.31	1.6667	1	1	$4,331.31	$4,331.31
Repair boiler, gas, 2000 MBH	7	1.00 Ea.	$5,513.06	$6,436.35	3.5714	3	3	$19,309.05	$19,309.05
Replace boiler, gas, 2000 MBH	30	1.00 Ea.	$47,742.79	$55,703.30	0.8333	0	0	$0.00	$0.00
Repair chemical feed system	15	1.00 Ea.	$996.45	$1,186.00	1.6667	1	1	$1,186.00	$1,186.00
Replace chemical feed system	15	1.00 Ea.	$968.06	$1,122.61	1.6667	1	1	$1,122.61	$1,122.61
Replace metal flue, all fuel SS, 6" diameter metal flue / chimney	15	1.00 L.F.	$185.43	$213.70	1.6667	1	1	$213.70	$213.70
Maintenance and repair breaker, enclosed, 240 V, 1 pole	25	6.00 Ea.	$463.72	$581.74	1.0000	1	1	$581.74	$581.74
Maintenance and inspection circuit breaker, enclosed, 240 V, 1 pole	1	6.00 Ea.	$208.13	$261.09	25.0000	25	25	$6,527.36	$6,527.36
Replace circuit breaker enclosed, 240 V, 1 pole circuit breaker	50	6.00 Ea.	$3,146.84	$3,747.73	0.5000	0	0	$0.00	$0.00
Maintenance and inspection circuit breaker, enclosed, 240 V, 2 pole	1	4.00 Ea.	$138.75	$174.06	25.0000	25	25	$4,351.57	$4,351.57
Replace circuit breaker enclosed, 240 V, 2 pole circuit breaker	50	4.00 Ea.	$3,667.37	$4,289.46	0.5000	0	0	$0.00	$0.00
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	1.00 Ea.	$43.82	$54.97	3.1250	3	3	$164.90	$164.90
Maintenance and inspection safety switch, 3 pole, heavy duty	1	1.00 Ea.	$43.82	$54.97	25.0000	25	25	$1,374.18	$1,374.18
Replace safety switch, heavy duty 30 A	25	1.00 Ea.	$767.57	$911.04	1.0000	1	1	$911.04	$911.04
Replace safety switch, heavy duty 200 A	25	1.00 Ea.	$2,624.07	$3,070.13	1.0000	1	1	$3,070.13	$3,070.13
Replace incandescent lighting fixture lamp for explosion proof fixture	5	30.00 Ea.	$785.76	$946.83	5.0000	5	5	$4,734.13	$4,734.13
Inspect intercom master station	0.5	1.00 Ea.	$185.00	$232.08	50.0000	50	50	$11,604.20	$11,604.20
Replace intercom master station	15	0.90 Ea.	$2,971.04	$3,464.55	1.6667	1	1	$3,464.55	$3,464.55
Inspect intercom remote station	1	6.00 Ea.	$167.96	$210.71	25.0000	25	25	$5,267.69	$5,267.69
Inspect camera and monitor	0.5	6.00 Ea.	$420.49	$527.50	50.0000	50	50	$26,375.12	$26,375.12
Check and repair manual pull station	10	3.60 Ea.	$341.96	$420.86	2.5000	2	2	$841.73	$841.73
Replace manual pull station	15	3.60 Ea.	$828.27	$995.42	1.6667	1	1	$995.42	$995.42
Minor repairs to fire alarm control panel	5	0.90 Ea.	$144.25	$175.88	5.0000	5	5	$879.41	$879.41
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	50.0000	50	50	$2,901.05	$2,901.05
Replace fire alarm control panel	15	0.90 Ea.	$2,101.74	$2,557.26	1.6667	1	1	$2,557.26	$2,557.26
Minor repairs to annunciation panel	5	0.90 Ea.	$144.25	$175.88	5.0000	5	5	$879.41	$879.41
Maintenance and inspection annunciation panel	0.5	1.00 Ea.	$46.25	$58.02	50.0000	50	50	$2,901.05	$2,901.05
Replace annunciation panel	15	0.90 Ea.	$1,125.37	$1,352.24	1.6667	1	1	$1,352.24	$1,352.24
Replace fire alarm bell, 6"	20	1.80 Ea.	$360.78	$437.08	1.2500	1	1	$437.08	$437.08
Maintenance and repair electrical service ground	25	1.00 M.L.F.	$95.46	$119.33	1.0000	1	1	$119.33	$119.33
Replace electrical service ground	50	1.00 M.L.F.	$4,839.30	$5,886.42	0.5000	0	0	$0.00	$0.00
Maintenance and repair building structure ground	7	1.00 M.L.F.	$95.46	$119.33	3.5714	3	3	$358.00	$358.00
Replace building structure ground	50	1.00 M.L.F.	$5,828.43	$7,049.47	0.5000	0	0	$0.00	$0.00
Maintenance and repair of general wiring lightning protection system	1	1.00 M.L.F.	$111.32	$137.36	25.0000	25	25	$3,433.98	$3,433.98
Replace lightning protection general wiring system	25	0.90 M.L.F.	$12,081.85	$14,306.08	1.0000	1	1	$14,306.08	$14,306.08
Maintenance and repair lightning ground rod	1	2.00 Ea.	$190.92	$238.67	25.0000	25	24	$5,966.65	$5,727.98
Replace lightning ground rod	25	2.00 Ea.	$515.56	$637.11	1.0000	1	1	$637.11	$637.11
Refinish concrete patio	3	5,044.00 S.F.	$4,200.87	$5,107.07	8.3333	8	8	$40,856.56	$40,856.56
Refinish metal handicap ramp	3	1.00 S.F.	$2.07	$2.52	8.3333	8	8	$20.19	$20.19
Minor chain link fence repairs, per 10 LF	1	1.00 Ea.	$29.69	$36.62	25.0000	25	25	$915.54	$915.54
Replace bent 1-5/8" top rail, per 20 LF	2	1.00 Ea.	$122.79	$145.30	12.5000	12	12	$1,743.64	$1,743.64
Replace 2" line post	5	1.00 Ea.	$700.32	$827.52	5.0000	5	5	$4,137.58	$4,137.58
Replace 400W H.P.S. lamp, pole-mounted fixture	10	7.20 Ea.	$1,063.59	$1,258.77	2.5000	2	2	$2,517.55	$2,517.55
Replace 400W H.P.S. ballast, pole-mounted fixture	10	8.00 Ea.	$4,442.53	$5,261.00	2.5000	2	2	$10,522.00	$10,522.00
			$215,618.71	$254,714.08				MR Subtotal:	$330,703.05
								MR Per Year:	$13,228.12
								PM Total:	$3,346.96
								Subtotal:	$16,575.08
								Total Per Unit:	$16,575.08

FAC 7512 Outdoor Swimming Pool

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $16,575.08
UM: EA
Expected Service Life: 25
Model Size: 1

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Wheelchair lift, annualized	1	1.21	$28.28	$111.68	$0.0000	139.96	176.30	214.04
Drink fountain, annualized	4	2.48	$144.60	$133.67	$0.0000	278.26	332.82	394.61
Boiler, steam, oil, gas, or comb. fired, 500 to 1000 MBH, annualized	1	20.70	$103.56	$1,332.45	$0.0000	1,436.01	1,846.10	2,261.37
Centrifugal, over 1 HP, annualized	2	2.39	$27.55	$128.59	$0.0000	156.14	197.48	240.19
Panelboard, 225 A and above, annualized	1	0.44	$25.95	$31.37	$0.0000	57.32	69.33	82.63
Motor control center, over 400 A, annualized	2	0.78	$51.90	$55.78	$0.0000	107.67	129.59	154.11
						$2,175.36	$2,751.62	$3,346.96

FAC 7513 Golf Course

FY25 SUC:	$93,778.19 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Composite of multiple FACS

FAC 7513 SUC FY16v18 -Golf Course
UM: EA
Design Size: 1
ESL: 25
Assume 18 Holes, 150 AC

Composit of FACs

FAC Component	Modeled Units	Model as	Reference FAC	Quantity	Unit Cost (FY16)	Component Cost
Cart Path	LF	Sidewalk and Walkway	8524	5280	0.00110	5.808
Storm Drainage	LF	Covered Storage Shed, Installation	8711	5280	0.00040	2.112
Pond Aeration	GA	Transient and Recreational Lodging Support Facility	8315	1960200	0.0034	6664.680
Cart Bridges	EA	Cart Bridge	Note	4	439.91	1759.640
Water Distribution System	LF	Water Distribution Line, Potable	8421	5280	0.70	3696.000
Irrigation System	LF	Water Distribution Line, Non-Potable	8451	19845	0.71	14089.950
Restrooms (6M+ 1 F)	SF	Latrine / Shower Facility	7234	4800	6.17	29616.000
Shelters with vending/water	SF	Misc Personnel Shelter	7384	240	0.49	117.600
Snack bar	SF	Exchange Eating Facility	7331	1200	7.06	8472.000
					SUC	**$ 64,423.79**

Note:
Cart Bridge: semi annual structural inspection + minor maintenance =
1.5 hours per bridge 2 x WG7s5 @ $29.97 + $350 for equipment and material

FAC 7514 Golf Driving Range

FY25 SUC:	$9,707.70 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Composite of multiple FACS

FAC 7514 SUC FY16v18 -Golf Driving Range
UM: EA
Design Size: 1
ESL: 25

25 positions with shelter; 10 ft OC 12 ft deep per UFC 4-750-02N
Footprint planning size = 900 ft x 620 ft

Composit of FACs

FAC Component	Modeled Units	Model as	Reference FAC	Quantity	Unit Cost (FY16)	Component Cost
Shelter	SF	Misc Personnel Shelter	7384	3000	0.49	1470.00
Lighting	EA	Exterior Lighting, Pole	8122	64	43.80	2803.20
Perimeter Fence	LF	Boundry Fence and Wall	8721	2420	0.99	2395.80
					SUC	**$ 6,669.00**

Reference:
DoD Real Property Categorization System (RPCS); 2015
UFC 4-750-02N , 4 December, 2003
Fence assumed to be safety barrier against unauthoized entry - no "curtain fence" required per layout

FAC 7515 Golf Pitch and Putt Course

FY25 SUC:	$46,889.09 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Composite of multiple FACS

FAC 7515 SUC FY16v18 -Golf Pitch and Putt Course
UM: EA
Design Size:
ESL 1
Assume 9 Holes, 75 AC 25

Composit of FACs

FAC Component	Modeled Units	Model as	Reference FAC	Quantity	Unit Cost (FY16)	Component Cost
Cart Path	LF	Sidewalk and Walkway	8524	2640	0.00110	2.904
Storm Drainage	LF	Covered Storage Shed, Installation	8711	2640	0.00040	1.056
Pond Aeration	GA	Transient and Recreational Lodging Support Facility	8315	980100	0.0034	3332.340
Cart Bridges	EA	Cart Bridge	Note	2	439.91	879.820
Water Distribution System	LF	Water Distribution Line, Potable	8421	2640	0.70	1848.000
Irrigation System	LF	Water Distribution Line, Non-Potable	8451	9922.5	0.71	7044.975
Restrooms (3M+ 1 F)	SF	Latrine / Shower Facility	7234	2400	6.17	14808.000
Shelters with vending/water	SF	Misc Personnel Shelter	7384	120	0.49	58.800
Snack bar	SF	Exchange Eating Facility	7331	600	7.06	4236.000
					SUC	**$ 32,211.90**

Note:
Cart Bridge: semi annual structural inspection + minor maintenance =
1.5 hours per bridge 2 x WG7s5 @ $29.97 + $350 for equipment and material =

FAC 7516 Outdoor Recreation Area

FY25 SUC:	$1,429.64 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Local Government Authority and R.S. Means Cost Data

Park Maintenance Standards
Fairfax County Park Authority

Foreword

The responsibility of maintaining the Fairfax County Park Authority's multitude of diverse facilities contained in over 23,000 acres of parkland and over 400 parks is shared by multiple operations with the Agency.

- The Park Operations Division manages all of the Park Authority's non-staffed parks and provides maintenance support to all staffed parks. There are six geographically defined maintenance operations (Area Crews) spread across the County that manage all aspects of maintenance in non-staffed parks and provide outside maintenance support to staffed parks within their defined areas. There are also five operations (Equipment Support, Facility Support, Forestry Crew, Mobile Crew, Turf Crew) that provide specialized maintenance support to the Area Crews and indoor and outdoor operations at the staffed parks countywide.
- The Park Services Division's manages maintenance operations at each of its golf courses, lake front parks, and within all of its RECenters.
- The Resource Management Division manages maintenance operations at many of its staffed parks, an active farm, and a garden park.

Due to the large number of parks requiring care, diversity of facilities within each park, and with the responsibility for maintaining varied types of facilities shared at times by multiple operations; the Park Authority has established a set of standards that are not defined by individual parks or park classification types, but are defined by facility types which allows the individual maintenance operations to customize their operations plans and to apply standards for only those facilities which they have responsibility for. The Park Authority's maintenance standards require the same frequency and standard of maintenance to be applied to all like facilities. For facilities that are similar in type but for varied reasons may require a different frequency or standard of maintenance, the standards are defined for the different levels of care.

Maintenance Tasks that are routine or recurring in nature are identified and listed for each Facility Type. The information relevant to each Maintenance Task is presented in three categories: Frequency, Labor Hours per Recurrence, and Total Annual Labor Hours. The Frequency identified with each Maintenance Task identifies how often maintenance is to occur and may show time frames for when during the year it should occur. When applicable, a total amount of occurrences per year is also given. The information provided can be used as a basis for the development of a preventive maintenance program when compared to the established maintenance inventory.

A standard has been created that identifies the total number of Labor Hours per Recurrence that are needed to complete a task. Since the number of staff available to complete tasks varies from operation to operation and day to day, the standards have been designed to allow each operation to determine the hours needed to complete the tasks regardless of the staff available to them. This also provides operations with varied crew sizes flexibility in determining how to efficiently and effectively complete multiple tasks. Tasks can either be completed by one staff member or by multiple staff members, depending upon the nature of the task. When one staff member is assigned to complete a task then the figure shown for that task under the Labor Hours per Recurrence category is approximately how long the task should take to complete. When multiple staff members are assigned to complete a task, then the figure shown for that task under the Labor Hours per Recurrence category can be divided by the number of staff members available to complete the task which will result in a figure that shows approximately how long the task should take to complete.

Maintenance tasks are reported and tracked through an Integrated Workplace Management System called Tririga. Tririga automates service requests and self service requests in demand maintenance, preventive maintenance, and project management for dispatching, approvals, scheduling, cost tracking, and reports such as leases, inventory, equipment use/life expectancy, and expenses. Park staff can initiate, track, manage, and report on all requests online.

Reviewed March 2014

Park Operations Division Director

Table of Contents

Amenities

Benches

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Conduct a Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
Metal	Replace Seat or Back	Every 10 Years	1.0	0.1
Recycled	Replace Seat or Back	Every 10 Years	1.0	0.1
Wood	Replace Seat or Back	Every 5 years	2.0	0.4
	Painting	Every 2 Years	1.5	0.3

Bollards

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safetly and Maintenance Inspection (per Site)	4 Times Annually	0.1	0.4
Metal	Painting	Every 5 Years	2.0	0.4
Removable Bollard	Painting and Replacing Reflective Tape	Every 5 Years	2.0	0.4

Fencing and Railing

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 100' Section)	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Repairs	Every 2 Years	2.0	1.0

Gates

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Painting and Miscellaneous Repairs	Every 2 Years	1.0	0.5

Guardrail and Barricades

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 100 Linear Feet)	Safety and Maintenance Inspection	4 Times Annually	0.2	0.8
Metal Guardrail (Per 500 Linear Feet)	Repairs	Every 10 Years	2.0	0.2
Wood Guardrail and Cable (Per 200 Linear Feet)	Repairs	Every 3 Years	2.0	0.7

Parking Lots

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 25 Spaces)	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
		Weekly, 13 Times per Year (December - February)	0.1	1.3
	Reset Car Stops	Twice per Year	0.3	0.6
	Replace Car Stop	Annually	0.5	0.5
	Snow and Ice Removal	Average of 3 Events Annually	0.6	1.8
Asphalt (Per 25 Spaces)	Pot Hole Repairs	Twice per Year	0.5	1.0
	Cleaning	Twice per Year	0.5	1.0
	Spraying Weeds	Twice per Year	0.2	0.4
	Striping (Contracted service)	Every 3 Years	5.0	1.7
Gravel (Per 25 Spaces)	Regrading	Annually	6.0	6.0
	Spraying Weeds	Twice per Year	0.4	0.8

Parking Lot and Roadway Lighting

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Lighting	Safety and Maintenance Inspection	Weekly	0.2	10.4
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	2.0	2.0

Roadways

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 250 Linear Feet of Roadway)	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Snow and Ice Removal	Average of 3 Events Annually	0.4	1.2
Asphalt (Per 250 Linear Feet of Roadway)	Pot Hole Repairs	Twice per Year	0.5	1.0
	Striping (Contracted service)	Every 3 Years	0.7	0.2
Gravel (Per 250 Linear Feet of Roadway)	Regrading	Annually	3.0	3.0

Signage

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All Types	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
Metal	Replacement	Every 10 Years	1.0	0.1
Wood	Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Replacement	Every 10 Years	4.0	0.4

Trash Receptacles

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
55 Gallon Can with Dome	Painting	Every 2 Years	1.0	0.5
	Replacement	Every 3 Years for Receptacle	1.5	0.5
		Every 5 Years for Dome	0.5	0.1
		Every 10 Years for 4" X 4" Wood Posts	2.0	0.2
30 Gallon Can	Replacement	Every 5 years	0.5	0.1

Athletic Fields

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	3 Times Per Week, 96 Times per Year April - November)	0.80	76.80
		Weekly, 20 Times per Year (December - April)	0.80	16.00
	Amenity Inspection	Weekly, 32 Times per Year (April - November)	0.80	25.60
	Dragging and Raking Warning Tracks	Weekly, 32 Times per Year (April - November)	0.50	16.00
	Concrete Pads Cleaning	Every 2 Weeks, 16 Times per Year (April - November)	1.30	20.80
	Weeding Warning Tracks and Mowstrips	Every 2 Months, 4 Times per Year (April, June, August, October)	1.50	6.00
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Wet Lining	Twice Annually	1.00	2.00
	Bases and Plates Replacement	Annually	0.60	0.60
	Bases and Plates Set-Up	Annually	1.20	1.20
	Bleachers Maintenance and Repairs	Annually	2.60	2.60

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Fencing Maintenance and Repairs	Annually	11.30	11.30
	Adding Material to Warning Tracks and Mowstrips	Every 2 Years	1.50	0.75
	Foul Poles Maintenance and Repairs	Every 3 Years	4.50	1.49
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70' - Grass Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.50	240.00
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Infield Edging	Annually	5.70	5.70
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	49.00	16.17
60' or 70' - Skinned Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.60	249.60
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	43.00	14.19

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
65' - Skinned Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.60	249.60
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	43.00	14.19

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
90' - Grass Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.70	259.20
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.30	147.20
	Infield Edging	Annually	9.00	9.00
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	49.00	16.17
90' - Skinned Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.60	249.60
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.30	147.20
	Infield Edging	Annually	5.50	5.50
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	43.00	14.19

Level 1 - Rectangles
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	3 Times Per Week, 96 Times per Year (April - November)	0.80	76.80
		Weekly, 20 Times per Year (December - March)	0.80	16.00
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.50	96.00
	Amenity Inspection	Weekly, 32 Times per Year (April - November)	0.60	19.20
	Irrigation Maintenance and Repairs	Twice Annually	8.00	16.00
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Wet Lining	Twice Annually	6.30	12.60
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Field Renovation	Annually	8.30	8.30
	Goals Maintenance and Repairs	Every 2 Years	8.00	4.00
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39

Level 1 - Rectangles
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week, 72 Times per Year (March - November)	0.80	57.60
		Weekly, 16 Times per Year (December - March)	0.80	12.80
	Dragging and Raking Warning Tracks	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Concrete Pads Cleaning	Every 2 Weeks, 18 Times per Year (March - November)	1.30	23.40
	Weeding Warning Tracks and Mowstrips	Every 2 Months, 4 Times per Year (April, June, August, October)	1.80	7.20
	Wet Lining	Twice Annually	1.00	2.00
	Bases and Plates Replacement	Annually	0.60	0.60
	Bases and Plates Set-Up	Annually	1.20	1.20
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Fencing Maintenance and Repairs	Annually	10.10	10.10
	Adding Material to Warning Tracks and Mowstrips	Every 2 Years	1.80	0.90
	Foul Poles Maintenance and Repairs	Every 3 Years	4.50	1.49

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70' - Grass Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.50	180.00
	Mowing	Weekly, 32 Times per Year (March - November)	1.40	44.80
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	5.70	5.70
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20
60' or 70' - Grass Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.50	180.00
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.40	89.60
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	5.70	5.70
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70 - Skinned Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (March - November)	1.40	44.80
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20
60' or 70' - Skinned Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.40	89.60
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
65' - Skinned Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (March - November)	1.40	44.80
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20
65' - Skinned Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.40	89.60
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
90' - Grass Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times per Week, 72 Times per Year (April - November)	2.70	194.40
	Mowing	Weekly, 32 Times per Year (April - November)	2.00	64.00
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	9.00	9.00
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	43.00	14.19
90' - Grass Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times per Week, 72 Times per Year (April - November)	2.70	194.40
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	9.00	9.00
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	43.00	14.19

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
90' - Skinned Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times per Week, 72 Times per Year (April - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (April - November)	2.00	64.00
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	5.50	5.50
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	40.00	13.20
90' - Skinned Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times per Week, 72 Times per Year (April - November)	2.60	187.20
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	5.50	5.50
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	40.00	13.20

Level 2 - Rectangles
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week, 72 Times per Year (March - November)	0.80	57.60
		Weekly, 16 Times per Year (December - March)	0.80	12.80
	Wet Lining	Twice Annually	6.30	12.60
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Field Renovation	Annually	8.30	8.30
	Goals Maintenance and Repairs	Every 2 Years	8.00	4.00
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 2 - Rectangles
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.50	96.00
	Irrigation Maintenance and Repairs	Twice Annually	8.00	16.00
Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.60	21.60
	Mowing	Weekly, 32 Times per Year (April - November)	1.50	48.00
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week, 72 Times per Year (March - November)	0.80	57.60
		Weekly, 16 Times per Year (December - March)	0.80	12.80
	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Dragging and Raking Warning Tracks	Weekly, 32 Times per Year (April - November)	0.20	6.40
	Concrete Pads Cleaning	Every 2 Weeks, 18 Times per Year (March - November)	1.30	23.40
	Weeding Warning Tracks and Mowstrips	Every 2 Months, 4 Times per Year (April, June, August, October)	0.80	3.20
	Wet Lining	Twice Annually	1.00	2.00
	Bases and Plates Replacement	Annually	0.60	0.60
	Bases and Plates Set-Up	Annually	1.20	1.20
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Fencing Maintenance and Repairs	Annually	3.60	3.60
	Adding Material to Warning Tracks and Mowstrips	Every 2 Years	0.80	0.40

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Foul Poles Maintenance and Repairs	Every 3 Years	4.50	1.49
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70' - Grass Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.50	180.00
	Mowing	Weekly, 32 Times per Year (April - November)	1.40	44.80
	Infield Edging	Annually	5.70	5.70
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 4 Years	18.00	4.50
60' or 70' - Skinned Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (April - November)	1.40	44.80
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	18.00	5.94

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
65' - Skinned Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (April - November)	1.40	44.80
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	18.00	5.94
90' - Grass Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.70	194.40
	Mowing	Weekly, 32 Times per Year (April - November)	2.00	64.00
	Infield Edging	Annually	9.00	9.00
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	21.00	6.93

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
90' - Skinned Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (April - November)	2.00	64.00
	Infield Edging	Annually	5.50	5.50
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	18.00	5.94
T-Ball	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	1.10	79.20
	Mowing	Weekly, 32 Times per Year (April - November)	1.40	44.80
	Infield Edging	Annually	4.00	4.00
	Infield Renovation	Every 4 Years	18.00	4.50

Level 3 - Rectangles
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week, 72 Times per Year (March - November)	0.80	57.60
		Weekly, 16 Times per Year (December - March)	0.80	12.80
	Amenity Inspection	Weekly, 36 Times per Year (April - November)	0.50	18.00
	Mowing	Weekly, 32 Times per Year (April - November)	1.50	48.00
	Wet Lining	Twice Annually	6.30	12.60
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Field Renovation	Annually	8.30	8.30
	Goals Maintenance and Repairs	Every 2 Years	8.00	4.00
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 4 - Ball Diamonds
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week	0.80	83.20
	Concrete Pads Cleaning	Monthly	1.30	15.60
	Aluminum Player Benches Maintenance and Repairs	Annually	0.50	0.50
	Artificial Mound - Replace pitching plate and minor repairs	Annually	2.00	2.00
	Bases and Plates Set-Up	Annually	1.20	1.20
	Bases and Plates Replacement	Annually	0.60	0.60
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Fencing Maintenance and Repairs	Annually	11.30	11.30
	Foul Poles Maintenance and Repairs	Every 3 Years	4.50	1.49
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 4 - Ball Diamonds
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70' - Lighted	Amenity Inspection	Weekly	0.80	41.60
	Dragging/Grooming	Weekly	1.40	72.80
	Spot-Dress with Rubber Infill	Monthly	2.00	24.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	1.40	11.20
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Spiking	Annually	1.40	1.40
	Top-Dress with Rubber Infill	Every 4 Years	4.00	1.00
60' or 70' - Non-Lighted	Amenity Inspection	Weekly	0.50	26.00
	Dragging/Grooming	Weekly	1.40	72.80
	Spot-Dress with Rubber Infill	Monthly	2.00	24.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	1.40	11.20
	Spiking	Annually	1.40	1.40
	Top-Dress with Rubber Infill	Every 4 Years	4.00	1.00

Level 4 - Ball Diamonds
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
65' or Above - Lighted	Amenity Inspection	Weekly	0.80	41.60
	Dragging/Grooming	Weekly	2.80	145.60
	Spot-Dress with Rubber Infill	Monthly	3.00	36.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	2.80	22.40
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Spiking	Annually	2.80	2.80
	Top-Dress with Rubber Infill	Every 4 Years	8.00	2.00
65' or Above - Non-Lighted	Amenity Inspection	Weekly	0.50	26.00
	Dragging/Grooming	Weekly	2.80	145.60
	Spot-Dress with Rubber Infill	Monthly	3.00	36.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	2.80	22.40
	Spiking	Annually	2.80	2.80
	Top-Dress with Rubber Infill	Every 4 Years	8.00	2.00

Level 4 - Rectangles
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week	0.80	83.20
	Dragging/Grooming	Weekly	2.80	145.60
	Spot-Dress with Rubber Infill	Monthly	1.00	12.00
	Wet Lining	6 Times per Year (As Needed)	2.50	15.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	2.80	22.40
	Aluminum Player Benches Maintenance and Repairs	Annually	0.50	0.50
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Spiking	Annually	2.80	2.80
	Goals Maintenance and Repairs	Every 2 Years	8.00	4.00
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4
	Top-Dress with Rubber Infill	Every 4 Years	6.00	1.50

Level 4 - Rectangles
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Lighted	Amenity Inspection	Weekly	0.60	31.20
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
Non-Lighted	Amenity Inspection	Weekly	0.50	26.00

Turf Program

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Irrigated Fields (Per Acre)	Fertilizer Applications	Monthly, 4 Times per Year (April, June, September, November)	0.80	3.20
	Aeration	Twice Annually	1.80	3.60
	Pesticide Applications	Twice Annually	1.30	2.60
	Field Inspections	Annually	0.80	0.80
	Overseeding	Annually	1.90	1.90
	Soil Amendments	Every 3 Years	0.80	0.26
	Soil Sampling	Every 3 Years	0.50	0.17
Non-Irrigated Fields (Per Acre)	Fertilizer Applications	Monthly, 3 Times per Year (April, June, October)	0.80	2.40
	Aeration	Twice Annually	1.80	3.60
	Field Inspections	Annually	0.80	0.80
	Overseeding	Annually	1.90	1.90
	Pesticide Applications	Annually	1.30	1.30
	Soil Amendments	Every 3 Years	0.80	0.26
	Soil Sampling	Every 3 Years	0.50	0.17

Buildings

Building Envelop and Interior

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Doors Exterior	Safety and Maintenance Inspection	Annually	2.0	2.0
Electrical Load Center	Safety and Maintenance Inspection	Annually	1.0	1.0
Elevators (RECenters)	Safety and Maintenance Inspection (Contracted Service)	Monthly	1.0	12.0
Emergency Lights	Safety and Maintenance Inspection	Monthly	1.0	12.0
Exhaust Fans	Safety and Maintenance Inspection	Twice Annually	0.5	1.0
Exit Lights	Safety and Maintenance Inspection	Monthly	2.0	24.0
Exterior (Each Building)	Minor Repairs and Touch-Up Painting	Annually	10	10.0
	Repainting	Every 5 Years	300	60.0
Fire Alarm	Safety and Maintenance Inspection	Annually	3.0	3.0
Fire Alarm Pull Stations	Safety and Maintenance Inspection	Monthly	1.0	12.0
Fire Extinguishers	Safety and Maintenance Inspection	Annually	1.0	1.0
Interior Lights	Safety and Maintenance Inspection	Annually	2.0	2.0
Interior Walls and Ceilings (Per 1,000 Square Feet of Building Space)	Minor Repairs and Touch-Up Painting	Annually	30	30.0
	Repainting	Every 5 Years	160	32.0
Kitchen Exhaust Hood	Safety and Maintenance Inspection	Annually	1.0	1.0
Motors 1 to 75 hp	Safety and Maintenance Inspection	Annually	8.0	8.0

Building Envelop and Interior

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Roof	Safety and Maintenance Inspection	Annually	3.0	3.0
Roof Drains\Gutters	Cleaning, Safety and Maintenance Inspection (Contracted Service)	Twice Annually	4.0	8.0
Security System	Safety and Maintenance Inspection	Monthly	3.0	36.0
Smoke Detectors	Safety and Maintenance Inspection	Twice Annually	2.0	4.0
Sprinkler System	Safety and Maintenance Inspection	Annually	2.0	2.0
Sump Pump	Safety and Maintenance Inspection	Annually	2.0	2.0
Water Heater	Safety and Maintenance Inspection	Annually	1	1.0
Wheel Chair Lifts (Historic Sites)	Safety and Maintenance Inspection (Contracted Service)	Monthly	1.0	12.0
Windows	Safety and Maintenance Inspection	Annually	2.0	2.0

Heating and Cooling Systems

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Boilers	Cleaning, Safety and Maintenance Inspection	Annually	5.0	5.0
	Monthly Chemical Treatment	Monthly	1.0	12.0
Chillers	Safety and Maintenance Inspection	Annually	8.0	8.0
Cooling Towers	Safety and Maintenance Inspection	Annually	6.0	6.0
	Cleaning	4 Times Annually	6.0	24.0
Geothermal	Safety and Maintenance Inspection	Monthly	6.0	72.0
	Change Filters	4 Times Annually	4.0	16.0
HVAC System Up to 5 Tons	Safety and Maintenance Inspection	4 Times Annually	2.0	8.0
HVAC System 5 Tons and Above	Safety and Maintenance Inspection	4 Times Annually	4.0	16.0

Water Supply and Sewer

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Backflow Preventer	Safety and Maintenance Inspection	Annually	2.0	2.0
Gravity Flow Septic System	Cleaning, Safety and Maintenance Inspection (Contracted Service)	Every 3 Years	1.0	0.3
Pumped Septic System	Cleaning, Safety and Maintenance Inspection (Contracted Service)	Every 3 Years	1.0	0.3
Sewer Ejector Pump	Safety and Maintenance Inspection	Twice Annually	4.0	8.0
Well System	Safety and Maintenance Inspection	Annually	2.0	2.0

Farm and Equestrian Features

Farm Animals

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Animal Barns	Cleaning Stalls	Daily	2.0	730.0
Dairy Cow	Milking	Twice Daily	1.0	730.0
Livestock and Poultry	General Maintenance and cleaning	Twice Daily	1.0	730.0
Pasture	Remove Ground Trash and Empty Receptacles	Weekly	1.0	52.0
	Safety and Maintenance Inspection	Weekly	0.5	26.0
	Fertilizing and Seeding	Twice Annually	30.0	60.0
	Mowing	Annually	25.0	25.0

Fencing

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 100' Section)	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Repair	4 Times Annually	2.0	8.0
	Paint fence	Every 5 years	16.0	3.2
	Replace	Every 10 Years	32.0	3.2

Horse Stalls

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly, 35 Times per Year (April - November)	1.0	35.0
		Monthly, 4 Times per Year (December - March)	1.0	4.0
	Safey and Maintenance Inspection	Weekly, 35 Times per Year (April - November)	1.5	52.5
		Monthly, 4 Times per Year (December - March)	1.0	4.0
	Emptying Manure Bin	Twice Monthly, 16 Times per Year (April - November)	15.0	240.0
	Grinding Manure	Monthly	8.0	96.0
	Miscellaneous Repairs	Weekly	2.0	104.0

Indoor Riding Arenas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.3	109.5
	Remove Ground Trash and Empty Receptacles	Daily	0.2	73.0
	Bathrooms and Office Cleaning	Daily	0.5	182.5
	Refurnishing Jumps	Annually	40.0	40.0
Riding surface	Drag	Twice Weekly, 60 Times per Year (October - April)	1.0	60.0
		Weekly, 22 Times per Year (May - September)	1.0	22.0
	Water	Twice Weekly, 60 Times per Year (October - April)	1.0	60.0
		Weekly, 22 Times per Year (May - September)	1.0	22.0
	Level	Twice Annually	6.0	12.0

Outdoor Riding Arenas

Description		Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Frying Pan Farm Park	Remove Ground Trash and Empty Receptacles	Daily	0.2	73.0
	Safety and Maintenance Inspection	Daily	0.2	73.0
	Refurnish picnic tables/ bleachers	Annually	40.0	40.0
	Drag Riding Surface	Monthly	1.0	12.0
	Water	Monthly, 9 Times per Year (March - November)	1.0	9.0
	Level	Annually	6.0	6.0
	Supervision and Aid of equestrian Shows	Weekly	16.0	832.0
Turner Farm Park	Remove Ground Trash and Empty Receptacles	Daily	0.2	73.0
	Safety and Maintenance Inspection	Daily	0.2	73.0
	Refurnish picnic tables/ bleachers	Annually	40.0	40.0
	Drag Riding Surface	Monthly	1.0	12.0
	Water	Monthly, 9 Times per Year (March - November)	1.0	9.0
	Level	Annually	6.0	6.0

Frying Pan Farm Park Buildings

Description		Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Visitor Center	Event Clean up	Twice Weekly	3.0	312.0
	Restrooms and Entry Cleaning	Daily	0.5	182.5
School House	Cleaning	Daily, 6 Days per Week	0.5	156.0
Elmore Farm	Restrooms Cleaning	Weekly	0.5	26.0
Meeting House	Inspection of Building and Surrounding Area	Twice Annually	1.0	2.0

Forested and Other Treed Areas

Forested and Other Treed Areas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Downed Trees	Cutting Up a Downed Tree	Per Tree	7.5	7.5
Miscellaneous Tree Work	Flagging	Per Job	14	14
	Winching Trees	Per Tree	4	4
Park Inspections	Citizen Contact Follow Up	Per Job	2	2
	Developed Parks	Every 3 Years	4	1.32
	Playgrounds	Every 2 Years	1	0.5
Tree Spoils	Chipping of Brush	Per Tree	6	6
	Debris Dispersion	Per Job	3	3
	Removal of Wood from Site	Per Tree	9	9
	Stump Removal	Per Tree	4	4

Forested and Other Treed Areas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Upright Trees	Cabling Trees	Per Tree	3	3
	Felling of a Live or Dead Tree	Per Tree	3	3
	Putting a Hand Line in Tree	Per Tree	1	1
	Tree Pruning via Climbing	Per Tree	4.5	4.5
	Tree Pruning From a Bucket Truck	Per Tree	3	3
	Tree Removal From a Bucket Truck	Per Tree	4.5	4.5
	Tree Pruning From the Ground	Per Tree	2	2
	Tree Removal via Climbing	Per Tree	12	12
	Tree Removal with Crane (Contracted Service)	Per Tree	6	6
	Tree Removal without Crane (Contracted Service)	Per Tree	3	3

Golf Courses

Driving Ranges

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.2	73.0
	Remove Ground Trash and Empty Receptacles	Twice Daily, 428 Times per Year, (April - October)	0.2	85.6
		Daily, 151 Times per Year (November - March)	0.2	30.2
	Collect Range Balls	5 Times Daily, 1,070 Times Per Year (April - October)	1.0	1070.0
		2 Times Daily, 302 Times Per Year (November - March)	1.0	302.0
	Collect Range Ball Baskets	3 Times Daily, 642 Times Per Year (April - October)	0.4	256.8
		Daily, 151 Times Per Year (November - March)	0.4	60.4
	Blow Off Surface (Per 10 Stations	Weekly, 30 Times per Year (April - October)	0.1	3.0
		Monthly, 5 Times per Year (November - March)	0.1	0.5
	Fairway with Tri Plex reel mower (Per Acre)	Twice Weekly, 70 Times per Year (April - November)	1.5	105.0

Driving Ranges

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Fairway with 5-Gang reel mower (Per Acre)	Twice Weekly, 70 Times per Year (April - November)	0.7	49.0
	Irrigation Operation and Maintenance Inspection	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Leaf and Debris Removal (Per Acre)	4 Times Annually	0.5	2.0
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0
Station	Change Mat	Every 2 Years	0.2	0.1

Fairways

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.1	36.5
	Fairway with Tri Plex reel mower (Per Acre)	3 Times Weekly, 105 Times per Year (April - November)	1.5	157.5
	Fairway with 5-Gang reel mower (Per Acre)	3 Times Weekly, 105 Times per Year (April - November)	0.7	73.5
	Irrigation Operation and Maintenance Inspection	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Spot Watering	35 Times Annually	0.3	10.5
	Leaf and Debris Removal (Per Acre)	22 Times Annually	0.5	11.0
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0

General Course Maintenance
(18 Hole Course)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Twice Daily, 428 Times per Year, (April - October)	1.5	642.0
		Daily, 151 Times per Year (November - March)	1.5	226.5
	Water Coolers - Clean, Fill and Place (Per 5 Coolers)	Daily, 214 times per Year (April - October)	1.0	214.0
	Irrigation Programing	Daily, 245 Times per Year (March - November)	0.5	122.5
	Mowing (Per 1,000 Square Feet)	Twice Weekly, 70 Mowings per Year	0.2	14.0
	General Irrigation Leak Repairs	10 Repairs Annually	2.5	25.0
	Irrigation Pump Service	6 Times Annually	0.3	1.8
	Irrigation System Spring Start-Up and Winterization (18 Hole Course)	Twice Annually	8.0	16.0

Greens

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.1	36.5
	Cut Holes	Daily, 225 Times per Year	0.1	22.5
	Mow with Tri Plex Reel Mower (Per 6,000 Square Feet)	Daily, 210 Mowings per Year	0.3	63.0
	Mow with Walk Behind Reel Mower (Per 6,000 Square Feet)	Daily, 210 Mowings per Year	0.4	84.0
	Irrigation Operation and Maintenance Inspection (Per Green)	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Spot Watering (Per Green)	70 Times Annually	0.3	21.0
	Leaf and Debris Removal (Per 6,000 Square Feet)	34 Times per Year	0.2	6.8
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0

Power and Pull Carts

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Power Carts	Clean, Charge, Safety and Maintenance Inspection	Daily	0.2	73.0
Pull Carts	Safety and Maintenance Inspection (Per 20 Carts)	Daily	0.1	36.5
	Service and Repair As Necessary (Per Cart)	Monthly	0.1	1.2

Putting Greens

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.1	36.5
	Cut Holes	Daily, 275 Times per Year	0.1	27.5
	Mow with Tri Plex Reel Mower (Per 6,000 Square Feet)	Daily, 210 Mowings per Year	0.3	63.0
	Mow with Walk Behind Reel Mower (Per 6,000 Square Feet)	Daily, 210 Mowings per Year	0.4	84.0
	Irrigation Operation and Maintenance Inspection	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Spot Watering	70 Times Annually	0.3	21.0
	Leaf and Debris Removal (Per 6,000 Square Feet)	4 Times per Year	0.2	0.8
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0

Roughs

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Mowing (Per Acre)	Mow with 3-Gang Pull Behind	Twice Weekly, 70 Mowings per Year	1.2	84.0
	Mow with 5-Gang Pull Behind	Twice Weekly, 70 Mowings per Year	0.6	42.0
	Mow with 7-Gang Pull Behind	Twice Weekly, 70 Mowings per Year	0.4	28.0
	Mow with 72" Outfront Mower	Twice Weekly, 70 Mowings per Year	2.0	140.0
	Mow with 32" Walk Behind	Twice Weekly, 70 Mowings per Year	4.2	294.0
	Mow with 10' Outfront Mower	Twice Weekly, 70 Mowings per Year	0.5	35.0
	Roughs with Zero turn 48" to 72"	Twice Weekly, 70 Mowings per Year	1.8	126.0

Sand Traps

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 5, 000 Square Feet)	Rake	Every Other Day, 138 Days per Year (March - Novemer)	0.2	27.6
		Weekly, 13 Times per Year (December - February)	0.2	2.6
	Edge	3 Times Annually	1.0	3.0
	Weed Control	3 Times Annually	0.2	0.6
	Fill and Level	2 Times Annually	0.5	1.0

Tees

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.1	36.5
	Move Tee Markers	Daily, 225 Times per Year	0.1	22.5
	Mow with Tri Plex Reel Mower (Per 6,000 Square Feet)	3 Times Weekly, 105 Mowings per Year	0.3	31.5
	Irrigation Operation and Maintenance Inspection	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Spot Watering	70 Times Annually	0.3	21.0
	Leaf and Debris Removal (Per 6,000 Square Feet)	4 Times per Year	0.2	0.8
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0

Turf Maintenance

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Aeration (Per 6,000 Square Feet)	Greens - Solid Tines	4 Times Annually	0.7	2.8
	Tees - Solid Tines	4 Times Annually	0.7	2.8
	Greens - Core Tines with Cores Pick	Annually	1.4	1.4
	Tees - Core Tines with Cores Picked Up	Annually	1.4	1.4
	Tees - Core Tines with Cores Dragged In	Annually	1.2	1.2
Aeration (Per Acre)	Fairways - Solid Tines	Twice Annually	1.2	2.4
	Roughs - Solid Tines	Twice Annually	1.0	2.0
	Fairways - Core Tines with Cores Dragged In	Annually	1.6	1.6
Fertilizer	Granular Application with Lily Spreader (Per Acre)	4 Times Annually	0.3	1.2
Liquid Application - Any Product	Liquid Application with 100 Gallon Spray Tank (Per 6,000 Square Feet)	3 Times Annually	0.1	0.3
	Liquid Application with 200 Gallon Spray Tank (Per Acre)	3 Times Annually	0.3	0.9
	Preperation and Loading Spray Tanks	6 Times Annually	0.3	1.8
	Calibrating Spray Tank	6 Times Annually	0.3	1.8

Turf Maintenance

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Pesticide	Granular Application with Lily Spreader (Per Acre)	2 Times Annually	0.3	0.6
Seeding	Power Seeding Greens (Per 6,000 Square Feet)	Annually	0.7	0.7
	Power Seeding Fairways (Per Acre)	Annually	0.7	0.7
	Broadcast Seeding After Aeration On Greens (Per 6,000 Square Feet)	Annually	0.2	0.2
	Broadcast Seeding After Aeration in Fairway (Per Acre)	Annually	0.2	0.2
Thatch removal per 6000 sqft (Per 6,000 Square Feet)	Greens and Bentgrass Tees with Debris Removal	Annually	1.2	1.2
	All Other Areas Without Debris Removal	Annually	0.7	0.7
Top Dressing (Per 6,000 Square Feet)	Fine Turf Areas with Core Aeration and Brush In	Annually	0.7	0.7
	Light Application On Greens for Speed and Turf Managment	Annually	0.4	0.4
Wetting Agents - Nutrients	Granular Application with Walk Behind Spreader (Per 6,000 Square Feet)	Annually	0.2	0.2

Managed Landscapes

One of the Maintenance Tasks associated with some of the facilities in the Managed Landscapes section is mowing. The Park Authority has established five levels of mowing classifications that are applied to a portion of or all of the mowing areas within a park.

Class A – Formal lawn areas which typically are associated with facilities that are rented for weddings, meetings, or parties. Areas are mowed once every seven days at a height of 2 ½”.

Class B – Parks containing one or more developed facility. Facilities include: staffed facilities not already mowed as a Class “A”, recreation centers, athletic fields, courts, playgrounds, picnic and pavilion areas, amphitheaters, active historical and cultural resource properties, and master planned open play areas. Trail systems that do not directly support a developed facility, or are not within a park with a developed facility, will not be mowed as a Class “B”. Areas are mowed once every 14 days at a height of 2 ½” to 3”.

Class C – (<u>This Class is also addressed in the Trails and Crossings Section</u>) Parks containing areas with established and maintained natural surface trails (i.e. grass, dirt, woodchip), or street frontage developed with a sidewalk or surfaced roadside trail within a residential area, not already being mowed as part of a Class “A” or “B” site. Areas are mowed once every 28 days at a height of 2 ½” to 3”.

Class D – (<u>This Class is addressed in the Trails and Crossings Section</u>) Parks containing areas with surfaced trails (i.e. concrete, stone dust, gravel, asphalt), that are not already being mowed as part of a Class “A”, “B”, or “C” site. If there is street frontage with a sidewalk or surfaced roadside trail that connects to a Park Authority maintained trail and is adjoining a commercial or industrial area, then the street frontage should be mowed along with the trail. These trails are typically within a stream valley or a park without any developed facilities. Areas are mowed 3 times per year at a height of 3” to 4”.

Class E – Parks containing areas that are designated for meadow management, stormwater features where woody plants are undesirable, or planned for future development. It may be necessary to remove any large diameter trees and bushes prior to mowing. Areas are mowed once every 1 to 2 years at a height of 3” to 4”.

Much of the Park Authority’s mowing is performed with contracted mowing services. Staff performs all specialized mowing such as the mowing of athletic fields and golf courses, the mowing of facilities that require infrequent mowing like trails and meadows, and the mowing of parks where contracted mowing services have not yet been established.

Gardens and Landscape Beds

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Landscape Beds	Weeding	Monthly, 8 Times per Year (April - November)	0.5	4
(Per 1,000 Square Feet of Bed)				
	Integrated Pest Management	Monthly, 8 Times per Year (April - November)	0.2	1.6
	Pruning	4 Times Annually	0.5	2
	Mulching	Twice Annually	1	2
	Planting of Annuals	Annually	4	4
Public Plots	Remove Ground Trash and Empty Receptacles	Weekly	0.5	26.0
	Safety and Maintenance Inspection	Twice Annually	0.5	1.0
	Debris Removal	Annually	4.6	4.6
	Maintain Roadways	Annually	3.0	3

General Grounds

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per Acre)	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
		Weekly, 13 Times per Year (December - February)	0.1	1.3
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Ground Repairs	Every 2 Years	2.0	1.0
Mowing - Class A (Per Acre)	Bulk and Trim Mowing - By Staff	Weekly, 32 Times per Year (April - Mid-November)	1.6	51.2
	Contracted Mowing - Staff Site Inspections	Weekly, 32 Times per Year (April - Mid-November)	0.3	9.6
Mowing - Class B (Per Acre)	Bulk and Trim Mowing - By Staff	Every 14 Days, 16 Times per Year (April - Mid-November)	1.3	20.8
	Contracted Mowing - Staff Site Inspections	Every 14 Days, 16 Times per Year (April - Mid-November)	0.3	4.8
Mowing - Class C (Per Acre)	Bulk and Trim Mowing - By Staff	Monthly (Every 28 Days), 9 Times per Year (April - Mid-November)	1.2	10.8
	Contracted Mowing - Staff Site Inspections	Monthly (Every 28 Days), 9 Times per Year (April - Mid-November)	0.3	2.7

Meadows and Fields

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per Acre)	Remove Ground Trash	Monthly	0.3	3.6
Mowing - Class E (Per Acre)	Bulk Mowing - By Staff	Annually	2.6	2.6

Operating Equipment

Staff members using equipment or performing maintenance or repairs on equipment should always follow the instructions and guidelines from the Operators Manual provided with each piece of equipment.

The Park Authority's vehicles and trailers are maintained and repaired by the Fairfax County's Department of Vehicle Services and are therefore not covered within the Park Authority's Maintenance Standards.

Large Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Front End Loaders	Cleaning and Safety Inspection	Daily (Typically 50 Times per Year)	0.5	25.0
	Routine Preventive Maintenance	Twice Annually	4.0	8.0
	Repairs	Annually	2.0	2.0
Heavy Construction (Grader, Roller, Asphalt Spreader, Chipper, Skid Steer, Dozer)	Cleaning and Safety Inspection	Daily (Typically 50 Times per Year)	0.5	25.0
	Routine Preventive Maintenance	Twice Annually	8.0	16.0
	Repairs	Annually	2.0	2.0
Infield Conditioners	Cleaning and Safety Inspection	Daily (Typically 105 Times per Year)	0.5	52.5
	Routine Preventive Maintenance	3 Times Annually	2.0	6.0
	Repairs	Annually	2.0	2.0
Off-Road Utility Vehicles	Cleaning and Safety Inspection	Daily (Typically 120 Times per Year)	0.5	60.0
	Routine Preventive Maintenance	Twice Annually	4.0	8.0
	Repairs	Annually	2.0	2.0

Large Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Outfront Mowers 6' and Below	Cleaning and Safety Inspection	Daily (Typically 105 Times per Year)	0.5	52.5
	Blade Sharpening	Weekly, 35 Times per Year	1.0	35.0
	Routine Preventive Maintenance	Twice Annually	4.0	8.0
	Repairs	Annually	2.0	2.0
Outfront Mowers 10' and Above	Cleaning and Safety Inspection	Daily (Typically 120 Times per Year)	0.5	60.0
	Blade Sharpening	Weekly, 35 Times per Year	1.0	35.0
	Routine Preventive Maintenance	Twice Annually	6.0	12.0
	Repairs	Annually	2.0	2.0
Reel Mowers	Cleaning and Safety Inspection	Daily (Typically 230 Times per Year)	0.5	115.0
	Blade Sharpening	Quarterly	5.0	20.0
	Routine Preventive Maintenance	Twice Annually	2.0	4.0
	Repairs	Annually	2.0	2.0
	Rebuild Reel Units	Annually	4.0	4.0

Large Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Tractors	Cleaning and Safety Inspection	Daily (Typically 30 Times per Year)	0.5	15.0
	Routine Preventive Maintenance	Twice Annually	4.0	8.0
	Repairs	Annually	2.0	2.0
Walkbehind Mowers	Cleaning and Safety Inspection	Daily (Typically 105 Times per Year)	0.5	52.5
	Blade Sharpening	Weekly, 35 Times per Year	1.0	35.0
	Routine Preventive Maintenance	3 Times Annually	2.0	6.0
	Repairs	Annually	2.0	2.0
Ice Resurfacer	Cleaning and Safety Inspection	Daily	0.5	182.5
	Routine Preventive Maintenance	3 Times Annually	2.0	6.0
	Repairs	Annually	4.0	4.0

Small Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Blowers	Cleaning and Safety Inspection	Daily (Typically 40 Times per Year)	0.2	8.0
	Routine Preventive Maintenance	Annually	1.0	1.0
	Repairs	Annually	2.0	1.0
Chainsaw	Cleaning, Sharpening and Adjusting	Daily (Typically 60 Times per Year)	1.5	90.0
	Replacing Chain	Monthly	0.3	3.6
	Replacing Chain Bar	3 Times Annually	0.3	0.9
	Repairs	Annually	2	2.0
Edger	Cleaning and Safety Inspection	Daily (Typically 10 Times per Year)	0.2	2.0
	Routine Preventive Maintenance	Annually	1.5	1.5
	Repairs	Annually	2.0	1.0
Generators	Cleaning and Safety Inspection	Daily (Typically 20 Times per Year)	0.2	4.0
	Routine Preventive Maintenance	Annually	1.0	1.0
	Repairs	Every 2 Years	2.0	1.0

Small Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Hedge Trimmers	Cleaning and Safety Inspection	Daily (Typically 20 Times per Year)	0.2	4.0
	Routine Preventive Maintenance	Annually	1.5	1.5
	Repairs	Every 2 Years	2.0	1.0
Pole Saw	Cleaning and Safety Inspection	Daily (Typically 20 Times per Year)	0.2	4.0
	Routine Preventive Maintenance	Annually	2.5	2.5
	Repairs	Every 2 Years	2.0	1.0
Sod Cutter	Cleaning and Safety Inspection	Daily (Typically 10 Times per Year)	0.2	2.0
	Routine Preventive Maintenance	Annually	1.5	1.5
	Repairs	Every 2 Years	2.0	1.0
String Trimmers	Cleaning and Safety Inspection	Daily (Typically 105 Times per Year)	0.2	21.0
	Routine Preventive Maintenance	Annually	2.0	2.0
	Repairs	Every 2 Years	2.0	1.0

Other Park Features

Amphitheaters

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Mason District Park	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
		Weekly, 13 Times per Year (December - February)	0.1	1.3
	Safety and Maintenance Inspection	Weekly, 39 Times per Year (March - November)	0.2	7.8
		Monthly, 3 Times per Year (December - February)	0.2	0.6
	Painting and Miscellaneous Repairs	Annually	8	8.0
	Replenish Surfacing	Annually	6	6.0
All Others	Remove Ground Trash and Empty Receptacles	Twice Weekly, 26 Times per Year (June - August)	0.1	2.6
		Weekly, 39 Times per Year (September - May)	0.1	3.9
	Safety and Maintenance Inspection	Weekly, 39 Times per Year (March - November)	0.2	7.8
		Monthly, 3 Times per Year (December - February)	0.2	0.6
	Painting and Miscellaneous Repairs	Annually	8	8.0
	Replenish Surfacing	Annually	6	6.0

Campgrounds

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	1.5	547.5
	Remove Ground Trash, Empty Receptacles, and Clean Bathhouse	Daily, 7 Days per Week, 252 Days per Year (March - November)	7.0	1764.0
		Daily, 5 Days per Week, 60 Days per Year (December - April)	3.0	180.0
	Debris Removal, Cleaning of Grills, and Repairs as Needed	Weekly, 36 Times per Year (March - November)	8	288
		Monthly (December - February)	4	12
	Mowing	Weekly (April - November)	33	1056.0
	Snow and Ice Removal	Average of 3 Events Annually	8	24
	Leaf Removal and Gutter Cleaning	Annually	180	180.0
	Prepping and Painting Grills	Annually	66	66
	Painting and Repairing Picnic Tables	Annually	205	205
	Raking Sites and Repairing Roads	Weekly, 31 Times per Year (May - November)	6	186

Carousels

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily, 214 Times per Year (April - October)	0.2	42.8
		Monthly, 5 Times per Year (November - March)	0.2	1.0
	Remove Ground Trash and Empty Receptacles	Daily, 214 Times per Year (April - October)	0.5	107.0
		Monthly, 5 Times per Year (November - March)	0.2	1.0
	Preventive Maintenance (Cleaning, greasing, oiling)	Monthly, 7 Times Per Year (April - October)	2.0	14.0
	Teardown and Assembly - Burke Lake	Twice Annually	48.0	96.0
	- Other Parks	Twice Annually	16.0	32.0
	Painting and Miscellaneous Repairs	Annually	6.0	6.0

Fitness Courses

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Station	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Replenish Surfacing	Every 2 Years	1	0.5
	Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0

Frisbee Golf Courses

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Station	Remove Ground Trash and Empty Receptacles	Weekly	0.10	5.20
	Safety and Maintenance Inspection	4 Times Annually	0.10	0.40
	Mowing	Monthly, 8 Times per Year (April - November)	1.00	8.00
	Pruning - Trees and Shrubs	Annually	1.50	1.50
	Repairs	Every 2 Years	1.00	0.50

Marinas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Lake	Remove Trash from Shoreline	Weekly, 21 Times per Year (May - September)	12.0	252.0
	Storm Clean-up	Average of 3 Events Annually	16.0	48.0
Launch Area	Safety and Maintenance Inspection	Daily, 214 Times per Year (April - October)	0.2	42.8
		Weekly, 21 Times per Year (November - March)	0.2	4.2
	Remove Ground Trash and Empty Receptacles	Daily, 214 Times per Year (April - October)	0.2	42.8
		Weekly, 21 Times per Year (November - March)	0.2	4.2
	Miscellaneous Repairs	Annually	2.0	2.0
Paddle Boats	Safety and Maintenance Inspection	Per Use, 4,200 Inspections per Year	0.1	420.0
	Miscellaneous Repairs (Per 10 Boats)	Annually (As Needed)	2.0	2.0
Row Boats	Safety and Maintenance Inspection	Per Use, 5,600 Inspections per Year	0.1	560.0
	Miscellaneous Repairs (Per 10 Boats)	Annually (As Needed)	1.0	1.0

Marinas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Canoes	Safety and Maintenance Inspection	Per Use, 1,650 Inspections per Year	0.1	165.0
	Miscellaneous Repairs (Per 10 Boats)	Annually (As Needed)	1.0	1.0
Row Boats W/Trolling Motor	Safety and Maintenance Inspection	Per Use, 1,040 Inspections per Year	0.1	104.0
	Battery Inspection and Charge	Per Use, 1,040 Inspections per Year	0.1	104.0
	Motor Repair	Annually, 150 Repairs per Year	0.5	75.0

Miniature Golf Courses

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily, 130 Times per Year (May - October)	1.0	130.0
	Remove Ground Trash and Empty Receptacles	Daily, 130 Times per Year (May - October)	0.2	26.0
	Blowing Off All Surfaces	Daily, 130 Times per Year (May - October)	0.5	65.0
	Mowing	Every 10 Days, 22 Times per Year (April - November)	3.0	66.0
	Pruning of Shrubs	Twice Annually	8.0	16.0
	Winterize and Start-Up Water Features	Twice Annually	15.0	30.0
	Miscellaneous Hole Repairs	Annually	36.0	36.0
	Painting and Repairing of Benches	Every 2 Years	1.0	0.5
	Painting and Repairing of Bridges	Every 2 Years	2.0	1.0

Off-Leash Dog Areas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
		Weekly, 13 Times per Year (December - February)	0.1	1.3
	Mowing (not needed at all facilities)	Every 2 Weeks, 16 Times per Year (April - November)	1	16.0
	Safety and Maintenance Inspection	4 Times Annually	0.3	1.2
	Surface Grooming	Twice Annually	6	12.0
	Fencing Repairs	Annually	3	3.0

Outdoor Restrooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Restrooms - Open Year Round	Safety and Maintenance Inspection	Twice Weekly	0.1	10.4
	Remove Ground Trash and Empty Receptacles	Twice Weekly	0.1	10.4
	Restock Toilet Paper	Twice Weekly	0.1	10.4
	Sweep and Wet Mop Floor	Twice Weekly	0.30	31.20
	Wipe Down Mirrors	Twice Weekly	0.10	10.40
	Clean Sinks With a Germicidal Detergent	Twice Weekly	0.10	10.40
	Clean Toilets and Urinals With a Germicidal Detergent	Twice Weekly	0.20	20.80
	Clean Partitions, Toilet Paper Disensors, Sanitary Napkin Boxes, and Hand Dryers With a Germicidal Detergent	Weekly	0.60	31.20

Outdoor Restrooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Restrooms - Open Spring thru Fall	Safety and Maintenance Inspection	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
	Restock Toilet Paper	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
	Sweep and Wet Mop Floor	Twice Weekly, 78 Times per Year (March - November)	0.30	23.40
	Wipe Down Mirrors	Twice Weekly, 78 Times per	0.10	7.80
	Clean Sinks With a Germicidal Detergent	Twice Weekly, 78 Times per Year (March - November)	0.10	7.80
	Clean Toilets and Urinals With a Germicidal Detergent	Twice Weekly, 78 Times per Year (March - November)	0.20	15.60
	Clean Partitions, Toilet Paper Disensors, Sanitary Napkin Boxes, and Hand Dryers With a Germicidal Detergent	Weekly, 39 Times per Year (March - November)	0.60	23.40

Outdoor Swimming Pools

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Inspect Diving Board	Daily, 90 Times per Year (May - September)	0.1	9.0
	Inspect Drain Covers, Gutters, Grates, and Skimmers	Daily, 90 Times per Year (May - September)	0.5	45.0
	Inspect Chemical Controller, Dispensor, and Feeders	Daily, 90 Times per Year (May - September)	0.4	36.0
	Inspect Ladders, Rails, Escutcheon Plates	Daily, 90 Times per Year (May - September)	0.1	9.0
	Inspect Racing Lane Dividers	Daily, 90 Times per Year (May - September)	0.1	9.0
	Remove Ground Trash and Empty Receptacles	Daily, 90 Times per Year (May - September)	0.2	18.0
	Safety and Maintenance Inspection	Daily, 90 Times per Year (May - September)	0.5	45.0
	Vacuuming Pool Bottom	4 Times per Week, 52 Times per Year (May - September)	1.5	78.0
	Blow/Hose Off All Surfaces	Twice Weekly, 26 Times per Year (May - September)	0.5	13.0
	Inspect and Service Vacuum	Weekly, 13 Times per Year (May - September)	0.2	2.6

Outdoor Swimming Pools

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Backwashing	Weekly, 13 Times per Year (May - September)	2.5	32.5
	Service Ladders, Rails, Escutcheon Plates	Weekly, 13 Times per Year (May - September)	0.1	1.3
	Shock Pool	Weekly, 13 Times per Year (May - September)	1.0	13.0
	Service Chemical Controller, Dispensor, and Feeders	Monthly, 4 Times per Year (May - September)	1.6	6.4
	Service Diving Board	Monthly, 4 Times per Year (May - September)	0.4	1.6
	Service Drain Covers, Gutters, Grates, and Skimmers	Monthly, 4 Times per Year (May - September)	2.0	8.0
	Service Racing Lane Dividers	Monthly, 4 Times per Year (May - September)	0.5	2.0
	Draining and Cleaning	Annually	108.0	108.0

Picnic Areas and Shelters

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.5	39.0
		Weekly, 13 Times per Year (December - February)	0.5	6.5
	Safety and Maintenance Inspection	4 Times Annually	0.5	2.0
	Clean Grills (per Grill)	Twice Annually	0.1	0.2
	Table Painting and Miscellaneous Repairs (per Table)	Annually	1.5	1.5
	Replace Grill	Every 10 Years	2.4	0.2
	Replace Table	Every 10 Years	2	0.2
Picnic Areas (Per 10 Tables)	Replenish Wood Chips	Every 3 Years	4.0	1.3
Shelters	Blow Off Concrete Pad	Monthly	0.5	6.0
	Painting and Miscellaneous Repairs	Every 10 Years	60.0	6.0

Playgrounds

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	Weekly	0.2	10.4
	Comprehensive Safety Inspection	4 Times Annually	2	8.0
	Repairs	Annually	3	3.0
Engineered Wood Fiber Surface	Replenish Engineered Wood Fiber	Every 3 Years	12	4.0
	Renovate and Replace Surfacing	Every 10 years	160.0	16.0
Rubber Surface	Blow Off All Surfaces and Debris Removal	Weekly	1.0	52.0
	Repairs (Per 1,000 square feet of surface) (Contracted Service)	Every 5 Years	1.0	0.2

Skate Parks

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.5	182.5
	Remove Ground Trash and Empty Receptacles	Daily	0.2	73.0
	Blow Off All Surfaces	Twice Weekly	0.5	52.0
Sales Booth	Clean all interior surfaces	Daily	0.3	109.5
	Wipe exterior surfaces	Monthly	0.5	6.0
	Sand interior wood surfaces	Anually	2.0	2.0
Seating Area	Rinse Off	Daily, 120 Times per Year (May - September)	0.2	24.0
Ramps	Repair Broken or Cracked Skatelite (one sheet)	4 Times Annually	2.0	8.0

Trains

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Engine and Cars	Safety and Maintenance Inspection	Daily, 180 Times per Year (April - September)	0.5	90.0
	Train Cleaning	Twice Monthly, 12 Times per Year (April - September)	4.0	48.0
	Engine Maintenance	Twice Annually	8.0	16.0
	Winterize	Annually	4.0	4.0
	Painting and Miscellaneous Repairs	Annually	10.0	10.0
Track	Track & Switches - Safety and Maintenance Inspection	Daily, 180 Times per Year (April - September)	0.5	90.0
	Track Ties - Safety and Maintenance Inspection	Monthly, 6 Times per Year (April - September)	2.0	12.0
	Tie replacment	60 Replacements Annually	0.3	18.0
	Miscellaneous Repairs	Annually	8	8.0

Water Parks

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Twice Daily, 90 Days per Year (May - September)	1.0	180.0
	Inspect Chemical Controller, Dispensor, and Feeders	Daily, 90 Times per Year (May - September)	0.4	36.0
	Inspect Drain Covers, Gutters, Grates, and Skimmers	Daily, 90 Times per Year (May - September)	0.5	45.0
	Inspect Ladders, Rails, Escutcheon Plates	Daily, 90 Times per Year (May - September)	0.1	9.0
	Safety and Maintenance Inspection	Daily, 90 Times per Year (May - September)	0.5	45.0
	Vacuuming Pool Bottom	4 Times per Week, 52 Times per Year (May - September)	1.5	78.0
	Blow/Hose Off All Surfaces	Twice Weekly, 26 Times per Year (May - September)	0.5	13.0
	Mowing	Every 10 Days, 22 Mowings per Year (April - November)	12	264.0
	Backwashing	Weekly, 13 Times per Year (May - September)	2.5	32.5
	Clean Grills	Weekly, 13 Times per Year (May - September)	0.5	6.5
	Inspect and Service Vacuum	Weekly, 13 Times per Year (May - September)	0.2	2.6

Water Parks

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Service Ladders, Rails, Escutcheon Plates	Weekly, 13 Times per Year (May - September)	0.1	1.3
	Shock Pool	Weekly, 13 Times per Year (May - September)	1.0	13.0
	Repair Funbrellas and Tents	6 Times per Year (May - September)	6	36.0
	Service Chemical Controller, Dispensor, and Feeders	Monthly, 4 Times per Year (May - September)	1.6	6.4
	Service Drain Covers, Gutters, Grates, and Skimmers	Monthly, 4 Times per Year (May - September)	2.0	8.0
	Weeding Planter Beds and Fencelines	3 Times per Year (May - September)	4	12.0
	Pump and Plumbing Repairs	Twice Annually	8	16.0
	Draining and Cleaning	Annually	108.0	108.0
	Painting and Repairing Picnic Tables	Annually	27	27.0
	Pre-season Site Clean-up and Preparation	Annually	138	138.0

Outdoor Courts

Basketball

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.2	10.4
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Net Replacement	4 Times Annually	1	4.0
	Removing Court Surface Debris	Twice per Year	0.5	1.0
	Surface Repairs (Contracted Service)	Every 5 Years	1	0.2
	Painting - Backboard and Support Post	Every 10 Years	3	0.3
	Rim Replacement	Every 10 Years	2	0.2
Lighting	Safety and Maintenance Inspection	Weekly, 36 Times per Year (April - November)	0.1	3.6
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	1.5	1.5

Horseshoe

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Repair Pitching Boxes	Twice per Year	8.0	16.0

Shuffleboard

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Restriping	Every 5 Years	4	0.8

Tennis

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Removing Court Surface Debris	Monthly, 6 Times per Year (October - December and March - May)	0.8	4.8
	Fencing Repairs	Annually	4	4.0
	Net Replacement	Annually	1	1.0
	Surface Repairs (Contracted Service)	Every 5 Years	2	0.4
	Restriping and Color-Coating (Contracted Service)	Every 5 Years	2	0.4
	Net Post Replacement	Every 10 Years	4	0.4

Tennis

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Practice	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Removing Court Surface Debris	Monthly, 6 Times per Year (October - December and March - May)	0.8	4.8
	Fencing Repairs	Annually	4	4.0
	Painting and Miscellaneous Wall Repairs	Every 3 Years	6	2.0
	Surface Repairs (Contracted Service)	Every 5 Years	2	0.4
	Restriping and Color-Coating (Contracted Service)	Every 5 Years	1	0.2
Lighting	Safety and Maintenance Inspection	Weekly, 36 Times per Year (April - November)	0.1	3.6
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	1.5	1.5

Volleyball

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Net Replacement	Annually	1	1
	Replenish Sand	Every 2 Years	6	3
Lighting	Safety and Maintenance Inspection	Weekly, 36 Times per Year (April - November)	0.1	3.6
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	1.5	1.5

RECenters

Fitness Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Cardiovascular	Routine Cleaning - Small Center	Daily	0.50	182.50
	- Medium Center	Daily	1.00	365.00
	- Large Center	Daily	2.00	730.00
	Prevenative Maintenace (small)	Weekly	0.50	26.00
	Prevenative Maintenace (medium)	Weekly	1.00	52.00
	Prevenative Maintenace (large)	Weekly	2.00	104.00
	Repairs - New Equipment	Monthly	1.00	12.00
	- Old Equipment	Monthly	3.00	36.00
Cybex Strength	Routine Cleaning	Daily	1.00	365.00
	Prevenative Maintenace	Weekly	2.00	104.00
	Repairs - New Equipment	Monthly	1.00	12.00
	- Old Equipment	Monthly	3.00	36.00
Fitlinxx	System upkeep & Information updates	Daily	1.00	365.00
	Safety and Maintenance Inspection	Twice Weekly	0.50	52.00
	Repairs	Monthly	0.50	6.00
Free Weights	Routine Cleaning	Weekly	0.50	26.00
	Safety and Maintenance Inspection	Weekly	0.50	26.00
Group Exercise	Safety and Maintenance Inspection	8 Times Annually	0.50	4.00
	Routine Cleaning	4 Times Annually	1.00	4.00
	Equipment/Supplies Replacement	4 Times Annually	2.00	8.00

Fitness Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Spin Bikes	Routine Cleaning	Daily	0.50	182.50
	Safety and Maintenance Inspection	Weekly	0.50	26.00
	Repairs	Weekly	2.00	104.00
	Deep cleaning	Monthly	2.00	24.00

Fitness Rooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Trash and Empty Receptacles	Twice Daily	0.10	73.00
	Safety and Maintenance Inspection	Daily	0.10	36.50
Audio Equipment	Safety and Maintenance Inspection	Weekly	0.10	5.20
	Equipment/Supplies Replacement	Quarterly	1.00	4.00
Baseboards and Window Ledges	Wipe Down	Weekly	0.30	15.60
Fans	Routine Cleaning	Weekly	2.00	104.00
Fixtures	Routine Maintenance and Cleaning	Monthly	0.50	6.00
Floors	Routine Maintenance and Cleaning	Daily	1.00	365.00
	Deep Cleaning (mop)	Weekly	1.50	18.00
Windows and Mirrors	Routine Maintenance and Cleaning	Weekly	0.50	26.00
Stretching Area	Routine Cleaning	Weekly	0.50	26.00
	Safety and Maintenance Inspection	Weekly	0.50	26.00
	Equipment Replacement	Bi-Annually	2.00	4.00

Gyms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.3	1642.5
	Remove Trash and Empty Receptacles	Twice Daily	0.3	219.0
	Sweep with Large Push Broom (Per 1,000 Square Feet)	Daily	0.5	182.5
	Floor Maintainer (Floor Scrub Machine, Lee District Only)	Weekly	1.50	78.00
	Mop (Per 1,000 Square Feet)	Weekly	0.50	26.00
	Net Replacement	Twice Annually	1	2.0
	Stripping Wax Floor with Separate Wet Pick-up (Per 1,000 Square Feet)	Twice Annually	1.25	2.50
	Wax (Per 1,000 Square Feet)	Twice Annually	1.00	2.00
	Miscellaneous Repairs	Annually	5.00	5.00
	Rim Replacement	Every 2 Years	2	1.0
Bleachers	Safety and Maintenance Inspection	Daily	0.3	109.5
	Sweep and Clean	Daily	1.0	365.0
	Miscellaneous Repairs	Annually	10.0	10.0

Ice Skating Arenas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Bench Areas (Warming Room)	Sweep, Mop and Clean	Daily	1.00	365.00
	Sweep, Mop and Clean All Restrooms	Daily	0.40	146.00
Bleachers and Benches	Sweep and Clean	Daily	0.20	73.00
Hallway Between Team Rooms	Sweep and Mop Floor	Daily	0.20	73.00
Ice Rink	Remove Trash and Empty Receptacles	Twice Daily	0.50	365.00
	Safety and Maintenance Inspection	Daily	0.10	36.50
	Sweep and Mop Floor	Daily	0.20	73.00
	Clean and Wipe Down Boards	Weekly	0.50	26.00
	Miscellaneous Repairs	Monthly	1.00	12.00
	Annual Shutdown	Annually	630.00	630.00
Team Rooms	Remove Trash and Empty Receptacles	Daily	0.30	109.50
	Safety and Maintenance Inspection	Daily	0.10	36.50
	Swept and Mopped	Daily	0.20	73.00
	Wipe Down and Disinfect Mirrors and Shelves	Daily	0.10	36.50
	Wipe Down Baseboards and Window Ledges	Weekly	0.50	26.00

Locker Rooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.10	547.50
	Remove Trash and Empty Receptacles	Twice Daily	0.10	73.00
Benches	Clean and Disinfect (per bench)	Daily	0.10	36.50
Floors	Sweep Disenfect and Squeegee	Daily	0.30	109.50
	Scrub with Floor Machine and Squeegee (Per 1,000 Square Feet)	Monthly	0.50	6.00
Lockers	Dust Tops of Lockers	Weekly	0.20	10.40
Mirrors	Wipe Down	Daily	0.20	73.00
Partitions	Clean Fixtures With a Germicidal Detergent	Weekly	0.50	26.00
Sanitary Napkin Box	Clean Fixtures With a Germicidal Detergent	Weekly	0.25	13.00
Toilets and Urinals	Clean Fixtures With a Germicidal Detergent (Per Toilet/Urinal)	Daily	0.05	18.25

Natatoriums

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Airshutes and Slides	Safety and Maintenance Inspection	Twice Weekly	0.1	10.4
	Service and Repairs	Every 2 Months	1.0	6.0
Bleachers	Sweep and Clean	Daily	0.5	182.5
	Safety and Maintenance Inspection	Weekly	0.3	15.6
	Miscellaneous Repairs - Wood	Every 2 Years	8.0	4.0
	- Metal	Every 2 Years	2.0	1.0
Filter and Storage Rooms, and Lifeguard Office	Cleaninng and Organizing	Weekly	1.0	52.0
Guard Chairs	Inspect	Daily	0.2	73.0
	Service and Cleaning	Annually	12.0	12.0
Life Saving and Safety Equipment	Inspection	Daily	0.4	146.0
	Service	Monthly	1.0	12.0

Natatoriums

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Pools	Pool Chemical Readings	Every 2 Hours	0.1	365.0
	Hose Off All Surfaces			
	- 50 Meter Pool Tiled	Daily	1.0	365.0
	- 25 Meter Pool Tiled	Daily	0.5	182.5
	- 50 Meter Pool Cement	Daily	0.7	255.5
	Inspect Chemical Controller, Dispensor, and Feeders	Daily	0.2	73.0
	Inspect Deck Vacuum	Daily	0.1	36.5
	Inspect Diving Board	Daily	0.1	36.5
	Inspect Drain Covers, Gutters, Grates, and Skimmers - 50 Meter Pool	Daily	0.2	73.0
	- 25 Meter Pool	Daily	0.1	36.5
	Inspect Ladders, Rails, Escutcheon Plates	Daily	0.4	146.0
	Inspect Racing Lane Dividers			
	- 50 Meter Pool	Daily	0.2	73.0
	- 25 Meter Pool	Daily	0.1	36.5
	Inspect Submersible Vacuum	Daily	0.2	73.0
	Inspect Underwater Lights	Daily	0.1	36.5
	Remove Trash and Empty Receptacles	Daily	0.2	73.0

Natatoriums

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Pools	Safety and Maintenance Inspection	Daily	0.1	36.5
	Scum Line Cleaning - 50 Meter Pool	Daily	0.7	255.5
	- 25 Meter Pool	Daily	0.4	146.0
	Vacuuming Pool Bottom - 50 Meter Pool	Daily	1.5	547.5
	- 25 Meter Pool	Daily	1.0	365.0
	Slot Drains Cleaning	Daily	0.2	73.0
	Backwashing - DE	Weekly	2.5	130.0
	- High Rate Sand	Monthly	1.0	12.0
	Service and Clean Ladders, Rails, Escutcheon Plates	Weekly	1.0	52.0
	Service Chemical Controller, Dispensor, and Feeders	Weekly	1.0	52.0
	Service Underwater Lights	Weekly	1.0	52.0
	Cleaning of the Deck Caulking	Monthly	0.7	8.4
	Service Diving Board	Monthly	1.0	12.0
	Shock Pool (Pools without UV)	Monthly	2.0	24.0
	UV Lighting System Inspection and Cleaning	Monthly	0.2	2.4
	Service Racing Lane Dividers			
	- 50 Meter Pool	Annually	16.0	16.0
	- 25 Meter Pool	Annually	10.0	10.0

Natatoriums

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Pools	Service Deck Vacuum	Every 2 Years	1.0	0.5
	Service Drain Covers, Gutters, Grates, and Skimmers - 50 Meter Pool	Every 2 Years	5.0	2.5
	- 25 Meter Pool	Every 2 Years	2.0	1.0
	Service Submersible Vacuum	Every 2 Years	2.0	1.0
Whirlpool / Spas	Spa Chemical Readings	Hourly	0.1	547.5
	Inspect Chemical Controller, Dispensor, and Feeders	Daily	0.1	36.5
	Inspect Ladders, Rails, Escutcheon Plates	Daily	0.1	36.5
	Scum Line Cleaning	Daily	0.3	109.5
	Spa Cover - Covering, Uncovering and Storing	Daily	0.3	109.5
	Drain, Clean and Refill	Weekly	0.5	26.0
	Service and Clean Ladders, Rails, Escutcheon Plates	Weekly	0.5	26.0
	Service Chemical Controller, Dispensor, and Feeders	Weekly	0.5	26.0
	Service Drain Covers, Gutters, Grates, and Skimmers	Monthly	0.5	6.0
	Spa Cover Cleaning	Monthly	0.5	6.0

Offices, Lobbies, Halls, Miscellaneous Rooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.10	547.50
	Remove Trash and Empty Receptacles	Twice Daily	0.10	73.00
Baseboards	Wipe Down (Per 50 Feet)	Weekly	0.30	15.60
Carpet	Vacuuming- (Per 3,000 Square Feet)	Daily	1.00	365.00
	Spot/Stains Removal	Weekly	0.50	26.00
	Bonnet Buffing (Per 500 Square Feet)	Monthly	1.00	12.00
	Carpet Extraction (Per 500 Square Feet)	Twice Annually	0.50	1.00
Dust	Furniture and Equipment	Weekly	0.50	26.00
Return Vents	Clean Vents with Broom or Vacuum with Attachement	Weekly	0.10	5.20
Trash Receptacles	Wash Interior and Exterior	Monthly	0.10	1.20
Vinyl or Tile Floors	Mop (Per 1,000 Square Feet)	Daily	0.50	182.50
	Sweep (Per 1,000 Square Feet)	Daily	0.30	109.50
	Stripping Wax Floors with Separate Wet Pick-Up (Per 1,000 Square Feet)	Twice Annually	1.30	2.60
	Wax (Per 1,000 Square Feet)	Twice Annually	1.00	2.00
Walls	Cleaning (Per 300 Square Feet)	Monthly	1.00	12.00
Windows/Mirrors/Ledges	Cleaning (Per 100 Square Feet)	Daily	0.20	73.00

Restrooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.10	547.50
	Remove Trash and Empty Receptacles	Twice Daily	0.10	73.00
Baseboards	Wipe Down (Per 50 Feet)	Weekly	0.30	15.60
Floors	Sweep and Wet Mop (Per Restroom)	Daily	0.30	109.50
	Scrub with Floor Machine and Squeegee (Per 1,000 Square Feet)	4 Times Annually	0.50	2.00
Mirrors	Wipe Down	Daily	0.20	73.00
Partitions	Clean Fixtures With a Germicidal Detergent	Weekly	0.50	26.00
Sanitary Napkin Box	Clean Fixtures With a Germicidal Detergent	Weekly	0.30	15.60
Sinks	Clean Fixtures With a Germicidal Detergent	Daily	0.10	36.50
Toilets and Urinals	Clean Fixtures With a Germicidal Detergent	Daily	0.20	73.00

Saunas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.10	547.50
	Cleaned and Disenfected	Daily	0.30	109.50

Trails and Crossings

Bridges and Crossings

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Monthly	0.3	3.6
Bridges	Miscellaneous Repairs	Every 2 Years	8.0	4.0
Low Water Crossings	General Maintenance and Cleaning	3 Times Annually	2.0	6.0

Trails

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All Trails	Safety and Maintenance Inspection (Per 1,000 linear feet of trail)	Monthly	0.1	1.2
	Tree and Brush Pruning (Per 1,000 linear feet of trail)	Annually	2.0	2.0
	Snow and Ice Removal - Performed on select trails only. (Per 1,000 linear feet of trail)	Average of 3 Events Annually	1.0	3.0
	Leaf and Debris Removal (Per 1,000 linear feet of trail)	Annually	0.3	0.3
	Cleaning and Repair of Culvert Pipes (Per Pipe)	Annually	0.5	0.5
All Surfaced Trails (Asphalt, Concrete, Gravel, Wood Chip)	Mowing of Grass Along Trail - Class D (Per 1,000 linear feet of trail)	3 Mowings Annually (Spring, Summer, Fall)	0.5	1.5
Asphalt (Average 8' wide - 2,500' long)	Patch and Repair Holes (Average of 4 square feet per repair.)	Every 3 Years	1.5	0.5
	Repair Small Section (Average of 32 square feet per repair.)	Every 10 Years	4.5	0.5
	Repair Large Section (Average of 400 square feet per repair.)	Every 15 Years	8.0	0.6

Trails

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Concrete (Average 4' wide - 5,000' long)	Repair Small Section (Average of 18 square feet per repair.) (Contracted Service)	Every 10 Years	1.0	0.1
	Repair Large Section (Average of 240 square feet per repair.) (Contracted Service)	Every 20 Years	1.0	0.1
Gravel (Average 8' wide - 1,000' long)	Repair Small Section (Average of 32 square feet per repair.)	Annually	2.0	2.0
	Resurfacing Resurfacing of top 1"	Every 10 Years	6.0	0.6
Natural (Average 6' wide - 500' long)	Mowing - Class C (Per 500 linear feet of trail)	Monthly (Every 28 Days), 9 Times per Year (April - November)	0.2	1.8
	Repair Small Section (Average of 36 square feet per repair.)	Annually	2.0	2.0
	Resurfacing Resurfacing of top 1" or more	Every 5 Years	3.0	0.6
Trail Lighting	Safety and Maintenance Inspection	Weekly, 36 Times per Year (April - November)	0.1	3.6
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	2	2.0

Trails

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Wood Chip (Average 8' wide - 500' long)	Repair Small Section (Average of 64 square feet per repair.)	Annually	1.0	1.0
	Resurfacing Resurfacing of top 1" or more	Every 7 Years	2.0	0.3

Summary

While it is important to identify the individual Maintenance Tasks associated with various facilities, it is also beneficial to summarize the tasks for each facility. The Summary section was developed to provide a quick reference guide showing the total annual labor requirements to maintain each facility.

Facility Type	Total Annual Labor Hours
Amenities	
Bench - Metal	0.5
Bench - Recycled	0.5
Bench - Wood	1.1
Bollard - Metal	0.8
Bollard - Removable	0.8
Fencing and Railing (Per 100')	1.4
Gates	0.9
Guardrail and Barricades - Metal (Per 500')	4.2
Guardrail and Barricades - Wood or Cable (Per 200')	2.3
Parking Lots - Asphalt (Average 25 Space Lot)	16.5
Parking Lots - Gravel (Average 25 Space Lot)	19.2
Parking Lot and Roadway Lighting	12.4
Roadways - Asphalt (Per 250 Linear Feet)	2.8
Roadways - Gravel (Per 250 Linear Feet)	4.6
Signage - Metal	0.5
Signage - Wood	1.8
Trash Receptacles - 55 Gallon Can with Dome	1.3
Trash Receptacles - 30 Gallon Can	0.1

Facility Type	Total Annual Labor Hours
Athletic Fields	
Level 1 Athletic Fields - Lighted and Irrigated	
Ball Diamonds	
60' or 70' - Grass Infield	601.0
60' or 70' - Skinned Infield	606.9
65' - Skinned Infield	606.9
90' - Grass Infield	644.1
90' - Skinned Infield	629.0
Rectangles	259.2
Level 2 Athletic Fields - Lighted or Irrigated (Not Both)	
Ball Diamonds	
60' or 70' - Grass Infield, Lighted	423.2
60' or 70' - Grass Infield, Irrigated	470.0
60' or 70 - Skinned Infield, Lighted	428.7
60' or 70' - Skinned Infield, Irrigated	475.5
65' - Skinned Infield, Lighted	428.7
65' - Skinned Infield, Irrigated	475.5
90' - Grass Infield, Lighted	462.5
90' - Grass Infield, Irrigated	528.5
90' - Skinned Infield, Lighted	450.8
90' - Skinned Infield, Irrigated	516.8
Rectangles with Irrigation	231.2
Rectangles with Lighting	175.2
Level 3 - Athletic Fields - Not Lighted or Irrigated	
Ball Diamonds	
60' or 70' - Grass Infield	376.7
60' or 70' - Skinned Infield	383.6
65' - Skinned Infield	383.6
90' - Grass Infield	417.4
90' - Skinned Infield	405.7
T-Ball	269.1
Rectangles	167.2
Level 4 - Athletic Fields - Synthetic Turf Fields	
Ball Diamonds	
60' or 70' - Lighted	276.8
60' or 70' - Non-Lighted	256.8
65' or Above - Lighted	375.2
65' or Above - Non-Lighted	355.2
Rectangles with Lighting	327.1
Rectangles	317.5
Turf Program	
Irrigated Athletic Fields (Per Acre)	12.5
Non-Irrigated Athletic Fields (Per Acre)	10.4

Facility Type	Total Annual Labor Hours
Buildings	
Building Envelop and Interior	
Doors Exterior	2.0
Electrical Load Center	1.0
Elevator (RECenters)	12.0
Emergency Lights	12.0
Exhaust Fans	1.0
Exit Lights	24.0
Exterior	70.0
Fire Alarm	3.0
Fire Alarm Pull Stations	12.0
Fire Extinguishers (per 10)	1.0
Interior Walls and Ceilings (Per 1,000 Square Feet)	62.0
Kitchen Exhaust Hood	1.0
Lights	2.0
Motors 1 to 75 hp	8.0
Roof	3.0
Roof Drains\Gutters	8.0
Security System	36.0
Sprinkler System	2.0
Sump Pump	2.0
Water Heater	1.0
Wheel Chair Lift (Historic sites)	12.0
Windows	2.0
Heating and Cooling Systems	
Boilers	17.0
Chillers	8.0
Cooling Towers	30.0
Geothermal	88.0
HVAC System Up to 5 Tons	8.0
HVAC System 5 Tons and Above	16.0
Water Supply and Sewer	
Backflow Preventer	2.0
Gravity Flow Septic System	0.3
Pumped Septic System	0.3
Sewer Ejector Pump	8.0
Well System	2.0

Facility Type	Total Annual Labor Hours
Farm and Equestrian Features	
Animal Barns	730.0
Dairy Cow	730.0
Livestock and Poultry	730.0
Pasture	163.0
Fencing (Per 100')	14.8
Horse Stalls	535.5
Indoor Riding Arenas	581.0
Outdoor Riding Arenas - Frying Pan Farm Park	1,045.0
Outdoor Riding Arenas - Turner Farm Park	213.0
Frying Pan Farm Park Buildings	678.5
Forested and Other Treed Areas	
Downed Trees	7.5
Miscellaneous Tree Work	
Flagging	14.0
Winching	4.0
Park Inspections	
Citizen Contact Follow Up	2.0
Developed Parks	1.3
Playgrounds	0.5
Tree Spoils	
Chipping of Brush	6.0
Debris Dispersion	3.0
Removal of Wood from Site	9.0
Stump Removal	4.0
Upright Trees	
Cabling Trees	3.0
Felling of Tree	3.0
Putting a Hand Line in Tree	1.0
Tree Pruning via Climbing	4.5
Tree Pruning from a Bucket Truck	3.0
Tree Removal From a Bucket Truck	4.5
Tree Pruning from the Ground	2.0
Tree Removal via Climbing	12.0
Tree Removal with Crane (Contracted Service)	6.0
Tree Removal without Crane (Contracted Service)	3.0
Golf Courses	
Driving Ranges (Average of 25 Stations)	2,043.1
Fairways (Per Acre)	294.5
General Course Maintenance	1,261.8
Greens	239.3
Power Carts & Pull Carts (Per 20 Cars)	110.7
Putting Greens	238.3
Roughs (*See Actual Standard for Details)	*
Sand Traps (Per 5,000 Square Feet)	34.8
Tees	117.8
Turf Maintenance (*See Actual Standard for Details)	*

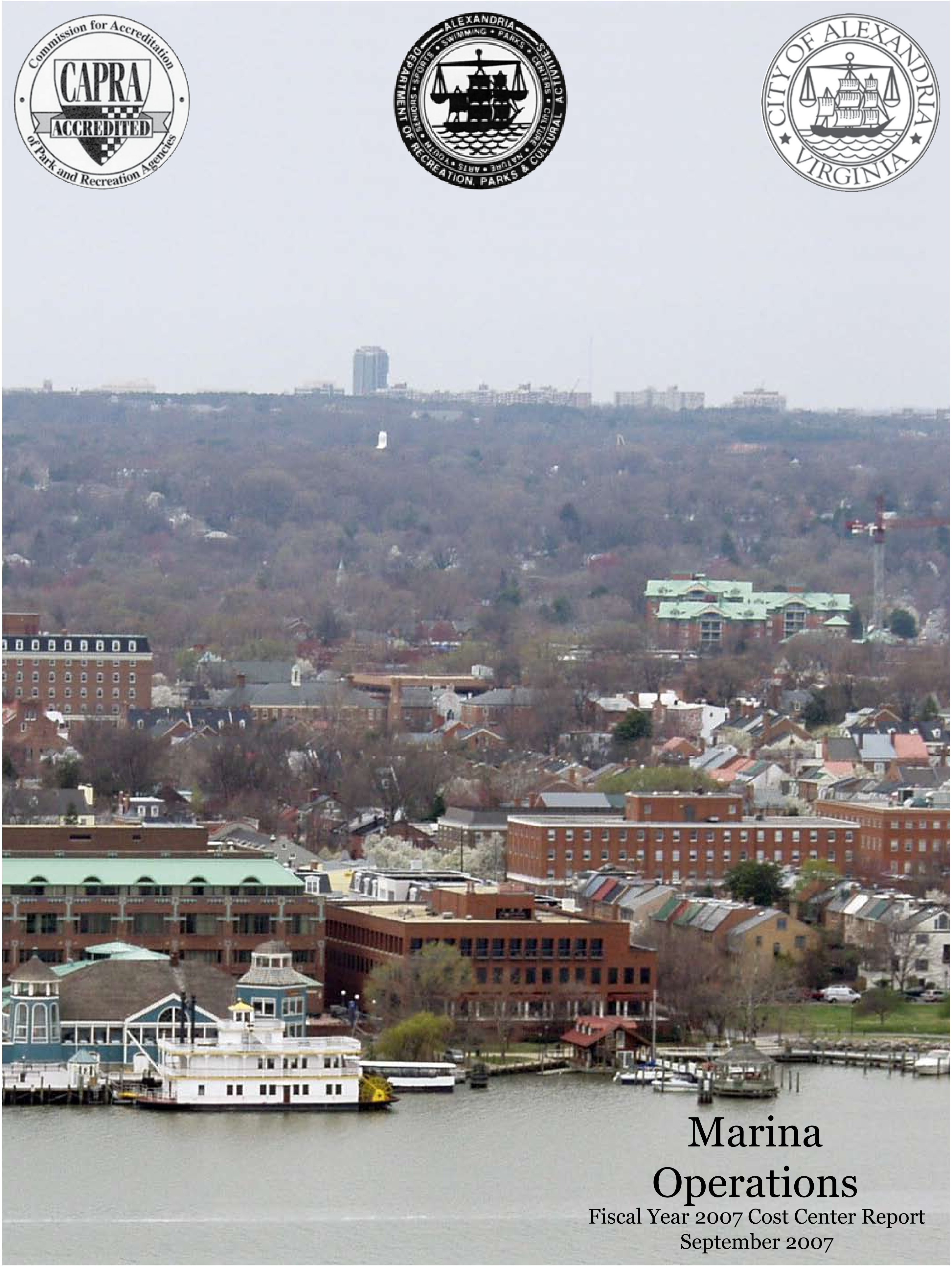
Facility Type	Total Annual Labor Hours
Managed Landscapes	
Gardens and Landscape Beds	
Landscape Beds (Per 1,000 Square Feet)	13.6
Public Plots	34.6
General Grounds	
Trash Removal and Miscellaneous Work (Per Acre)	6.6
Mowing - Class A (Per Acre Staff Mowed)	57.8
Mowing - Class A (Per Acre Contract Mowed)	16.2
Mowing - Class B (Per Acre Staff Mowed)	27.4
Mowing - Class B (Per Acre Contract Mowed)	11.4
Mowing - Class C (Per Acre Staff Mowed)	17.4
Mowing - Class C (Per Acre Contract Mowed)	9.3
Meadows and Fields	6.2
Operating Equipment	
Large Engine Equipment	
Front End Loaders Loaders	35.0
Heavy Construction	43.0
Infield Conditioners	60.5
Off-Road Utility Vehicles	70.0
Outfront Mowers 6' and Below	97.5
Outfront Mowers 10' and Above	109.0
Reel Mowers	145.0
Tractors	25.0
Walkbehind Mowers	95.5
Ice Resurfacer	192.5
Small Engine Equipment	
Blowers	10.0
Chainsaw	96.5
Edger	4.5
Generators	6.0
Hedge Trimmers	6.5
Pole Saw	7.5
Sod Cutter	4.5
String Trimmers	24.0

Facility Type	Total Annual Labor Hours
Other Park Features	
Mason Amphitheater	31.5
Other Amphitheaters	28.9
Campgrounds	4,508.5
Carousels	299.8
Fitness Courses (Per Station)	7.1
Frisbee Golf Courses (Per Hole)	15.6
Marinas	
Lake	300.0
Launch Area	96.0
Paddle Boats (Per 10 Boats)	422.0
Row Boats (Per 10 Boats)	561.0
Canoes (Per 10 Boats)	166.0
Row Boats W/Trolling Motor	283.0
Miniature Golf Courses	370.5
Off-Leash Dog Areas	41.3
Outdoor Restrooms - Year Round	135.2
Outdoor Restrooms - Partial Year	101.4
Outdoor Swimming Pools	437.4
Picnic Areas (Capacity of 60)	51.0
Picnic Shelters (Capacity of 60)	61.6
Playground with Engineered Wood Fiber Surface	46.6
Playground with Rubber Surface	78.8
Skate Parks	457.0
Train - Engine and Cars	168.0
Train Track	128.0
Water Parks	1,077.3
Outdoor Courts	
Basketball	
Lighted	21.6
Non-Lighted	16.5
Horseshoe	21.6
Shuffleboard	6.4
Tennis	
Lighted	21.7
Non-Lighted	16.6
Practice Tennis	
Lighted	22.1
Non-Lighted	17.0
Volleyball	
Lighted	14.7
Non-Lighted	9.6

Facility Type	Total Annual Labor Hours
RECenters	
Fitness Equipment	
Cardiovascular (Small Center)	244.50
Cardiovascular (Medium Center)	453.0
Cardiovascular (Large Center)	870.0
Cybex Strength	517.0
Fitlinxx	423.0
Free Weights	52.0
Group Exercise	16.0
Spin Bikes	336.5
Fitness Rooms	709.3
Gyms	2,645.0
Ice Skating Arenas	2,081.0
Locker Rooms	913.2
Natatoriums	
Airshutes and Slides	16.4
Bleachers	202.1
Filter and Storage Rooms	52.0
Guard Chairs	85.0
Life Saving and Safety Equipment	158.0
Pools (25 Meter - w/tile)	2,072.8
Pools (50 Meter w/tile)	2,611.8
Pools (50 Meter w/cement)	2,502.3
Whirlpool / Spas	929.5
Offices, Lobbies, Halls, Miscellaneous Rooms (Each)	1,454.1
Restrooms	971.7
Saunas	657.0
Trails and Crossings	
Bridges	7.6
Low Water Crossings	9.6
Trails	
Asphalt (Per 2,500 Linear Feet)	10.0
Concrete (Per 5,000 Linear Feet)	8.7
Gravel (Per 1,000 Linear Feet)	11.1
Natural (Per 500 Linear Feet)	11.4
Wood Chip (Per 500 Linear Feet)	9.8
Trail Lighting	5.6

FAC 7517 Recreational Pier

FY25 SUC:	$719.29 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Commercial Sources



Marina Operations

Fiscal Year 2007 Cost Center Report

September 2007

Marina Operations
Marina Cost Center Fiscal Year 2007

Published and Printed by
The City of Alexandria
Department of Recreation, Parks & Cultural Activities
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Photos courtesy of the Department of Recreation, Parks & Cultural Activities Staff

Technical Layout and Design
Beth Carton, Park Planner

Digital Imaging Assistance
Beth Carton, Park Planner

The Alexandria City Marina Operations Section of the Park Operations and Capital Development Division’s mission is to:

“Provide efficient professional service to visiting boaters, tourists and citizens while providing an inviting maritime atmosphere in a manner that reflects well on the character of the City of Alexandria”

In order to fulfill the mission, Alexandria City Marina personnel are trained to:

- Act as goodwill ambassadors for the City by promoting tourism and local business patronage.
- Insure that Alexandria City Marina and Docking operations maintain a favorable relationship with neighboring residents and businesses.
- Exercise time and material cost consciousness, while implementing business practices that meet or exceed Marina Industry and City Standards. These practices are carried out in a labor-intensive environment requiring acute safety awareness on the part of each employee.
- Promote clean Marina practices and assist in developing programs and procedures to keep the Potomac River and City waterfront environment safe.

Marina Operations

Fiscal Year 2007 Cost Center Report
September 2007

C. Alexander/Department of RPCA

Alexandria City Marina

City of Alexandria
Department of Recreation,
Parks & Cultural Activities
September 2007

Table of Contents

Marina Operations

Background

History

The renovation of the piers at the Torpedo Factory was completed in the spring of 1985. Construction was completed on the new Founders Park piers the following year. The combined projects provided the City with 51 transient boat slips for small vessels up to 40 feet in length, and a number of berthing areas for larger charter, cruise and ship of character vessels. With the anticipation of boating and pedestrian activity in these areas increasing, a City policy was developed concerning docking, security control, and fees.

In 1985 there was one commercial vessel permanently docked at the Alexandria City Marina site, the *Cherry Blossom*, and one ship of character docked at Waterfront Park, *Schooner Alexandria*. Today, six commercial vessels which provide site seeing tours, shuttle service, and private charters dock at the Alexandria City Marina. These vessels are the *Matthew Hayes*, *Miss Christin*, *Admiral Tilp*, *Cherry Blossom*, *Miss Mallory*, and *Potomac Bell*. One ship of character, the *Dory Boat*, is docked at Waterfront Park.

Today, Alexandria City Marina Staff oversee and coordinate the operation and maintenance of 61 boat slips, three T-head piers and hundreds of feet of seawall docking space within the Alexandria City Marina, as well as seawall docking at Waterfront Park. Alexandria City Marina Staff also serve as the first point of contact for citizens and tourists entering this gateway to the City of Alexandria, the City's waterfront and historic district.

B. Carton/Department of RPCA

Alexandria City Marina

B. Carton/Department of RPCA

Alexandria City Marina

Marina Operations

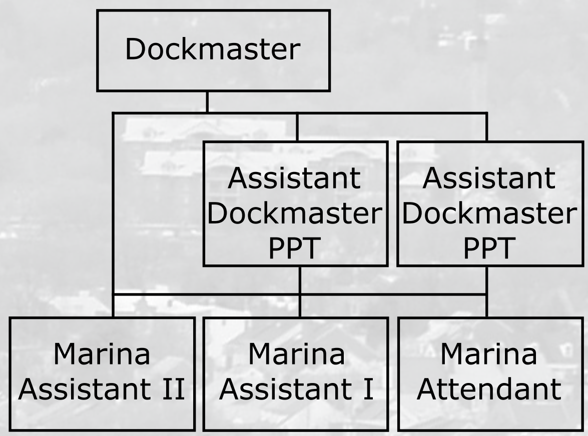
Background

Overview

The Alexandria City Marina is surrounded by parks, quaint restaurants, shops, historic sites, and walking/bike trails. The Alexandria City Marina also hosts public concerts. For boating enthusiasts, the Alexandria City Marina is a 3-mile cruise from the Washington Marina in DC and the James River Creek Marina in Maryland, making it widely accessible within the region. In addition to affording a spectacular view of the Potomac River, the Alexandria City Marina has overnight boat slip docking with additional short-term docking space on sea walls and adjacent areas. The Alexandria City Marina offers docking for pleasure boats and commercial vessels.

Personnel Organization

- Dockmaster
- Assistant Dockmaster
  2 Part-Time Positions
- Marina Assistant II
  1-2 Seasonal Positions
- Marina Assistant I
  6-7 Seasonal Positions
- Marina Attendant
  1 Seasonal Position



C. Alexander/Department of RPCA

Chart House

B. Carton/Department of RPCA

Alexandria City Marina

Current Services Provided

Current Operations

Location: City waterfront from King Street to Queen Street

Operating Hours: In-Season: (1 April - 31 October)
Monday - Thursday 10:00 a.m. - 9:00 p.m.
Friday 10:00 a.m. - 10:00 p.m.
Saturday 8:00 a.m. - 10:00 p.m.
Sunday 8:00 a.m. - 9:00 p.m.

Off-Season: (1 November - March 31)
All Days 10:00 a.m. - 5:00 p.m.

Night Security: Daily, year-round 9:00 p.m. - 5:00 a.m. (contract)

Piers: A/B Pier, located behind Torpedo Factory, southern most Alexandria City Marina pier
C/D Pier and Seawall, used for commercial docking
E/F Pier, by Seaport Foundation facility, with gazebo on the end
G/H Pier, northern most pier, gazebo in the middle, ends in a T-head
Waterfront Park bulkhead

Commercial Slip Agreements: Presently, the City holds license agreements with two commercial companies: Potomac River Boat Company (PRC) and L.A. Yachts. PRC docks five boats at the Alexandria City Marina. The vessels are used for tours, water taxi, and charters. L.A. Yachts docks the *Potomac Belle* at the Alexandria City Marina, this vessel is used solely for charters.

Each vessel has its own license agreement. The City negotiates with the company on the terms and docking fees for each vessel when the individual license comes up for renewal.

Current Operations

Pleasure Boat License Agreements: Forty slips are reserved for pleasure boat owners holding license agreements. The agreements run 1 April through 31 March, and the docking fees are paid on an annual basis. Rate increases went into effect July 1, 2006. The current rate is $7.25 per foot per month, paid on an annual basis. The Alexandria City Marina maintains a wait list for the pleasure boat year-round slip spaces. There are approximately 50 names on the waitlist. By City Ordinance, pleasure boat license agreements are limited to boats with a maximum length of 40 feet.

Transient Pleasure Boats: The balance of the pleasure boat docking slips is used for transient boats. The fee for short-term visits, with a maximum length of four hours, is ten dollars. Visits over four hours are considered overnight stays and are assessed at a fee of one dollar per foot, per night during the off-season, and one dollar and a half per foot, per night for overnight docking in-season. Currently, during peak times in-season, the Alexandria City Marina is unable to accommodate all requests for docking space.

Commercial Vessels (short-term): Visiting cruise, charter, and commercial vessels, and ships of character dock at the Alexandria City Marina. The docking fee is three dollars per foot, per day. Two T-heads (one at the end of the A/B Pier, and one at the end of the G/H Pier) are used for docking these ships and large private yachts. Demand for these larger docking areas far exceeds the ability of the Alexandria City Marina to provide service. In-season, many requests are turned down due to lack of space. Commercial vessels seeking to dock more than four times per month must have approval from City Council. Visiting tall ships and ships of character add to the City's waterfront image and attract tourists.

Alexandria Fire Boat: The City's Fire Department docks their fire vessel at the Alexandria City Marina. The vessel is currently located on the E/F Pier.

Marina Operations

Current Services Provided

Current Operations

Slip Locations:				
	Pier A	13	Pier E	7
	Pier B	13	Pier F	8
	Pier C	Commercial Docking	Pier G	10
	Pier D	Commercial Docking	Pier H	10

*Plus Marina T-head and wall docking spaces (capacity based on size of vessels) and docking at Waterfront Park.

Utilities: Of the 61 docking slips, two have 50 amp connections and fifty-nine have one 30 amp connection each. Both the A/B and C/D Pier T-heads have one 50 amp connection each. The G/H Pier T-head has one 100 amp and three 50 amp connections. A fire suppression system was installed in 2002. All slips and T-heads have one water bib hook-up each. Currently no phone/cable hook-up or laundry facilities are provided.

Showers/Restrooms: Shower and restroom facilities are only available for license agreement holders and overnight transient boaters. The facility is secured with an electronic key card system.

Pump-out: A pump-out station is available for agreement holders to use as part of their contract. For all others docking at the Alexandria City Marina the fee is $25.00 per pump-out. Use of the station must be scheduled in advance, as the equipment is located in a docking space.

B. Carton/Department of RPCA

City Marina

C. Alexander/Department of RPCA

City Marina

Marina Staff Daily Services

Throughout the day Alexandria City Marina staff:

- Make periodic inspections of boats, piers, docks, and waterfront areas.
- Perform daily maintenance including litter removal, emptying trash cans, cleaning bathrooms, cleaning piers, repairing decking, repairing railings, and repairing benches.
- Assist boaters with docking and departing the Alexandria City Marina, enter transactions in computerized Point of Service (POS) and rental reservation system, and collect user fees.
- Prepare safety and security documentation. Prepare and monitor financial reports, reconcile fees collected, complete deposits, prepare and monitor daily reports and time sheets.
- Schedule boat slip reservations. Respond to VHF radio calls.

C. Alexander/Department of RPCA

City Marina

B. Carton/Department of RPCA

City Marina

Marina Staff Daily Services

- Enforce all rules and regulations of the Alexandria City Marina. Ensure the Alexandria City Marina is operating in accordance with the City of Alexandria Operation Plan, City Code, and Nautical Laws.

- Answer and resolve any problems, complaints or concerns from boaters, pedestrians, and visitors.

- Maintain vigilant security watch of the Alexandria City Marina, boats, and public/staff safety.

- Monitor and enforce all pleasure boat and commercial boat licenses. Ensure license compliance including payment of fees, updating of insurance, and Coast Guard documentation.

- Assist in emergency response/operations as needed and outlined in the Alexandria City Marina Operating Plan and Standard Operating Procedures. Follow all training and American Red Cross protocols.

B. Carton/Department of RPCA

A/B Pier

Department of RPCA Staff

C/D Pier

Marina Staff Daily Services

- Maintain navigational channel and docking areas. Contact Army Corps of Engineers and DC Harbor for assistance as needed.
- Maintain storm preparedness level as required by the Alexandria City Marina Storm Preparedness Plan. Activate preparedness levels as situations dictate.
- Train seasonal staff in the proper procedures for docking and securing boats, collecting and handling docking fees, and maintaining a clean, and attractive facility.
- Maintain current Department, Alexandria City Marina, and commercial boat information, and distribute information to the public.
- Coordinate all Alexandria City Marina water based activities and events.

Department of RPCA Staff

E/F Pier

C. Alexander/Department of RPCA

G/H Pier

Spring Marina Costs

April - May (9 weeks)

Staff Hours	1,480
Staff Costs	$28,313
Material Costs	$8,687
Total	$37,000

C. Alexander/Department of RPCA

Aerial View

Department of RPCA Staff

Transient Boater

Spring Activities

During operational hours, Alexandria City Marina Staff follow timelines and Standard Operating Procedures to coordinate year-round activities. The following are specific spring duties:

- License renewal process
- Work with eligible people from pleasure boat slip waitlist
- Begin accepting transient boat reservations on April 1st
- Prepare for and host events including Boat Club Visits, Tall Ship Visits, and Ship of Character Visits
- Prepare computerized boat slip rental and Point of Service (POS) system
- Perform water based pier and amenity repairs
- Identify winter damage and coordinate repairs
- Accommodate and assist spring boating traffic
- Prepare for April 1st start of new tour boat and water taxi season
- Prepare for summer dockings and schedule events
- Remove debris from Alexandria City Marina navigational areas and piers
- Prepare for and complete United States Coast Guard Facility Safety Inspection
- Prepare for and complete Commonwealth of Virginia Marina Operating Inspection

Storm season has begun, initiate storm preparedness plan.

Summer Activities

Below are specific summer duties:

- Prepare for and host events including Memorial Day Weekend, Waterfront Festival, 4th of July, City Birthday Celebration, Irish Festival, Labor Day Weekend, United States Coast Guard Vessel Safety Inspection Day, Boat Club Visits, Tall Ship Visits, Ship of Character Visits
- Accommodate influx of summer boating traffic and pedestrian foot traffic
- Coordinate Alexandria City Marina activities with Potomac Riverboat Company, L.A. Yachts, and Seaport Foundation
- Remove debris from Alexandria City Marina navigational areas and piers
- Concentrate on providing a visible staff presence at the Alexandria City Marina and Waterfront Park to assist boaters and pedestrian foot traffic

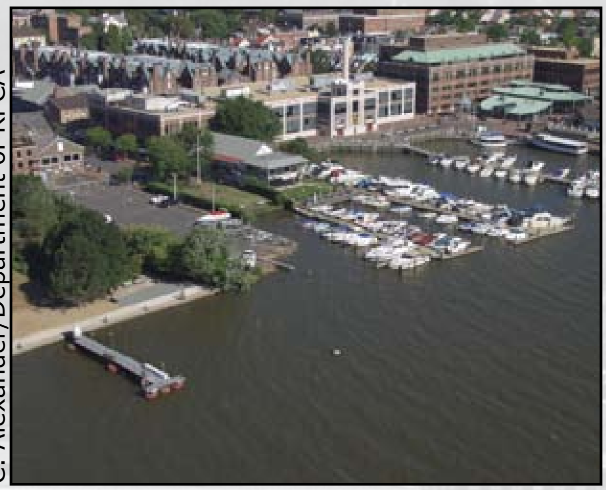
This is the critical storm and flooding season. Maintain storm readiness level to quickly activate Marina storm preparedness plan.

Summer Marina Costs

June - August (13 weeks)

Staff Hours	3,360
Staff Costs	$66,363
Material Costs	$5,740
Total	$72,103

C. Alexander/Department of RPCA



Aerial View

Department of RPCA Staff

A/B Pier

Fall Marina Costs

September - November (13 weeks)

Staff Hours	1,880
Staff Costs	$44,536
Material Costs	$3,464
Total	$48,000

Department of RPCA Staff

North End Marina

Fall Activities

Below are specific fall duties:

- Prepare for and host events including the Arts Festival Weekend, Raft Across the Potomac event with Old Dominion Boat Club, Halloween Festivities, Art Yacht
- Begin to prepare the Alexandria City Marina for winter months to avoid freeze damage
- Begin to prepare for Parade of Lights
- Prepare winter docking plan for license holders remaining at the Alexandria City Marina through the winter months

This is the critical storm and flooding season. Maintain storm readiness level to quickly activate Marina storm preparedness plan.

Department of RPCA Staff

A/B Pier, Torpedo Factory

Department of RPCA Staff

Nantucket Clipper Cruise Ship

Winter Activities

Below are specific winter duties:

- Prepare for, market, and host the annual Parade of Lights events
- Publish, print, and mail the Alexandria City Marina user survey, and tally results
- Develop and issue pleasure boat licenses

Prepare for spring storm season.

Winter Marina Costs

December - March (17 weeks)

Staff Hours	1,700
Staff Costs	$46,357
Material Costs	$2,643
Total	$49,000

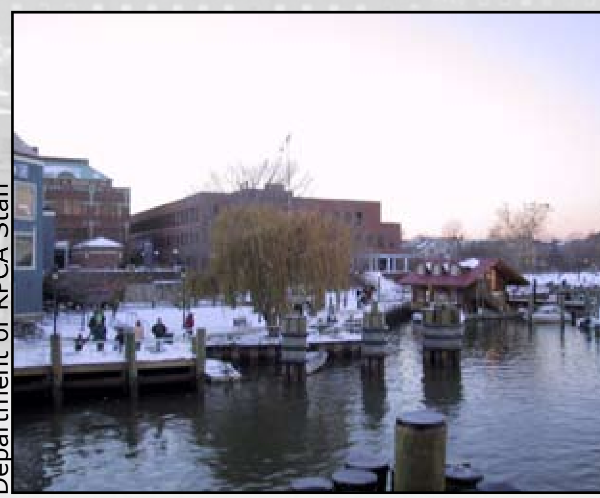
Department of RPCA Staff

Parade of Lights

Department of RPCA Staff

Marina in Winter

Department of RPCA Staff



Marina in Winter

C. Alexander/Department of RPCA

Waterfront Festival 2006

Department of RPCA Staff

Tall Ship Approaching Marina

Department of RPCA Staff

Parade of Lights

Festivals and Events

Waterfront Festival

The City Marina coordinates with the Department's Special Events Section and the American Red Cross every year in hosting the Waterfront Festival. This event commemorates Alexandria's maritime heritage. It features a number of tall ships, a blessing of the fleet, river cruises, races, arts and crafts, exhibits, food, music, and fireworks.

Host Tall Ships

Each summer the City Marina plays host to a variety of tall ships. Most notably this past summer were the *Kalmar Nyckel*, *Schooner Virginia* and *Sultana*. These ships are a huge draw for the public and offer a glimpse into Alexandria's history and rich maritime heritage.

Parade of Lights

Each December, Alexandria's harbor lights up for this annual parade of boats. Boat owners, who compete for great prizes, beautifully and imaginatively decorate their vessels. These sailing and powerboats cruise the City's historic waterfront on the Potomac River, making their way up to Washington, DC for the conclusion of the parade. Boat owners are not the only people who can enjoy the event, as there are a number of Alexandria City Marina based activities including music, and on shore attractions for the visiting public.

Vessel Safety Checks

In coordination with the United States Coast Guard (USCG), the Alexandria City Marina hosts this special day to allow its boaters and others on the river a chance to stop in and have the USCG inspect the vessels to ensure safe boating on the City's waterfront.

Alexandria City Marina Annual Revenue

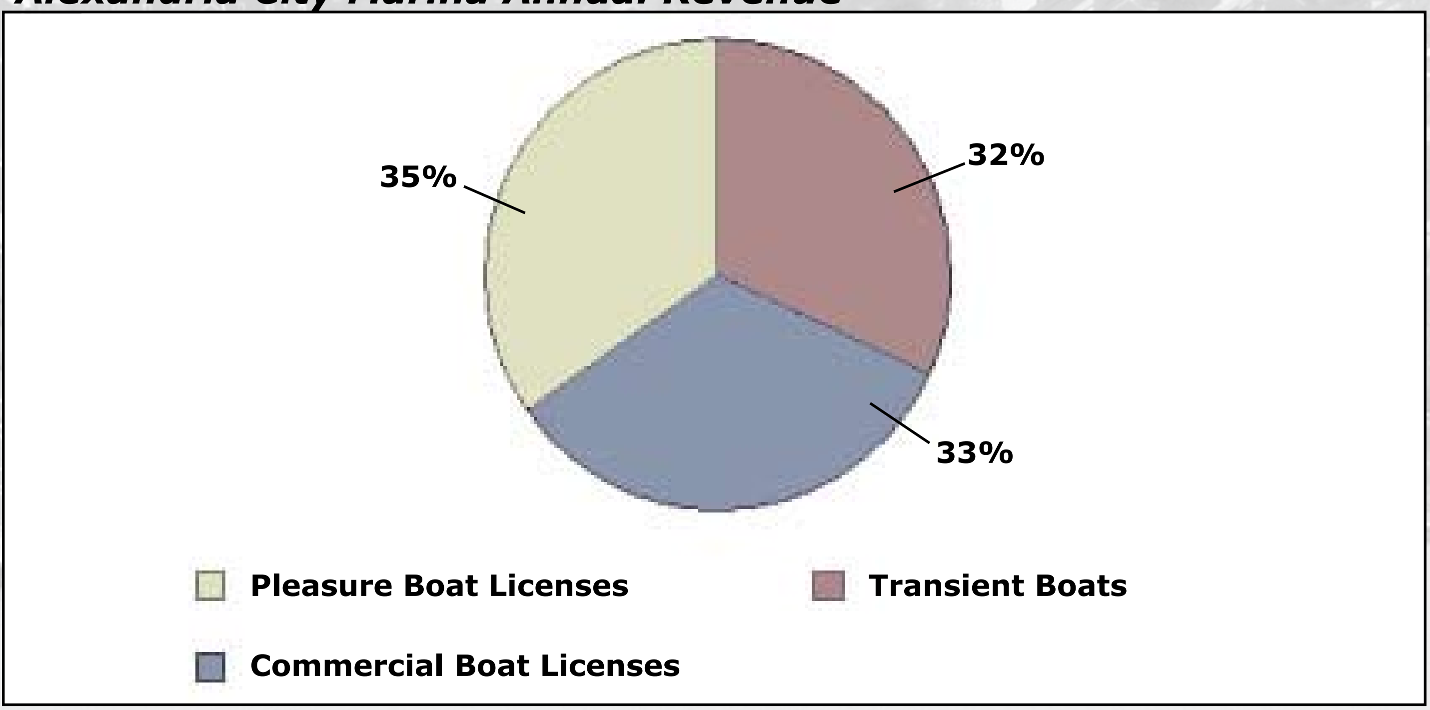
Figures from 2005, 2006 and 2007

License Type	FY05	FY06	FY07*
9105 Pleasure Boat Licenses	$75,000	$86,457	$106,946
9109 Commercial Boat Licenses	$95,000	$97,536	$101,659
9106 9107 9108 Transient Boats	$39,680	$66,869	$95,796
Total	$209,680	$250,862	$304,401

***As of 6/30/07**

Code Designations:
9105- Annual Pleasure Boats
9106- Short Term Transient Boats
9107- Overnight Transient Boats
9108- Visiting Commercial Vessels
9109- Annual Commercial Boats

Alexandria City Marina Annual Revenue



Additional Duties

Over the last several years, the list of Alexandria City Marina duties has grown to include the following:

- Coordinate berthing of six commercial boats and the Seaport Foundation.
- Accommodate additional tour boat to be added to City waterfront to serve National Harbor in 2008.
- Clear logs and debris from the Alexandria City Marina.
- Perform daily maintenance of Alexandria City Marina boardwalks, sidewalks, gazebos and seawalls.
- Dock boats and collect related fees at Waterfront Park.
- Pick up litter and maintain the brick area behind the Torpedo Factory Arts Center.
- Coordinate and adhere to Homeland Security requirments.

Core Activities

- Coordinate Alexandria City Marina docking activities for tour boats, charter and commercial vessels, ships of character, transient boat visits per City Code 6.3.
- Assist boating traffic approaching and departing Alexandria City Marina.
- Assist boating traffic approaching and departing Waterfront Park.
- Maintain the navigational areas in the Alexandria City Marina to provide safe boating access:
    - Remove debris from the water.
    - Maintain Alexandria City Marina piers.
    - Maintain Alexandria City Marina amenities (ladders, pier lights, rescue rings, railings, etc.).
    - Maintain Alexandria City Marina walkways.
    - Maintain Alexandria City Marina grassy areas.
- Accept and process user fees and boat docking reservations.
- Staff dockmaster office and Alexandria City Marina facility and answer visitor questions.
- Provide storm preparedness planning and staffing.

Service Levels and Maintenance Options

Service and Maintenance Levels

Level 1 - Meeting Future Needs

Provide Core Activities
Provide Special Event Assistance and Additional Duties

Operating Hours:	April-Oct: Mon-Th, 8am-10pm; Fri, 8am-12pm; Sat, 8am-12pm; Sun, 8am-9pm Nov-March: 9am-6pm daily
Staffing Levels:	Three additional full-time staff, add seasonal funds as needed
Clean-up:	Purchase boat and trash cleaning system for clean-up, provide staffing to operate, contract for debris removal
Security:	Install security cameras in key areas along the waterfront
Facility:	Explore possibilities for additional slip spaces and floating pier system
Operating Cost:	**$786,265/year plus CIP**

Level 2 - Meeting Projected Needs

Provide Core Activities
Provide 50% of Additional Duties

Operating Hours:	April-Oct: Mon-Th, 8am-9pm; Fri, 8am-10pm; Sat, 8am-10pm; Sun, 8am-9pm Nov-March: 9am-5pm daily
Staffing Levels:	Increase one part-time staff to full-time, add seasonal funds as needed
Clean-up:	Contract Trash Cat service and staffing to moniter the contract
Security:	Increase security contract to cover all un-staffed hours; install security system on piers
Facility:	Explore the possiblilities to create larger slip spaces, upgrade utilities; provide individually metered electrical hookups; repair or replace rope railings, sidewalks; and rebuild the Dockmaster's office
Operating Cost:	**$447,442/year plus CIP**

Level 3 - Current Level

Provide Core Activities

Operating Hours:	April-Oct: Mon-Th, 10am-9pm; Fri, 10am-10pm; Sat, 8am-10pm; Sun, 8am-9pm Nov-March: 10am-5pm daily
Staffing Levels:	In-season- 1 full-time, 2 part-time, plus seasonal, Out of season- 1 full-time, 2 part-time
Clean-up:	Lack of staff or equipment necessary to clean up waterways
Security:	9pm-5am, no coverage in early morning; insufficient coverage during peak times; no security system on piers
Facility:	Maintain at current level; including existing docking slip sizes and number, amount and type of utilities provided, stationary dock system, and present Dockmaster's office conditions
Budget FY07:	**$226,637/plus CIP**

Suggestions for Closing the Gap

- $66,000. Fund the two Assistant Dockmaster positions as full-time employees. The Alexandria City Marina is currently funded for one 40 hour permanent full-time Dockmaster and two 30 hour permanent part-time Assistant Dockmaster positions.

- $65,900. Alexandria City Marina staff funding needs to be increased to ensure that the Alexandria City Marina can be staffed from 8:00 a.m. - 9:00 p.m. daily. Contractor funding needs to be increased to ensure that the security contractor staffs the Alexandria City Marina from 9:00 p.m. - 8:00 a.m. daily and provides two staff persons on Friday, Saturday, and Sunday evenings. This funding will help to resolve unauthorized docking, vandalism and trespassing issues.

- $30,000. Temporary staff and contracted security cost. Provide additional funding for contract staff for additional fall operating hours.

- If the staff funding gaps cannot be filled significantly, reduce the Marina operating hours to allow for a minimum of two Alexandria City Marina staff per shift for the off-season months and four Alexandria City Marina staff per shift for the in-season months (April - October).

- $8,500. Purchase a work/maintenance cart for the use of the Alexandria City Marina staff to patrol the waterfront area, move supplies and equipment, and periodically assist with Alexandria City Marina trash removal.

- $69,500. Fund part-time and seasonal staff to perform reservation, duties at the Alexandria City Marina.

Operational Changes/Actions To Be Taken

Suggestions for Closing the Gap

- $21,685. Additional funding needed for Alexandria City Marina supplies and materials. The Alexandria City Marina is funded $16,000 annually for supplies and materials. The actual cost of supplies and materials is approximately $37,685.

Item	Cost
Custodial Supplies	$2,400
Rope and Supplies to Repair Railings	$1,600
15 Rescue Rings	$900
Blue Light Bulbs	$100
Yellow Light Bulbs	$200
Dock Light Fixture Repair/ Replacement	$3,000
Repair of 30 amp Electrical Connections	$2,000
Bench Repair	$3,000
Water Exit Ladder Repair/ Replacement	$550
Trash Receptacle Hard Plastic Can Liner Replacement	$240
First Aid Supplies	$600
Signs (water based boater signs)	$3,000
Johnboat Motor Repairs & Equipment	$800
Lifejacket Canisters	$120
Boat Line	$1,100
Dock Hardware	$800
Dock Cart	$225
Access Control System Service Contract	$2,000
Y Electrical Connections for Boats	$150
Uniforms	$2,200
Office Supplies	$900
Printing (Receipts and Forms)	$500
Electrical Contracting Service	$3,000
Tool and Hardware Replacement	$800
Water System Repairs	$7,000
Pump-out Repairs	$500
Total	**$37,685**

Operational Changes/Actions To Be Taken

Suggestions for Closing the Gap

- Cost of annual Trex decking repairs are paid for by General Services. In addition, RPCA and General Services split the cost for water pipe repairs when the cost exceeds $7,000. For the past two years the average cost to repair the water system damaged by winter freeze was $14,000.

- $45,000. Increase and designate capital improvement funding for repairs. Currently the Alexandria City Marina shares $90,000 annually in capital funding with the City's swimming pools. The Alexandria City Marina needs a capital improvement funding program specifically designated for the Alexandria City Marina, waterfront and docking repairs. The Alexandria City Marina's equipment and amenities are continually subjected to the impacts of the environment including: storm surges, storm force winds, driving rains and UV damage. It is imperative that capital funding be provided to repair and replace infrastructure and amenity damages before they escalate in cost and risk.

Department of RPCA Staff

2002 Trex Decking Project

Department of RPCA Staff

2002 Trex Decking Project

Operational Changes/Actions To Be Taken

Suggestions for Closing the Gap

- A structural and utilities study of the Alexandria City Marina should be conducted to examine the Alexandria City Marina piers, seawalls, electric and water utilities, and associated ancillary amenities.

  During the Waterfront Planning Process, an overall master plan for the Alexandria City Marina should be included.

  Seek grant funding through the Boating Infrastructure program to offset some of the costs that will be needed to update and upgrade the Alexandria City Marina facility.

  The Alexandria City Marina requires structural evaluation of the piers and bulkheads.

Department of RPCA Staff

2002 Fire Suppression Project

Department of RPCA Staff

Burst Pipe

C. Alexander/Department of RPCA

FAC 7517 Recreational Pier

UM = EA

See research paper below; no information is available on size, material, features

Assumed FAC 7517 (Pier) is similar to FAC 7518 (Marina); size assumed to average 50 ft; capable of berthing 3.33333333 small boats

97 craft berths are used for marina; therefore this FAC is 3/97 of FAC 7518

Requirements		Unit	Qty	Cost (2007)	Reduce material (contract) for facility maintenance only	Inflation 2007 to 2010	Prorate from 61 to 97 (Navy) slips		FAC 7517 to FAC 7518 Ratio	FAC 7517 Costs
	Spring costs (material)	EA	1	8687	0.4	1.082	1.590164	$ 5,978.59	0.03	184.9049
	Summer costs (material)	EA	1	5740	0.4	1.082	1.590164	$ 3,950.40	0.03	122.1773
	Fall costs (material)	EA	1	3464	0.4	1.082	1.590164	$ 2,384.00	0.03	73.73209
	Winter costs (material)	EA	1	2643	0.4	1.082	1.590164	$ 1,818.97	0.03	56.2569
TOTAL								$ 14,131.97		437.0712
PER UNIT (EA)								$ 14,131.97		437.0712

NAVY MWR MARINAS

http://www.mwr.navy.mil/mwrprgms/marinlst.htm		Moorings	Slips	Dry Storage
Naval Base, Coronado, California		80	**264**	120
Naval Base Point Loma San Diego, California		0	73	83
Naval Submarine Base New London, Connecticut		15	70	70
Naval Air Station Jacksonville, Florida		75	62	220
NAF Key West, Florida		21	126	18
Naval Support Activity Panama City, Florida		0	13	83
NAS Pensacola, Florida	Bayou Grande	15	**218**	209
NAS Pensacola, Florida	Sherman Cove	0	34	177
Naval Air Station Atlanta, Georgia		0	58	13
Navy Region Pearl Harbor, Hawaii		0	132	65
Naval Station Great Lakes, Illinois		80	90	30
Naval Support Activity Crane, Indiana		0	10	15
Naval Air Station Patuxent River, Maryland		0	**198**	95
NS Annapolis, Maryland		48	0	150
Mill Creek Marina		0	32	0
Navy Recreation Center Solomons, Maryland		0	129	82
Naval Shipyard Portsmouth, New Hampshire		90	97	80
NS Newport, Newport Rhode Island		27	**165**	0
Naval Station Norfolk, Virginia		0	14	19
Naval Amphibious Base Little Creek, Virginia		0	**162**	425
There are 5 Navy Marinas in list which provide no numbers				
Represents probably half of the inventory of Marinas			**1947**	**average sl**

Cost Factor 7518. Marina A facility for berthing pleaseur craft. Cost factors are based upon an a

There are approximately 50 major marinas on military bases spread throughout the United States and it
They range from the sailing marina tucked away at Dalgren, VA, to the 240-slip marina at Patrick Air Fo
All of these marinas have sailboats and powerboats for rent.
They range from houseboats to 25-foot deep sea fishing boats and 42-foot sailboats.
http://findarticles.com/p/articles/mi_m0BQK/is_6_8/ai_110961106/

FAC 7518 Marina

FY25 SUC:	$11,722.64 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Local Government Authority and R.S. Means Cost Data

FAC 7518 SUC FY16v18 - Marina
UM: EA

Design Size: 1
ESL 37
FAC Modeled with 90 slips (3708 sf) and 2 concrete boat ramps

Maintenance Type	Maintenance Activity	Frequecy	Duration (Hours)	Crew	Labor Rate (+ Fringe and Overhead)	Equipment	Equipment rate	Material	Material Quantity	Material Cost / Unit	Cost / Occurance	Occurances in ESL	Cost Over Lifetime
Preventative Maintenance	Safety and Maintenance Inspection	0.083	2.5	1 x WG9(5)	$ 36.67			0	0	0	$ 91.67	444	$ 40,703.46
Maintenance / Repair	Miscellaneous Repairs	1	32	2 x WG7(5)	$ 59.94			Cleats, moring rings, dock edge piling bumper	36	95.97	$ 5,373.04	37	$ 198,802.52
Maintenance / Repair	Repair Vinal decking, 10% of decking	5	40	2 x WG7(5)	$ 59.94	1 x Pickup Truck	$ 13.65	Vinyl Decking per SF	742	2.68	$ 4,932.21	7	$ 34,525.48
Maintenance / Repair	Minor Repairs to concrete ramp	15	80	1 x WG9(5) + 2 x WG7(5)	$ 96.61	1 x Truck, Dump	$ 34.40	Concrete per SF	480	3.10	$ 11,968.88	2	$ 23,937.77
											Sum of Costs over Lifetime		$ 297,969.22

Cost per Year $ 8,053.22

Cost per UM $ 8,053.22

References
DoD Real Property Categorization System (RPCS) FY2015
FY 2014 Real Property Assets Database
Fairfax County Park Authority Park Maintenance Standards Handbook March 2014
RS Means Facilities Construction Cost Data; 30th Ed
2015 Salary Tables from OPM.gov with Circular No. A-76 Revised RS
Means "Costworks" FMR 2015Q3

FAC 7521 Outdoor Playing Court

FY25 SUC:	$3,417.36 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7522 Athletic Field

FY25 SUC:	$9,545.95 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Fairfax County VA Park Authority

Park Maintenance Standards
Fairfax County Park Authority

Foreword

The responsibility of maintaining the Fairfax County Park Authority's multitude of diverse facilities contained in over 23,000 acres of parkland and over 400 parks is shared by multiple operations with the Agency.

- The Park Operations Division manages all of the Park Authority's non-staffed parks and provides maintenance support to all staffed parks. There are six geographically defined maintenance operations (Area Crews) spread across the County that manage all aspects of maintenance in non-staffed parks and provide outside maintenance support to staffed parks within their defined areas. There are also five operations (Equipment Support, Facility Support, Forestry Crew, Mobile Crew, Turf Crew) that provide specialized maintenance support to the Area Crews and indoor and outdoor operations at the staffed parks countywide.
- The Park Services Division's manages maintenance operations at each of its golf courses, lake front parks, and within all of its RECenters.
- The Resource Management Division manages maintenance operations at many of its staffed parks, an active farm, and a garden park.

Due to the large number of parks requiring care, diversity of facilities within each park, and with the responsibility for maintaining varied types of facilities shared at times by multiple operations; the Park Authority has established a set of standards that are not defined by individual parks or park classification types, but are defined by facility types which allows the individual maintenance operations to customize their operations plans and to apply standards for only those facilities which they have responsibility for. The Park Authority's maintenance standards require the same frequency and standard of maintenance to be applied to all like facilities. For facilities that are similar in type but for varied reasons may require a different frequency or standard of maintenance, the standards are defined for the different levels of care.

Maintenance Tasks that are routine or recurring in nature are identified and listed for each Facility Type. The information relevant to each Maintenance Task is presented in three categories: Frequency, Labor Hours per Recurrence, and Total Annual Labor Hours. The Frequency identified with each Maintenance Task identifies how often maintenance is to occur and may show time frames for when during the year it should occur. When applicable, a total amount of occurrences per year is also given. The information provided can be used as a basis for the development of a preventive maintenance program when compared to the established maintenance inventory.

A standard has been created that identifies the total number of Labor Hours per Recurrence that are needed to complete a task. Since the number of staff available to complete tasks varies from operation to operation and day to day, the standards have been designed to allow each operation to determine the hours needed to complete the tasks regardless of the staff available to them. This also provides operations with varied crew sizes flexibility in determining how to efficiently and effectively complete multiple tasks. Tasks can either be completed by one staff member or by multiple staff members, depending upon the nature of the task. When one staff member is assigned to complete a task then the figure shown for that task under the Labor Hours per Recurrence category is approximately how long the task should take to complete. When multiple staff members are assigned to complete a task, then the figure shown for that task under the Labor Hours per Recurrence category can be divided by the number of staff members available to complete the task which will result in a figure that shows approximately how long the task should take to complete.

Maintenance tasks are reported and tracked through an Integrated Workplace Management System called Tririga. Tririga automates service requests and self service requests in demand maintenance, preventive maintenance, and project management for dispatching, approvals, scheduling, cost tracking, and reports such as leases, inventory, equipment use/life expectancy, and expenses. Park staff can initiate, track, manage, and report on all requests online.

Reviewed March 2014

Park Operations Division Director

Table of Contents

Amenities

Benches

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Conduct a Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
Metal	Replace Seat or Back	Every 10 Years	1.0	0.1
Recycled	Replace Seat or Back	Every 10 Years	1.0	0.1
Wood	Replace Seat or Back	Every 5 years	2.0	0.4
	Painting	Every 2 Years	1.5	0.3

Bollards

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safetly and Maintenance Inspection (per Site)	4 Times Annually	0.1	0.4
Metal	Painting	Every 5 Years	2.0	0.4
Removable Bollard	Painting and Replacing Reflective Tape	Every 5 Years	2.0	0.4

Fencing and Railing

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 100' Section)	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Repairs	Every 2 Years	2.0	1.0

Gates

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Painting and Miscellaneous Repairs	Every 2 Years	1.0	0.5

Guardrail and Barricades

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 100 Linear Feet)	Safety and Maintenance Inspection	4 Times Annually	0.2	0.8
Metal Guardrail (Per 500 Linear Feet)	Repairs	Every 10 Years	2.0	0.2
Wood Guardrail and Cable (Per 200 Linear Feet)	Repairs	Every 3 Years	2.0	0.7

Parking Lots

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 25 Spaces)	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
		Weekly, 13 Times per Year (December - February)	0.1	1.3
	Reset Car Stops	Twice per Year	0.3	0.6
	Replace Car Stop	Annually	0.5	0.5
	Snow and Ice Removal	Average of 3 Events Annually	0.6	1.8
Asphalt (Per 25 Spaces)	Pot Hole Repairs	Twice per Year	0.5	1.0
	Cleaning	Twice per Year	0.5	1.0
	Spraying Weeds	Twice per Year	0.2	0.4
	Striping (Contracted service)	Every 3 Years	5.0	1.7
Gravel (Per 25 Spaces)	Regrading	Annually	6.0	6.0
	Spraying Weeds	Twice per Year	0.4	0.8

Parking Lot and Roadway Lighting

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Lighting	Safety and Maintenance Inspection	Weekly	0.2	10.4
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	2.0	2.0

Roadways

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 250 Linear Feet of Roadway)	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Snow and Ice Removal	Average of 3 Events Annually	0.4	1.2
Asphalt (Per 250 Linear Feet of Roadway)	Pot Hole Repairs	Twice per Year	0.5	1.0
	Striping (Contracted service)	Every 3 Years	0.7	0.2
Gravel (Per 250 Linear Feet of Roadway)	Regrading	Annually	3.0	3.0

Signage

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All Types	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
Metal	Replacement	Every 10 Years	1.0	0.1
Wood	Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Replacement	Every 10 Years	4.0	0.4

Trash Receptacles

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
55 Gallon Can with Dome	Painting	Every 2 Years	1.0	0.5
	Replacement	Every 3 Years for Receptacle	1.5	0.5
		Every 5 Years for Dome	0.5	0.1
		Every 10 Years for 4" X 4" Wood Posts	2.0	0.2
30 Gallon Can	Replacement	Every 5 years	0.5	0.1

Athletic Fields

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	3 Times Per Week, 96 Times per Year April - November)	0.80	76.80
		Weekly, 20 Times per Year (December - April)	0.80	16.00
	Amenity Inspection	Weekly, 32 Times per Year (April - November)	0.80	25.60
	Dragging and Raking Warning Tracks	Weekly, 32 Times per Year (April - November)	0.50	16.00
	Concrete Pads Cleaning	Every 2 Weeks, 16 Times per Year (April - November)	1.30	20.80
	Weeding Warning Tracks and Mowstrips	Every 2 Months, 4 Times per Year (April, June, August, October)	1.50	6.00
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Wet Lining	Twice Annually	1.00	2.00
	Bases and Plates Replacement	Annually	0.60	0.60
	Bases and Plates Set-Up	Annually	1.20	1.20
	Bleachers Maintenance and Repairs	Annually	2.60	2.60

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Fencing Maintenance and Repairs	Annually	11.30	11.30
	Adding Material to Warning Tracks and Mowstrips	Every 2 Years	1.50	0.75
	Foul Poles Maintenance and Repairs	Every 3 Years	4.50	1.49
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70' - Grass Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.50	240.00
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Infield Edging	Annually	5.70	5.70
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	49.00	16.17
60' or 70' - Skinned Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.60	249.60
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	43.00	14.19

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
65' - Skinned Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.60	249.60
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	43.00	14.19

Level 1 - Ball Diamonds
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
90' - Grass Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.70	259.20
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.30	147.20
	Infield Edging	Annually	9.00	9.00
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	49.00	16.17
90' - Skinned Infield	Daily Preparation	3 Times per Week, 96 Times per Year (April - November)	2.60	249.60
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.30	147.20
	Infield Edging	Annually	5.50	5.50
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	43.00	14.19

Level 1 - Rectangles
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	3 Times Per Week, 96 Times per Year (April - November)	0.80	76.80
		Weekly, 20 Times per Year (December - March)	0.80	16.00
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.50	96.00
	Amenity Inspection	Weekly, 32 Times per Year (April - November)	0.60	19.20
	Irrigation Maintenance and Repairs	Twice Annually	8.00	16.00
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Wet Lining	Twice Annually	6.30	12.60
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Field Renovation	Annually	8.30	8.30
	Goals Maintenance and Repairs	Every 2 Years	8.00	4.00
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39

Level 1 - Rectangles
Lighted and Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week, 72 Times per Year (March - November)	0.80	57.60
		Weekly, 16 Times per Year (December - March)	0.80	12.80
	Dragging and Raking Warning Tracks	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Concrete Pads Cleaning	Every 2 Weeks, 18 Times per Year (March - November)	1.30	23.40
	Weeding Warning Tracks and Mowstrips	Every 2 Months, 4 Times per Year (April, June, August, October)	1.80	7.20
	Wet Lining	Twice Annually	1.00	2.00
	Bases and Plates Replacement	Annually	0.60	0.60
	Bases and Plates Set-Up	Annually	1.20	1.20
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Fencing Maintenance and Repairs	Annually	10.10	10.10
	Adding Material to Warning Tracks and Mowstrips	Every 2 Years	1.80	0.90
	Foul Poles Maintenance and Repairs	Every 3 Years	4.50	1.49

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70' - Grass Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.50	180.00
	Mowing	Weekly, 32 Times per Year (March - November)	1.40	44.80
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	5.70	5.70
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20
60' or 70' - Grass Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.50	180.00
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.40	89.60
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	5.70	5.70
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70 - Skinned Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (March - November)	1.40	44.80
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20
60' or 70' - Skinned Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.40	89.60
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
65' - Skinned Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (March - November)	1.40	44.80
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20
65' - Skinned Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.40	89.60
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	40.00	13.20

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
90' - Grass Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times per Week, 72 Times per Year (April - November)	2.70	194.40
	Mowing	Weekly, 32 Times per Year (April - November)	2.00	64.00
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	9.00	9.00
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	43.00	14.19
90' - Grass Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times per Week, 72 Times per Year (April - November)	2.70	194.40
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	9.00	9.00
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	43.00	14.19

Level 2 - Ball Diamonds
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
90' - Skinned Infield, Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.80	28.80
	Daily Preparation	2 Times per Week, 72 Times per Year (April - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (April - November)	2.00	64.00
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Infield Edging	Annually	5.50	5.50
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	40.00	13.20
90' - Skinned Infield, Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Daily Preparation	2 Times per Week, 72 Times per Year (April - November)	2.60	187.20
	Mowing	Twice Weekly, 64 Times per Year (April - November)	2.00	128.00
	Irrigation Maintenance and Repairs	Twice Annually	8.60	17.20
	Infield Edging	Annually	5.50	5.50
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	40.00	13.20

Level 2 - Rectangles
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week, 72 Times per Year (March - November)	0.80	57.60
		Weekly, 16 Times per Year (December - March)	0.80	12.80
	Wet Lining	Twice Annually	6.30	12.60
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Field Renovation	Annually	8.30	8.30
	Goals Maintenance and Repairs	Every 2 Years	8.00	4.00
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 2 - Rectangles
Lighted or Irrigated (Not Both)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Irrigated	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Mowing	Twice Weekly, 64 Times per Year (April - November)	1.50	96.00
	Irrigation Maintenance and Repairs	Twice Annually	8.00	16.00
Lighted	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.60	21.60
	Mowing	Weekly, 32 Times per Year (April - November)	1.50	48.00
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week, 72 Times per Year (March - November)	0.80	57.60
		Weekly, 16 Times per Year (December - March)	0.80	12.80
	Amenity Inspection	Weekly, 36 Times per Year (March - November)	0.50	18.00
	Dragging and Raking Warning Tracks	Weekly, 32 Times per Year (April - November)	0.20	6.40
	Concrete Pads Cleaning	Every 2 Weeks, 18 Times per Year (March - November)	1.30	23.40
	Weeding Warning Tracks and Mowstrips	Every 2 Months, 4 Times per Year (April, June, August, October)	0.80	3.20
	Wet Lining	Twice Annually	1.00	2.00
	Bases and Plates Replacement	Annually	0.60	0.60
	Bases and Plates Set-Up	Annually	1.20	1.20
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Fencing Maintenance and Repairs	Annually	3.60	3.60
	Adding Material to Warning Tracks and Mowstrips	Every 2 Years	0.80	0.40

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Foul Poles Maintenance and Repairs	Every 3 Years	4.50	1.49
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70' - Grass Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.50	180.00
	Mowing	Weekly, 32 Times per Year (April - November)	1.40	44.80
	Infield Edging	Annually	5.70	5.70
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 4 Years	18.00	4.50
60' or 70' - Skinned Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (April - November)	1.40	44.80
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	18.00	5.94

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
65' - Skinned Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (April - November)	1.40	44.80
	Infield Edging	Annually	4.00	4.00
	Mound Reconstruction	Annually	5.10	5.10
	Infield Renovation	Every 3 Years	18.00	5.94
90' - Grass Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.70	194.40
	Mowing	Weekly, 32 Times per Year (April - November)	2.00	64.00
	Infield Edging	Annually	9.00	9.00
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	21.00	6.93

Level 3 - Ball Diamonds
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
90' - Skinned Infield	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	2.60	187.20
	Mowing	Weekly, 32 Times per Year (April - November)	2.00	64.00
	Infield Edging	Annually	5.50	5.50
	Mound Reconstruction	Annually	6.50	6.50
	Infield Renovation	Every 3 Years	18.00	5.94
T-Ball	Daily Preparation	2 Times Per Week, 72 Times per Year (March - November)	1.10	79.20
	Mowing	Weekly, 32 Times per Year (April - November)	1.40	44.80
	Infield Edging	Annually	4.00	4.00
	Infield Renovation	Every 4 Years	18.00	4.50

Level 3 - Rectangles
Not Lighted or Irrigated

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week, 72 Times per Year (March - November)	0.80	57.60
		Weekly, 16 Times per Year (December - March)	0.80	12.80
	Amenity Inspection	Weekly, 36 Times per Year (April - November)	0.50	18.00
	Mowing	Weekly, 32 Times per Year (April - November)	1.50	48.00
	Wet Lining	Twice Annually	6.30	12.60
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Field Renovation	Annually	8.30	8.30
	Goals Maintenance and Repairs	Every 2 Years	8.00	4.00
	Player Benches Maintenance and Repairs	Every 3 Years	4.20	1.39
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 4 - Ball Diamonds
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week	0.80	83.20
	Concrete Pads Cleaning	Monthly	1.30	15.60
	Aluminum Player Benches Maintenance and Repairs	Annually	0.50	0.50
	Artificial Mound - Replace pitching plate and minor repairs	Annually	2.00	2.00
	Bases and Plates Set-Up	Annually	1.20	1.20
	Bases and Plates Replacement	Annually	0.60	0.60
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Fencing Maintenance and Repairs	Annually	11.30	11.30
	Foul Poles Maintenance and Repairs	Every 3 Years	4.50	1.49
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4

Level 4 - Ball Diamonds
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
60' or 70' - Lighted	Amenity Inspection	Weekly	0.80	41.60
	Dragging/Grooming	Weekly	1.40	72.80
	Spot-Dress with Rubber Infill	Monthly	2.00	24.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	1.40	11.20
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Spiking	Annually	1.40	1.40
	Top-Dress with Rubber Infill	Every 4 Years	4.00	1.00
60' or 70' - Non-Lighted	Amenity Inspection	Weekly	0.50	26.00
	Dragging/Grooming	Weekly	1.40	72.80
	Spot-Dress with Rubber Infill	Monthly	2.00	24.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	1.40	11.20
	Spiking	Annually	1.40	1.40
	Top-Dress with Rubber Infill	Every 4 Years	4.00	1.00

Level 4 - Ball Diamonds
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
65' or Above - Lighted	Amenity Inspection	Weekly	0.80	41.60
	Dragging/Grooming	Weekly	2.80	145.60
	Spot-Dress with Rubber Infill	Monthly	3.00	36.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	2.80	22.40
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
	Spiking	Annually	2.80	2.80
	Top-Dress with Rubber Infill	Every 4 Years	8.00	2.00
65' or Above - Non-Lighted	Amenity Inspection	Weekly	0.50	26.00
	Dragging/Grooming	Weekly	2.80	145.60
	Spot-Dress with Rubber Infill	Monthly	3.00	36.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	2.80	22.40
	Spiking	Annually	2.80	2.80
	Top-Dress with Rubber Infill	Every 4 Years	8.00	2.00

Level 4 - Rectangles
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	2 Times Per Week	0.80	83.20
	Dragging/Grooming	Weekly	2.80	145.60
	Spot-Dress with Rubber Infill	Monthly	1.00	12.00
	Wet Lining	6 Times per Year (As Needed)	2.50	15.00
	Sweeping/Debris Removal	8 Times per Year, Mainly in Fall and Spring	2.80	22.40
	Aluminum Player Benches Maintenance and Repairs	Annually	0.50	0.50
	Bleachers Maintenance and Repairs	Annually	2.60	2.60
	Spiking	Annually	2.80	2.80
	Goals Maintenance and Repairs	Every 2 Years	8.00	4.00
	Signage Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Metal Sign Replacement	Every 10 Years	1.0	0.1
	Wood Sign Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0
	Wood Sign Replacement	Every 10 Years	4.0	0.4
	Top-Dress with Rubber Infill	Every 4 Years	6.00	1.50

Level 4 - Rectangles
Synthetic Turf, Lighted and Non-Lighted

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Lighted	Amenity Inspection	Weekly	0.60	31.20
	Lighting Maintenance and Repairs	Twice Annually	2.20	4.40
Non-Lighted	Amenity Inspection	Weekly	0.50	26.00

Turf Program

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Irrigated Fields (Per Acre)	Fertilizer Applications	Monthly, 4 Times per Year (April, June, September, November)	0.80	3.20
	Aeration	Twice Annually	1.80	3.60
	Pesticide Applications	Twice Annually	1.30	2.60
	Field Inspections	Annually	0.80	0.80
	Overseeding	Annually	1.90	1.90
	Soil Amendments	Every 3 Years	0.80	0.26
	Soil Sampling	Every 3 Years	0.50	0.17
Non-Irrigated Fields (Per Acre)	Fertilizer Applications	Monthly, 3 Times per Year (April, June, October)	0.80	2.40
	Aeration	Twice Annually	1.80	3.60
	Field Inspections	Annually	0.80	0.80
	Overseeding	Annually	1.90	1.90
	Pesticide Applications	Annually	1.30	1.30
	Soil Amendments	Every 3 Years	0.80	0.26
	Soil Sampling	Every 3 Years	0.50	0.17

Buildings

Building Envelop and Interior

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Doors Exterior	Safety and Maintenance Inspection	Annually	2.0	2.0
Electrical Load Center	Safety and Maintenance Inspection	Annually	1.0	1.0
Elevators (RECenters)	Safety and Maintenance Inspection (Contracted Service)	Monthly	1.0	12.0
Emergency Lights	Safety and Maintenance Inspection	Monthly	1.0	12.0
Exhaust Fans	Safety and Maintenance Inspection	Twice Annually	0.5	1.0
Exit Lights	Safety and Maintenance Inspection	Monthly	2.0	24.0
Exterior (Each Building)	Minor Repairs and Touch-Up Painting	Annually	10	10.0
	Repainting	Every 5 Years	300	60.0
Fire Alarm	Safety and Maintenance Inspection	Annually	3.0	3.0
Fire Alarm Pull Stations	Safety and Maintenance Inspection	Monthly	1.0	12.0
Fire Extinguishers	Safety and Maintenance Inspection	Annually	1.0	1.0
Interior Lights	Safety and Maintenance Inspection	Annually	2.0	2.0
Interior Walls and Ceilings (Per 1,000 Square Feet of Building Space)	Minor Repairs and Touch-Up Painting	Annually	30	30.0
	Repainting	Every 5 Years	160	32.0
Kitchen Exhaust Hood	Safety and Maintenance Inspection	Annually	1.0	1.0
Motors 1 to 75 hp	Safety and Maintenance Inspection	Annually	8.0	8.0

Building Envelop and Interior

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Roof	Safety and Maintenance Inspection	Annually	3.0	3.0
Roof Drains\Gutters	Cleaning, Safety and Maintenance Inspection (Contracted Service)	Twice Annually	4.0	8.0
Security System	Safety and Maintenance Inspection	Monthly	3.0	36.0
Smoke Detectors	Safety and Maintenance Inspection	Twice Annually	2.0	4.0
Sprinkler System	Safety and Maintenance Inspection	Annually	2.0	2.0
Sump Pump	Safety and Maintenance Inspection	Annually	2.0	2.0
Water Heater	Safety and Maintenance Inspection	Annually	1	1.0
Wheel Chair Lifts (Historic Sites)	Safety and Maintenance Inspection (Contracted Service)	Monthly	1.0	12.0
Windows	Safety and Maintenance Inspection	Annually	2.0	2.0

Heating and Cooling Systems

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Boilers	Cleaning, Safety and Maintenance Inspection	Annually	5.0	5.0
	Monthly Chemical Treatment	Monthly	1.0	12.0
Chillers	Safety and Maintenance Inspection	Annually	8.0	8.0
Cooling Towers	Safety and Maintenance Inspection	Annually	6.0	6.0
	Cleaning	4 Times Annually	6.0	24.0
Geothermal	Safety and Maintenance Inspection	Monthly	6.0	72.0
	Change Filters	4 Times Annually	4.0	16.0
HVAC System Up to 5 Tons	Safety and Maintenance Inspection	4 Times Annually	2.0	8.0
HVAC System 5 Tons and Above	Safety and Maintenance Inspection	4 Times Annually	4.0	16.0

Water Supply and Sewer

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Backflow Preventer	Safety and Maintenance Inspection	Annually	2.0	2.0
Gravity Flow Septic System	Cleaning, Safety and Maintenance Inspection (Contracted Service)	Every 3 Years	1.0	0.3
Pumped Septic System	Cleaning, Safety and Maintenance Inspection (Contracted Service)	Every 3 Years	1.0	0.3
Sewer Ejector Pump	Safety and Maintenance Inspection	Twice Annually	4.0	8.0
Well System	Safety and Maintenance Inspection	Annually	2.0	2.0

Farm and Equestrian Features

Farm Animals

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Animal Barns	Cleaning Stalls	Daily	2.0	730.0
Dairy Cow	Milking	Twice Daily	1.0	730.0
Livestock and Poultry	General Maintenance and cleaning	Twice Daily	1.0	730.0
Pasture	Remove Ground Trash and Empty Receptacles	Weekly	1.0	52.0
	Safety and Maintenance Inspection	Weekly	0.5	26.0
	Fertilizing and Seeding	Twice Annually	30.0	60.0
	Mowing	Annually	25.0	25.0

Fencing

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 100' Section)	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Repair	4 Times Annually	2.0	8.0
	Paint fence	Every 5 years	16.0	3.2
	Replace	Every 10 Years	32.0	3.2

Horse Stalls

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly, 35 Times per Year (April - November)	1.0	35.0
		Monthly, 4 Times per Year (December - March)	1.0	4.0
	Safey and Maintenance Inspection	Weekly, 35 Times per Year (April - November)	1.5	52.5
		Monthly, 4 Times per Year (December - March)	1.0	4.0
	Emptying Manure Bin	Twice Monthly, 16 Times per Year (April - November)	15.0	240.0
	Grinding Manure	Monthly	8.0	96.0
	Miscellaneous Repairs	Weekly	2.0	104.0

Indoor Riding Arenas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.3	109.5
	Remove Ground Trash and Empty Receptacles	Daily	0.2	73.0
	Bathrooms and Office Cleaning	Daily	0.5	182.5
	Refurnishing Jumps	Annually	40.0	40.0
Riding surface	Drag	Twice Weekly, 60 Times per Year (October - April)	1.0	60.0
		Weekly, 22 Times per Year (May - September)	1.0	22.0
	Water	Twice Weekly, 60 Times per Year (October - April)	1.0	60.0
		Weekly, 22 Times per Year (May - September)	1.0	22.0
	Level	Twice Annually	6.0	12.0

Outdoor Riding Arenas

Description		Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Frying Pan Farm Park	Remove Ground Trash and Empty Receptacles	Daily	0.2	73.0
	Safety and Maintenance Inspection	Daily	0.2	73.0
	Refurnish picnic tables/ bleachers	Annually	40.0	40.0
	Drag Riding Surface	Monthly	1.0	12.0
	Water	Monthly, 9 Times per Year (March - November)	1.0	9.0
	Level	Annually	6.0	6.0
	Supervision and Aid of equestrian Shows	Weekly	16.0	832.0
Turner Farm Park	Remove Ground Trash and Empty Receptacles	Daily	0.2	73.0
	Safety and Maintenance Inspection	Daily	0.2	73.0
	Refurnish picnic tables/ bleachers	Annually	40.0	40.0
	Drag Riding Surface	Monthly	1.0	12.0
	Water	Monthly, 9 Times per Year (March - November)	1.0	9.0
	Level	Annually	6.0	6.0

Frying Pan Farm Park Buildings

Description		Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Visitor Center	Event Clean up	Twice Weekly	3.0	312.0
	Restrooms and Entry Cleaning	Daily	0.5	182.5
School House	Cleaning	Daily, 6 Days per Week	0.5	156.0
Elmore Farm	Restrooms Cleaning	Weekly	0.5	26.0
Meeting House	Inspection of Building and Surrounding Area	Twice Annually	1.0	2.0

Forested and Other Treed Areas

Forested and Other Treed Areas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Downed Trees	Cutting Up a Downed Tree	Per Tree	7.5	7.5
Miscellaneous Tree Work	Flagging	Per Job	14	14
	Winching Trees	Per Tree	4	4
Park Inspections	Citizen Contact Follow Up	Per Job	2	2
	Developed Parks	Every 3 Years	4	1.32
	Playgrounds	Every 2 Years	1	0.5
Tree Spoils	Chipping of Brush	Per Tree	6	6
	Debris Dispersion	Per Job	3	3
	Removal of Wood from Site	Per Tree	9	9
	Stump Removal	Per Tree	4	4

Forested and Other Treed Areas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Upright Trees	Cabling Trees	Per Tree	3	3
	Felling of a Live or Dead Tree	Per Tree	3	3
	Putting a Hand Line in Tree	Per Tree	1	1
	Tree Pruning via Climbing	Per Tree	4.5	4.5
	Tree Pruning From a Bucket Truck	Per Tree	3	3
	Tree Removal From a Bucket Truck	Per Tree	4.5	4.5
	Tree Pruning From the Ground	Per Tree	2	2
	Tree Removal via Climbing	Per Tree	12	12
	Tree Removal with Crane (Contracted Service)	Per Tree	6	6
	Tree Removal without Crane (Contracted Service)	Per Tree	3	3

Golf Courses

Driving Ranges

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.2	73.0
	Remove Ground Trash and Empty Receptacles	Twice Daily, 428 Times per Year, (April - October)	0.2	85.6
		Daily, 151 Times per Year (November - March)	0.2	30.2
	Collect Range Balls	5 Times Daily, 1,070 Times Per Year (April - October)	1.0	1070.0
		2 Times Daily, 302 Times Per Year (November - March)	1.0	302.0
	Collect Range Ball Baskets	3 Times Daily, 642 Times Per Year (April - October)	0.4	256.8
		Daily, 151 Times Per Year (November - March)	0.4	60.4
	Blow Off Surface (Per 10 Stations	Weekly, 30 Times per Year (April - October)	0.1	3.0
		Monthly, 5 Times per Year (November - March)	0.1	0.5
	Fairway with Tri Plex reel mower (Per Acre)	Twice Weekly, 70 Times per Year (April - November)	1.5	105.0

Driving Ranges

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Fairway with 5-Gang reel mower (Per Acre)	Twice Weekly, 70 Times per Year (April - November)	0.7	49.0
	Irrigation Operation and Maintenance Inspection	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Leaf and Debris Removal (Per Acre)	4 Times Annually	0.5	2.0
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0
Station	Change Mat	Every 2 Years	0.2	0.1

Fairways

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.1	36.5
	Fairway with Tri Plex reel mower (Per Acre)	3 Times Weekly, 105 Times per Year (April - November)	1.5	157.5
	Fairway with 5-Gang reel mower (Per Acre)	3 Times Weekly, 105 Times per Year (April - November)	0.7	73.5
	Irrigation Operation and Maintenance Inspection	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Spot Watering	35 Times Annually	0.3	10.5
	Leaf and Debris Removal (Per Acre)	22 Times Annually	0.5	11.0
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0

General Course Maintenance
(18 Hole Course)

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Twice Daily, 428 Times per Year, (April - October)	1.5	642.0
		Daily, 151 Times per Year (November - March)	1.5	226.5
	Water Coolers - Clean, Fill and Place (Per 5 Coolers)	Daily, 214 times per Year (April - October)	1.0	214.0
	Irrigation Programing	Daily, 245 Times per Year (March - November)	0.5	122.5
	Mowing (Per 1,000 Square Feet)	Twice Weekly, 70 Mowings per Year	0.2	14.0
	General Irrigation Leak Repairs	10 Repairs Annually	2.5	25.0
	Irrigation Pump Service	6 Times Annually	0.3	1.8
	Irrigation System Spring Start-Up and Winterization (18 Hole Course)	Twice Annually	8.0	16.0

Greens

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.1	36.5
	Cut Holes	Daily, 225 Times per Year	0.1	22.5
	Mow with Tri Plex Reel Mower (Per 6,000 Square Feet)	Daily, 210 Mowings per Year	0.3	63.0
	Mow with Walk Behind Reel Mower (Per 6,000 Square Feet)	Daily, 210 Mowings per Year	0.4	84.0
	Irrigation Operation and Maintenance Inspection (Per Green)	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Spot Watering (Per Green)	70 Times Annually	0.3	21.0
	Leaf and Debris Removal (Per 6,000 Square Feet)	34 Times per Year	0.2	6.8
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0

Power and Pull Carts

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Power Carts	Clean, Charge, Safety and Maintenance Inspection	Daily	0.2	73.0
Pull Carts	Safety and Maintenance Inspection (Per 20 Carts)	Daily	0.1	36.5
	Service and Repair As Necessary (Per Cart)	Monthly	0.1	1.2

Putting Greens

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.1	36.5
	Cut Holes	Daily, 275 Times per Year	0.1	27.5
	Mow with Tri Plex Reel Mower (Per 6,000 Square Feet)	Daily, 210 Mowings per Year	0.3	63.0
	Mow with Walk Behind Reel Mower (Per 6,000 Square Feet)	Daily, 210 Mowings per Year	0.4	84.0
	Irrigation Operation and Maintenance Inspection	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Spot Watering	70 Times Annually	0.3	21.0
	Leaf and Debris Removal (Per 6,000 Square Feet)	4 Times per Year	0.2	0.8
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0

Roughs

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Mowing (Per Acre)	Mow with 3-Gang Pull Behind	Twice Weekly, 70 Mowings per Year	1.2	84.0
	Mow with 5-Gang Pull Behind	Twice Weekly, 70 Mowings per Year	0.6	42.0
	Mow with 7-Gang Pull Behind	Twice Weekly, 70 Mowings per Year	0.4	28.0
	Mow with 72" Outfront Mower	Twice Weekly, 70 Mowings per Year	2.0	140.0
	Mow with 32" Walk Behind	Twice Weekly, 70 Mowings per Year	4.2	294.0
	Mow with 10' Outfront Mower	Twice Weekly, 70 Mowings per Year	0.5	35.0
	Roughs with Zero turn 48" to 72"	Twice Weekly, 70 Mowings per Year	1.8	126.0

Sand Traps

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per 5, 000 Square Feet)	Rake	Every Other Day, 138 Days per Year (March - Novemer)	0.2	27.6
		Weekly, 13 Times per Year (December - February)	0.2	2.6
	Edge	3 Times Annually	1.0	3.0
	Weed Control	3 Times Annually	0.2	0.6
	Fill and Level	2 Times Annually	0.5	1.0

Tees

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.1	36.5
	Move Tee Markers	Daily, 225 Times per Year	0.1	22.5
	Mow with Tri Plex Reel Mower (Per 6,000 Square Feet)	3 Times Weekly, 105 Mowings per Year	0.3	31.5
	Irrigation Operation and Maintenance Inspection	Weekly, 35 Times per Year (March - November)	0.1	3.5
	Spot Watering	70 Times Annually	0.3	21.0
	Leaf and Debris Removal (Per 6,000 Square Feet)	4 Times per Year	0.2	0.8
	Irrigation Head Repair	Annually	1.0	1.0
	Valve Repair	Annually	1.0	1.0

Turf Maintenance

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Aeration (Per 6,000 Square Feet)	Greens - Solid Tines	4 Times Annually	0.7	2.8
	Tees - Solid Tines	4 Times Annually	0.7	2.8
	Greens - Core Tines with Cores Pick	Annually	1.4	1.4
	Tees - Core Tines with Cores Picked Up	Annually	1.4	1.4
	Tees - Core Tines with Cores Dragged In	Annually	1.2	1.2
Aeration (Per Acre)	Fairways - Solid Tines	Twice Annually	1.2	2.4
	Roughs - Solid Tines	Twice Annually	1.0	2.0
	Fairways - Core Tines with Cores Dragged In	Annually	1.6	1.6
Fertilizer	Granular Application with Lily Spreader (Per Acre)	4 Times Annually	0.3	1.2
Liquid Application - Any Product	Liquid Application with 100 Gallon Spray Tank (Per 6,000 Square Feet)	3 Times Annually	0.1	0.3
	Liquid Application with 200 Gallon Spray Tank (Per Acre)	3 Times Annually	0.3	0.9
	Preperation and Loading Spray Tanks	6 Times Annually	0.3	1.8
	Calibrating Spray Tank	6 Times Annually	0.3	1.8

Turf Maintenance

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Pesticide	Granular Application with Lily Spreader (Per Acre)	2 Times Annually	0.3	0.6
Seeding	Power Seeding Greens (Per 6,000 Square Feet)	Annually	0.7	0.7
	Power Seeding Fairways (Per Acre)	Annually	0.7	0.7
	Broadcast Seeding After Aeration On Greens (Per 6,000 Square Feet)	Annually	0.2	0.2
	Broadcast Seeding After Aeration in Fairway (Per Acre)	Annually	0.2	0.2
Thatch removal per 6000 sqft (Per 6,000 Square Feet)	Greens and Bentgrass Tees with Debris Removal	Annually	1.2	1.2
	All Other Areas Without Debris Removal	Annually	0.7	0.7
Top Dressing (Per 6,000 Square Feet)	Fine Turf Areas with Core Aeration and Brush In	Annually	0.7	0.7
	Light Application On Greens for Speed and Turf Managment	Annually	0.4	0.4
Wetting Agents - Nutrients	Granular Application with Walk Behind Spreader (Per 6,000 Square Feet)	Annually	0.2	0.2

Managed Landscapes

One of the Maintenance Tasks associated with some of the facilities in the Managed Landscapes section is mowing. The Park Authority has established five levels of mowing classifications that are applied to a portion of or all of the mowing areas within a park.

Class A – Formal lawn areas which typically are associated with facilities that are rented for weddings, meetings, or parties. Areas are mowed once every seven days at a height of 2 ½”.

Class B – Parks containing one or more developed facility. Facilities include: staffed facilities not already mowed as a Class “A”, recreation centers, athletic fields, courts, playgrounds, picnic and pavilion areas, amphitheaters, active historical and cultural resource properties, and master planned open play areas. Trail systems that do not directly support a developed facility, or are not within a park with a developed facility, will not be mowed as a Class “B”. Areas are mowed once every 14 days at a height of 2 ½” to 3”.

Class C – (This Class is also addressed in the Trails and Crossings Section) Parks containing areas with established and maintained natural surface trails (i.e. grass, dirt, woodchip), or street frontage developed with a sidewalk or surfaced roadside trail within a residential area, not already being mowed as part of a Class “A” or “B” site. Areas are mowed once every 28 days at a height of 2 ½” to 3”.

Class D – (This Class is addressed in the Trails and Crossings Section) Parks containing areas with surfaced trails (i.e. concrete, stone dust, gravel, asphalt), that are not already being mowed as part of a Class “A”, “B”, or “C” site. If there is street frontage with a sidewalk or surfaced roadside trail that connects to a Park Authority maintained trail and is adjoining a commercial or industrial area, then the street frontage should be mowed along with the trail. These trails are typically within a stream valley or a park without any developed facilities. Areas are mowed 3 times per year at a height of 3” to 4”.

Class E – Parks containing areas that are designated for meadow management, stormwater features where woody plants are undesirable, or planned for future development. It may be necessary to remove any large diameter trees and bushes prior to mowing. Areas are mowed once every 1 to 2 years at a height of 3” to 4”.

Much of the Park Authority’s mowing is performed with contracted mowing services. Staff performs all specialized mowing such as the mowing of athletic fields and golf courses, the mowing of facilities that require infrequent mowing like trails and meadows, and the mowing of parks where contracted mowing services have not yet been established.

Gardens and Landscape Beds

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Landscape Beds	Weeding	Monthly, 8 Times per Year (April - November)	0.5	4
(Per 1,000 Square Feet of Bed)				
	Integrated Pest Management	Monthly, 8 Times per Year (April - November)	0.2	1.6
	Pruning	4 Times Annually	0.5	2
	Mulching	Twice Annually	1	2
	Planting of Annuals	Annually	4	4
Public Plots	Remove Ground Trash and Empty Receptacles	Weekly	0.5	26.0
	Safety and Maintenance Inspection	Twice Annually	0.5	1.0
	Debris Removal	Annually	4.6	4.6
	Maintain Roadways	Annually	3.0	3

General Grounds

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per Acre)	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
		Weekly, 13 Times per Year (December - February)	0.1	1.3
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Ground Repairs	Every 2 Years	2.0	1.0
Mowing - Class A (Per Acre)	Bulk and Trim Mowing - By Staff	Weekly, 32 Times per Year (April - Mid-November)	1.6	51.2
	Contracted Mowing - Staff Site Inspections	Weekly, 32 Times per Year (April - Mid-November)	0.3	9.6
Mowing - Class B (Per Acre)	Bulk and Trim Mowing - By Staff	Every 14 Days, 16 Times per Year (April - Mid-November)	1.3	20.8
	Contracted Mowing - Staff Site Inspections	Every 14 Days, 16 Times per Year (April - Mid-November)	0.3	4.8
Mowing - Class C (Per Acre)	Bulk and Trim Mowing - By Staff	Monthly (Every 28 Days), 9 Times per Year (April - Mid-November)	1.2	10.8
	Contracted Mowing - Staff Site Inspections	Monthly (Every 28 Days), 9 Times per Year (April - Mid-November)	0.3	2.7

Meadows and Fields

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All (Per Acre)	Remove Ground Trash	Monthly	0.3	3.6
Mowing - Class E (Per Acre)	Bulk Mowing - By Staff	Annually	2.6	2.6

Operating Equipment

Staff members using equipment or performing maintenance or repairs on equipment should always follow the instructions and guidelines from the Operators Manual provided with each piece of equipment.

The Park Authority's vehicles and trailers are maintained and repaired by the Fairfax County's Department of Vehicle Services and are therefore not covered within the Park Authority's Maintenance Standards.

Large Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Front End Loaders	Cleaning and Safety Inspection	Daily (Typically 50 Times per Year)	0.5	25.0
	Routine Preventive Maintenance	Twice Annually	4.0	8.0
	Repairs	Annually	2.0	2.0
Heavy Construction (Grader, Roller, Asphalt Spreader, Chipper, Skid Steer, Dozer)	Cleaning and Safety Inspection	Daily (Typically 50 Times per Year)	0.5	25.0
	Routine Preventive Maintenance	Twice Annually	8.0	16.0
	Repairs	Annually	2.0	2.0
Infield Conditioners	Cleaning and Safety Inspection	Daily (Typically 105 Times per Year)	0.5	52.5
	Routine Preventive Maintenance	3 Times Annually	2.0	6.0
	Repairs	Annually	2.0	2.0
Off-Road Utility Vehicles	Cleaning and Safety Inspection	Daily (Typically 120 Times per Year)	0.5	60.0
	Routine Preventive Maintenance	Twice Annually	4.0	8.0
	Repairs	Annually	2.0	2.0

Large Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Outfront Mowers 6' and Below	Cleaning and Safety Inspection	Daily (Typically 105 Times per Year)	0.5	52.5
	Blade Sharpening	Weekly, 35 Times per Year	1.0	35.0
	Routine Preventive Maintenance	Twice Annually	4.0	8.0
	Repairs	Annually	2.0	2.0
Outfront Mowers 10' and Above	Cleaning and Safety Inspection	Daily (Typically 120 Times per Year)	0.5	60.0
	Blade Sharpening	Weekly, 35 Times per Year	1.0	35.0
	Routine Preventive Maintenance	Twice Annually	6.0	12.0
	Repairs	Annually	2.0	2.0
Reel Mowers	Cleaning and Safety Inspection	Daily (Typically 230 Times per Year)	0.5	115.0
	Blade Sharpening	Quarterly	5.0	20.0
	Routine Preventive Maintenance	Twice Annually	2.0	4.0
	Repairs	Annually	2.0	2.0
	Rebuild Reel Units	Annually	4.0	4.0

Large Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Tractors	Cleaning and Safety Inspection	Daily (Typically 30 Times per Year)	0.5	15.0
	Routine Preventive Maintenance	Twice Annually	4.0	8.0
	Repairs	Annually	2.0	2.0
Walkbehind Mowers	Cleaning and Safety Inspection	Daily (Typically 105 Times per Year)	0.5	52.5
	Blade Sharpening	Weekly, 35 Times per Year	1.0	35.0
	Routine Preventive Maintenance	3 Times Annually	2.0	6.0
	Repairs	Annually	2.0	2.0
Ice Resurfacer	Cleaning and Safety Inspection	Daily	0.5	182.5
	Routine Preventive Maintenance	3 Times Annually	2.0	6.0
	Repairs	Annually	4.0	4.0

Small Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Blowers	Cleaning and Safety Inspection	Daily (Typically 40 Times per Year)	0.2	8.0
	Routine Preventive Maintenance	Annually	1.0	1.0
	Repairs	Annually	2.0	1.0
Chainsaw	Cleaning, Sharpening and Adjusting	Daily (Typically 60 Times per Year)	1.5	90.0
	Replacing Chain	Monthly	0.3	3.6
	Replacing Chain Bar	3 Times Annually	0.3	0.9
	Repairs	Annually	2	2.0
Edger	Cleaning and Safety Inspection	Daily (Typically 10 Times per Year)	0.2	2.0
	Routine Preventive Maintenance	Annually	1.5	1.5
	Repairs	Annually	2.0	1.0
Generators	Cleaning and Safety Inspection	Daily (Typically 20 Times per Year)	0.2	4.0
	Routine Preventive Maintenance	Annually	1.0	1.0
	Repairs	Every 2 Years	2.0	1.0

Small Engine Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Hedge Trimmers	Cleaning and Safety Inspection	Daily (Typically 20 Times per Year)	0.2	4.0
	Routine Preventive Maintenance	Annually	1.5	1.5
	Repairs	Every 2 Years	2.0	1.0
Pole Saw	Cleaning and Safety Inspection	Daily (Typically 20 Times per Year)	0.2	4.0
	Routine Preventive Maintenance	Annually	2.5	2.5
	Repairs	Every 2 Years	2.0	1.0
Sod Cutter	Cleaning and Safety Inspection	Daily (Typically 10 Times per Year)	0.2	2.0
	Routine Preventive Maintenance	Annually	1.5	1.5
	Repairs	Every 2 Years	2.0	1.0
String Trimmers	Cleaning and Safety Inspection	Daily (Typically 105 Times per Year)	0.2	21.0
	Routine Preventive Maintenance	Annually	2.0	2.0
	Repairs	Every 2 Years	2.0	1.0

Other Park Features

Amphitheaters

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Mason District Park	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
		Weekly, 13 Times per Year (December - February)	0.1	1.3
	Safety and Maintenance Inspection	Weekly, 39 Times per Year (March - November)	0.2	7.8
		Monthly, 3 Times per Year (December - February)	0.2	0.6
	Painting and Miscellaneous Repairs	Annually	8	8.0
	Replenish Surfacing	Annually	6	6.0
All Others	Remove Ground Trash and Empty Receptacles	Twice Weekly, 26 Times per Year (June - August)	0.1	2.6
		Weekly, 39 Times per Year (September - May)	0.1	3.9
	Safety and Maintenance Inspection	Weekly, 39 Times per Year (March - November)	0.2	7.8
		Monthly, 3 Times per Year (December - February)	0.2	0.6
	Painting and Miscellaneous Repairs	Annually	8	8.0
	Replenish Surfacing	Annually	6	6.0

Campgrounds

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	1.5	547.5
	Remove Ground Trash, Empty Receptacles, and Clean Bathhouse	Daily, 7 Days per Week, 252 Days per Year (March - November)	7.0	1764.0
		Daily, 5 Days per Week, 60 Days per Year (December - April)	3.0	180.0
	Debris Removal, Cleaning of Grills, and Repairs as Needed	Weekly, 36 Times per Year (March - November)	8	288
		Monthly (December - February)	4	12
	Mowing	Weekly (April - November)	33	1056.0
	Snow and Ice Removal	Average of 3 Events Annually	8	24
	Leaf Removal and Gutter Cleaning	Annually	180	180.0
	Prepping and Painting Grills	Annually	66	66
	Painting and Repairing Picnic Tables	Annually	205	205
	Raking Sites and Repairing Roads	Weekly, 31 Times per Year (May - November)	6	186

Carousels

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily, 214 Times per Year (April - October)	0.2	42.8
		Monthly, 5 Times per Year (November - March)	0.2	1.0
	Remove Ground Trash and Empty Receptacles	Daily, 214 Times per Year (April - October)	0.5	107.0
		Monthly, 5 Times per Year (November - March)	0.2	1.0
	Preventive Maintenance (Cleaning, greasing, oiling)	Monthly, 7 Times Per Year (April - October)	2.0	14.0
	Teardown and Assembly - Burke Lake	Twice Annually	48.0	96.0
	- Other Parks	Twice Annually	16.0	32.0
	Painting and Miscellaneous Repairs	Annually	6.0	6.0

Fitness Courses

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Station	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Replenish Surfacing	Every 2 Years	1	0.5
	Painting and Miscellaneous Repairs	Every 2 Years	2.0	1.0

Frisbee Golf Courses

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Station	Remove Ground Trash and Empty Receptacles	Weekly	0.10	5.20
	Safety and Maintenance Inspection	4 Times Annually	0.10	0.40
	Mowing	Monthly, 8 Times per Year (April - November)	1.00	8.00
	Pruning - Trees and Shrubs	Annually	1.50	1.50
	Repairs	Every 2 Years	1.00	0.50

Marinas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Lake	Remove Trash from Shoreline	Weekly, 21 Times per Year (May - September)	12.0	252.0
	Storm Clean-up	Average of 3 Events Annually	16.0	48.0
Launch Area	Safety and Maintenance Inspection	Daily, 214 Times per Year (April - October)	0.2	42.8
		Weekly, 21 Times per Year (November - March)	0.2	4.2
	Remove Ground Trash and Empty Receptacles	Daily, 214 Times per Year (April - October)	0.2	42.8
		Weekly, 21 Times per Year (November - March)	0.2	4.2
	Miscellaneous Repairs	Annually	2.0	2.0
Paddle Boats	Safety and Maintenance Inspection	Per Use, 4,200 Inspections per Year	0.1	420.0
	Miscellaneous Repairs (Per 10 Boats)	Annually (As Needed)	2.0	2.0
Row Boats	Safety and Maintenance Inspection	Per Use, 5,600 Inspections per Year	0.1	560.0
	Miscellaneous Repairs (Per 10 Boats)	Annually (As Needed)	1.0	1.0

Marinas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Canoes	Safety and Maintenance Inspection	Per Use, 1,650 Inspections per Year	0.1	165.0
	Miscellaneous Repairs (Per 10 Boats)	Annually (As Needed)	1.0	1.0
Row Boats W/Trolling Motor	Safety and Maintenance Inspection	Per Use, 1,040 Inspections per Year	0.1	104.0
	Battery Inspection and Charge	Per Use, 1,040 Inspections per Year	0.1	104.0
	Motor Repair	Annually, 150 Repairs per Year	0.5	75.0

Miniature Golf Courses

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily, 130 Times per Year (May - October)	1.0	130.0
	Remove Ground Trash and Empty Receptacles	Daily, 130 Times per Year (May - October)	0.2	26.0
	Blowing Off All Surfaces	Daily, 130 Times per Year (May - October)	0.5	65.0
	Mowing	Every 10 Days, 22 Times per Year (April - November)	3.0	66.0
	Pruning of Shrubs	Twice Annually	8.0	16.0
	Winterize and Start-Up Water Features	Twice Annually	15.0	30.0
	Miscellaneous Hole Repairs	Annually	36.0	36.0
	Painting and Repairing of Benches	Every 2 Years	1.0	0.5
	Painting and Repairing of Bridges	Every 2 Years	2.0	1.0

Off-Leash Dog Areas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
		Weekly, 13 Times per Year (December - February)	0.1	1.3
	Mowing (not needed at all facilities)	Every 2 Weeks, 16 Times per Year (April - November)	1	16.0
	Safety and Maintenance Inspection	4 Times Annually	0.3	1.2
	Surface Grooming	Twice Annually	6	12.0
	Fencing Repairs	Annually	3	3.0

Outdoor Restrooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Restrooms - Open Year Round	Safety and Maintenance Inspection	Twice Weekly	0.1	10.4
	Remove Ground Trash and Empty Receptacles	Twice Weekly	0.1	10.4
	Restock Toilet Paper	Twice Weekly	0.1	10.4
	Sweep and Wet Mop Floor	Twice Weekly	0.30	31.20
	Wipe Down Mirrors	Twice Weekly	0.10	10.40
	Clean Sinks With a Germicidal Detergent	Twice Weekly	0.10	10.40
	Clean Toilets and Urinals With a Germicidal Detergent	Twice Weekly	0.20	20.80
	Clean Partitions, Toilet Paper Disensors, Sanitary Napkin Boxes, and Hand Dryers With a Germicidal Detergent	Weekly	0.60	31.20

Outdoor Restrooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Restrooms - Open Spring thru Fall	Safety and Maintenance Inspection	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
	Restock Toilet Paper	Twice Weekly, 78 Times per Year (March - November)	0.1	7.8
	Sweep and Wet Mop Floor	Twice Weekly, 78 Times per Year (March - November)	0.30	23.40
	Wipe Down Mirrors	Twice Weekly, 78 Times per	0.10	7.80
	Clean Sinks With a Germicidal Detergent	Twice Weekly, 78 Times per Year (March - November)	0.10	7.80
	Clean Toilets and Urinals With a Germicidal Detergent	Twice Weekly, 78 Times per Year (March - November)	0.20	15.60
	Clean Partitions, Toilet Paper Disensors, Sanitary Napkin Boxes, and Hand Dryers With a Germicidal Detergent	Weekly, 39 Times per Year (March - November)	0.60	23.40

Outdoor Swimming Pools

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Inspect Diving Board	Daily, 90 Times per Year (May - September)	0.1	9.0
	Inspect Drain Covers, Gutters, Grates, and Skimmers	Daily, 90 Times per Year (May - September)	0.5	45.0
	Inspect Chemical Controller, Dispensor, and Feeders	Daily, 90 Times per Year (May - September)	0.4	36.0
	Inspect Ladders, Rails, Escutcheon Plates	Daily, 90 Times per Year (May - September)	0.1	9.0
	Inspect Racing Lane Dividers	Daily, 90 Times per Year (May - September)	0.1	9.0
	Remove Ground Trash and Empty Receptacles	Daily, 90 Times per Year (May - September)	0.2	18.0
	Safety and Maintenance Inspection	Daily, 90 Times per Year (May - September)	0.5	45.0
	Vacuuming Pool Bottom	4 Times per Week, 52 Times per Year (May - September)	1.5	78.0
	Blow/Hose Off All Surfaces	Twice Weekly, 26 Times per Year (May - September)	0.5	13.0
	Inspect and Service Vacuum	Weekly, 13 Times per Year (May - September)	0.2	2.6

Outdoor Swimming Pools

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Backwashing	Weekly, 13 Times per Year (May - September)	2.5	32.5
	Service Ladders, Rails, Escutcheon Plates	Weekly, 13 Times per Year (May - September)	0.1	1.3
	Shock Pool	Weekly, 13 Times per Year (May - September)	1.0	13.0
	Service Chemical Controller, Dispensor, and Feeders	Monthly, 4 Times per Year (May - September)	1.6	6.4
	Service Diving Board	Monthly, 4 Times per Year (May - September)	0.4	1.6
	Service Drain Covers, Gutters, Grates, and Skimmers	Monthly, 4 Times per Year (May - September)	2.0	8.0
	Service Racing Lane Dividers	Monthly, 4 Times per Year (May - September)	0.5	2.0
	Draining and Cleaning	Annually	108.0	108.0

Picnic Areas and Shelters

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Twice Weekly, 78 Times per Year (March - November)	0.5	39.0
		Weekly, 13 Times per Year (December - February)	0.5	6.5
	Safety and Maintenance Inspection	4 Times Annually	0.5	2.0
	Clean Grills (per Grill)	Twice Annually	0.1	0.2
	Table Painting and Miscellaneous Repairs (per Table)	Annually	1.5	1.5
	Replace Grill	Every 10 Years	2.4	0.2
	Replace Table	Every 10 Years	2	0.2
Picnic Areas (Per 10 Tables)	Replenish Wood Chips	Every 3 Years	4.0	1.3
Shelters	Blow Off Concrete Pad	Monthly	0.5	6.0
	Painting and Miscellaneous Repairs	Every 10 Years	60.0	6.0

Playgrounds

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	Weekly	0.2	10.4
	Comprehensive Safety Inspection	4 Times Annually	2	8.0
	Repairs	Annually	3	3.0
Engineered Wood Fiber Surface	Replenish Engineered Wood Fiber	Every 3 Years	12	4.0
	Renovate and Replace Surfacing	Every 10 years	160.0	16.0
Rubber Surface	Blow Off All Surfaces and Debris Removal	Weekly	1.0	52.0
	Repairs (Per 1,000 square feet of surface) (Contracted Service)	Every 5 Years	1.0	0.2

Skate Parks

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Daily	0.5	182.5
	Remove Ground Trash and Empty Receptacles	Daily	0.2	73.0
	Blow Off All Surfaces	Twice Weekly	0.5	52.0
Sales Booth	Clean all interior surfaces	Daily	0.3	109.5
	Wipe exterior surfaces	Monthly	0.5	6.0
	Sand interior wood surfaces	Anually	2.0	2.0
Seating Area	Rinse Off	Daily, 120 Times per Year (May - September)	0.2	24.0
Ramps	Repair Broken or Cracked Skatelite (one sheet)	4 Times Annually	2.0	8.0

Trains

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Engine and Cars	Safety and Maintenance Inspection	Daily, 180 Times per Year (April - September)	0.5	90.0
	Train Cleaning	Twice Monthly, 12 Times per Year (April - September)	4.0	48.0
	Engine Maintenance	Twice Annually	8.0	16.0
	Winterize	Annually	4.0	4.0
	Painting and Miscellaneous Repairs	Annually	10.0	10.0
Track	Track & Switches - Safety and Maintenance Inspection	Daily, 180 Times per Year (April - September)	0.5	90.0
	Track Ties - Safety and Maintenance Inspection	Monthly, 6 Times per Year (April - September)	2.0	12.0
	Tie replacment	60 Replacements Annually	0.3	18.0
	Miscellaneous Repairs	Annually	8	8.0

Water Parks

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Twice Daily, 90 Days per Year (May - September)	1.0	180.0
	Inspect Chemical Controller, Dispensor, and Feeders	Daily, 90 Times per Year (May - September)	0.4	36.0
	Inspect Drain Covers, Gutters, Grates, and Skimmers	Daily, 90 Times per Year (May - September)	0.5	45.0
	Inspect Ladders, Rails, Escutcheon Plates	Daily, 90 Times per Year (May - September)	0.1	9.0
	Safety and Maintenance Inspection	Daily, 90 Times per Year (May - September)	0.5	45.0
	Vacuuming Pool Bottom	4 Times per Week, 52 Times per Year (May - September)	1.5	78.0
	Blow/Hose Off All Surfaces	Twice Weekly, 26 Times per Year (May - September)	0.5	13.0
	Mowing	Every 10 Days, 22 Mowings per Year (April - November)	12	264.0
	Backwashing	Weekly, 13 Times per Year (May - September)	2.5	32.5
	Clean Grills	Weekly, 13 Times per Year (May - September)	0.5	6.5
	Inspect and Service Vacuum	Weekly, 13 Times per Year (May - September)	0.2	2.6

Water Parks

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Service Ladders, Rails, Escutcheon Plates	Weekly, 13 Times per Year (May - September)	0.1	1.3
	Shock Pool	Weekly, 13 Times per Year (May - September)	1.0	13.0
	Repair Funbrellas and Tents	6 Times per Year (May - September)	6	36.0
	Service Chemical Controller, Dispensor, and Feeders	Monthly, 4 Times per Year (May - September)	1.6	6.4
	Service Drain Covers, Gutters, Grates, and Skimmers	Monthly, 4 Times per Year (May - September)	2.0	8.0
	Weeding Planter Beds and Fencelines	3 Times per Year (May - September)	4	12.0
	Pump and Plumbing Repairs	Twice Annually	8	16.0
	Draining and Cleaning	Annually	108.0	108.0
	Painting and Repairing Picnic Tables	Annually	27	27.0
	Pre-season Site Clean-up and Preparation	Annually	138	138.0

Outdoor Courts

Basketball

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.2	10.4
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Net Replacement	4 Times Annually	1	4.0
	Removing Court Surface Debris	Twice per Year	0.5	1.0
	Surface Repairs (Contracted Service)	Every 5 Years	1	0.2
	Painting - Backboard and Support Post	Every 10 Years	3	0.3
	Rim Replacement	Every 10 Years	2	0.2
Lighting	Safety and Maintenance Inspection	Weekly, 36 Times per Year (April - November)	0.1	3.6
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	1.5	1.5

Horseshoe

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Repair Pitching Boxes	Twice per Year	8.0	16.0

Shuffleboard

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Restriping	Every 5 Years	4	0.8

Tennis

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Removing Court Surface Debris	Monthly, 6 Times per Year (October - December and March - May)	0.8	4.8
	Fencing Repairs	Annually	4	4.0
	Net Replacement	Annually	1	1.0
	Surface Repairs (Contracted Service)	Every 5 Years	2	0.4
	Restriping and Color-Coating (Contracted Service)	Every 5 Years	2	0.4
	Net Post Replacement	Every 10 Years	4	0.4

Tennis

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Practice	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Removing Court Surface Debris	Monthly, 6 Times per Year (October - December and March - May)	0.8	4.8
	Fencing Repairs	Annually	4	4.0
	Painting and Miscellaneous Wall Repairs	Every 3 Years	6	2.0
	Surface Repairs (Contracted Service)	Every 5 Years	2	0.4
	Restriping and Color-Coating (Contracted Service)	Every 5 Years	1	0.2
Lighting	Safety and Maintenance Inspection	Weekly, 36 Times per Year (April - November)	0.1	3.6
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	1.5	1.5

Volleyball

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Ground Trash and Empty Receptacles	Weekly	0.1	5.2
	Safety and Maintenance Inspection	4 Times Annually	0.1	0.4
	Net Replacement	Annually	1	1
	Replenish Sand	Every 2 Years	6	3
Lighting	Safety and Maintenance Inspection	Weekly, 36 Times per Year (April - November)	0.1	3.6
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	1.5	1.5

RECenters

Fitness Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Cardiovascular	Routine Cleaning - Small Center	Daily	0.50	182.50
	- Medium Center	Daily	1.00	365.00
	- Large Center	Daily	2.00	730.00
	Prevenative Maintenace (small)	Weekly	0.50	26.00
	Prevenative Maintenace (medium)	Weekly	1.00	52.00
	Prevenative Maintenace (large)	Weekly	2.00	104.00
	Repairs - New Equipment	Monthly	1.00	12.00
	- Old Equipment	Monthly	3.00	36.00
Cybex Strength	Routine Cleaning	Daily	1.00	365.00
	Prevenative Maintenace	Weekly	2.00	104.00
	Repairs - New Equipment	Monthly	1.00	12.00
	- Old Equipment	Monthly	3.00	36.00
Fitlinxx	System upkeep & Information updates	Daily	1.00	365.00
	Safety and Maintenance Inspection	Twice Weekly	0.50	52.00
	Repairs	Monthly	0.50	6.00
Free Weights	Routine Cleaning	Weekly	0.50	26.00
	Safety and Maintenance Inspection	Weekly	0.50	26.00
Group Exercise	Safety and Maintenance Inspection	8 Times Annually	0.50	4.00
	Routine Cleaning	4 Times Annually	1.00	4.00
	Equipment/Supplies Replacement	4 Times Annually	2.00	8.00

Fitness Equipment

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Spin Bikes	Routine Cleaning	Daily	0.50	182.50
	Safety and Maintenance Inspection	Weekly	0.50	26.00
	Repairs	Weekly	2.00	104.00
	Deep cleaning	Monthly	2.00	24.00

Fitness Rooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Remove Trash and Empty Receptacles	Twice Daily	0.10	73.00
	Safety and Maintenance Inspection	Daily	0.10	36.50
Audio Equipment	Safety and Maintenance Inspection	Weekly	0.10	5.20
	Equipment/Supplies Replacement	Quarterly	1.00	4.00
Baseboards and Window Ledges	Wipe Down	Weekly	0.30	15.60
Fans	Routine Cleaning	Weekly	2.00	104.00
Fixtures	Routine Maintenance and Cleaning	Monthly	0.50	6.00
Floors	Routine Maintenance and Cleaning	Daily	1.00	365.00
	Deep Cleaning (mop)	Weekly	1.50	18.00
Windows and Mirrors	Routine Maintenance and Cleaning	Weekly	0.50	26.00
Stretching Area	Routine Cleaning	Weekly	0.50	26.00
	Safety and Maintenance Inspection	Weekly	0.50	26.00
	Equipment Replacement	Bi-Annually	2.00	4.00

Gyms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.3	1642.5
	Remove Trash and Empty Receptacles	Twice Daily	0.3	219.0
	Sweep with Large Push Broom (Per 1,000 Square Feet)	Daily	0.5	182.5
	Floor Maintainer (Floor Scrub Machine, Lee District Only)	Weekly	1.50	78.00
	Mop (Per 1,000 Square Feet)	Weekly	0.50	26.00
	Net Replacement	Twice Annually	1	2.0
	Stripping Wax Floor with Separate Wet Pick-up (Per 1,000 Square Feet)	Twice Annually	1.25	2.50
	Wax (Per 1,000 Square Feet)	Twice Annually	1.00	2.00
	Miscellaneous Repairs	Annually	5.00	5.00
	Rim Replacement	Every 2 Years	2	1.0
Bleachers	Safety and Maintenance Inspection	Daily	0.3	109.5
	Sweep and Clean	Daily	1.0	365.0
	Miscellaneous Repairs	Annually	10.0	10.0

Ice Skating Arenas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Bench Areas (Warming Room)	Sweep, Mop and Clean	Daily	1.00	365.00
	Sweep, Mop and Clean All Restrooms	Daily	0.40	146.00
Bleachers and Benches	Sweep and Clean	Daily	0.20	73.00
Hallway Between Team Rooms	Sweep and Mop Floor	Daily	0.20	73.00
Ice Rink	Remove Trash and Empty Receptacles	Twice Daily	0.50	365.00
	Safety and Maintenance Inspection	Daily	0.10	36.50
	Sweep and Mop Floor	Daily	0.20	73.00
	Clean and Wipe Down Boards	Weekly	0.50	26.00
	Miscellaneous Repairs	Monthly	1.00	12.00
	Annual Shutdown	Annually	630.00	630.00
Team Rooms	Remove Trash and Empty Receptacles	Daily	0.30	109.50
	Safety and Maintenance Inspection	Daily	0.10	36.50
	Swept and Mopped	Daily	0.20	73.00
	Wipe Down and Disinfect Mirrors and Shelves	Daily	0.10	36.50
	Wipe Down Baseboards and Window Ledges	Weekly	0.50	26.00

Locker Rooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.10	547.50
	Remove Trash and Empty Receptacles	Twice Daily	0.10	73.00
Benches	Clean and Disinfect (per bench)	Daily	0.10	36.50
Floors	Sweep Disenfect and Squeegee	Daily	0.30	109.50
	Scrub with Floor Machine and Squeegee (Per 1,000 Square Feet)	Monthly	0.50	6.00
Lockers	Dust Tops of Lockers	Weekly	0.20	10.40
Mirrors	Wipe Down	Daily	0.20	73.00
Partitions	Clean Fixtures With a Germicidal Detergent	Weekly	0.50	26.00
Sanitary Napkin Box	Clean Fixtures With a Germicidal Detergent	Weekly	0.25	13.00
Toilets and Urinals	Clean Fixtures With a Germicidal Detergent (Per Toilet/Urinal)	Daily	0.05	18.25

Natatoriums

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Airshutes and Slides	Safety and Maintenance Inspection	Twice Weekly	0.1	10.4
	Service and Repairs	Every 2 Months	1.0	6.0
Bleachers	Sweep and Clean	Daily	0.5	182.5
	Safety and Maintenance Inspection	Weekly	0.3	15.6
	Miscellaneous Repairs - Wood	Every 2 Years	8.0	4.0
	- Metal	Every 2 Years	2.0	1.0
Filter and Storage Rooms, and Lifeguard Office	Cleaninng and Organizing	Weekly	1.0	52.0
Guard Chairs	Inspect	Daily	0.2	73.0
	Service and Cleaning	Annually	12.0	12.0
Life Saving and Safety Equipment	Inspection	Daily	0.4	146.0
	Service	Monthly	1.0	12.0

Natatoriums

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Pools	Pool Chemical Readings	Every 2 Hours	0.1	365.0
	Hose Off All Surfaces			
	- 50 Meter Pool Tiled	Daily	1.0	365.0
	- 25 Meter Pool Tiled	Daily	0.5	182.5
	- 50 Meter Pool Cement	Daily	0.7	255.5
	Inspect Chemical Controller, Dispensor, and Feeders	Daily	0.2	73.0
	Inspect Deck Vacuum	Daily	0.1	36.5
	Inspect Diving Board	Daily	0.1	36.5
	Inspect Drain Covers, Gutters, Grates, and Skimmers - 50 Meter Pool	Daily	0.2	73.0
	- 25 Meter Pool	Daily	0.1	36.5
	Inspect Ladders, Rails, Escutcheon Plates	Daily	0.4	146.0
	Inspect Racing Lane Dividers			
	- 50 Meter Pool	Daily	0.2	73.0
	- 25 Meter Pool	Daily	0.1	36.5
	Inspect Submersible Vacuum	Daily	0.2	73.0
	Inspect Underwater Lights	Daily	0.1	36.5
	Remove Trash and Empty Receptacles	Daily	0.2	73.0

Natatoriums

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Pools	Safety and Maintenance Inspection	Daily	0.1	36.5
	Scum Line Cleaning - 50 Meter Pool	Daily	0.7	255.5
	- 25 Meter Pool	Daily	0.4	146.0
	Vacuuming Pool Bottom - 50 Meter Pool	Daily	1.5	547.5
	- 25 Meter Pool	Daily	1.0	365.0
	Slot Drains Cleaning	Daily	0.2	73.0
	Backwashing - DE	Weekly	2.5	130.0
	- High Rate Sand	Monthly	1.0	12.0
	Service and Clean Ladders, Rails, Escutcheon Plates	Weekly	1.0	52.0
	Service Chemical Controller, Dispensor, and Feeders	Weekly	1.0	52.0
	Service Underwater Lights	Weekly	1.0	52.0
	Cleaning of the Deck Caulking	Monthly	0.7	8.4
	Service Diving Board	Monthly	1.0	12.0
	Shock Pool (Pools without UV)	Monthly	2.0	24.0
	UV Lighting System Inspection and Cleanin	Monthly	0.2	2.4
	Service Racing Lane Dividers			
	- 50 Meter Pool	Annually	16.0	16.0
	- 25 Meter Pool	Annually	10.0	10.0

Natatoriums

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Pools	Service Deck Vacuum	Every 2 Years	1.0	0.5
	Service Drain Covers, Gutters, Grates, and Skimmers - 50 Meter Pool	Every 2 Years	5.0	2.5
	- 25 Meter Pool	Every 2 Years	2.0	1.0
	Service Submersible Vacuum	Every 2 Years	2.0	1.0
Whirlpool / Spas	Spa Chemical Readings	Hourly	0.1	547.5
	Inspect Chemical Controller, Dispensor, and Feeders	Daily	0.1	36.5
	Inspect Ladders, Rails, Escutcheon Plates	Daily	0.1	36.5
	Scum Line Cleaning	Daily	0.3	109.5
	Spa Cover - Covering, Uncovering and Storing	Daily	0.3	109.5
	Drain, Clean and Refill	Weekly	0.5	26.0
	Service and Clean Ladders, Rails, Escutcheon Plates	Weekly	0.5	26.0
	Service Chemical Controller, Dispensor, and Feeders	Weekly	0.5	26.0
	Service Drain Covers, Gutters, Grates, and Skimmers	Monthly	0.5	6.0
	Spa Cover Cleaning	Monthly	0.5	6.0

Offices, Lobbies, Halls, Miscellaneous Rooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.10	547.50
	Remove Trash and Empty Receptacles	Twice Daily	0.10	73.00
Baseboards	Wipe Down (Per 50 Feet)	Weekly	0.30	15.60
Carpet	Vacuuming- (Per 3,000 Square Feet)	Daily	1.00	365.00
	Spot/Stains Removal	Weekly	0.50	26.00
	Bonnet Buffing (Per 500 Square Feet)	Monthly	1.00	12.00
	Carpet Extraction (Per 500 Square Feet)	Twice Annually	0.50	1.00
Dust	Furniture and Equipment	Weekly	0.50	26.00
Return Vents	Clean Vents with Broom or Vacuum with Attachement	Weekly	0.10	5.20
Trash Receptacles	Wash Interior and Exterior	Monthly	0.10	1.20
Vinyl or Tile Floors	Mop (Per 1,000 Square Feet)	Daily	0.50	182.50
	Sweep (Per 1,000 Square Feet)	Daily	0.30	109.50
	Stripping Wax Floors with Separate Wet Pick-Up (Per 1,000 Square Feet)	Twice Annually	1.30	2.60
	Wax (Per 1,000 Square Feet)	Twice Annually	1.00	2.00
Walls	Cleaning (Per 300 Square Feet)	Monthly	1.00	12.00
Windows/Mirrors/Ledges	Cleaning (Per 100 Square Feet)	Daily	0.20	73.00

Restrooms

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.10	547.50
	Remove Trash and Empty Receptacles	Twice Daily	0.10	73.00
Baseboards	Wipe Down (Per 50 Feet)	Weekly	0.30	15.60
Floors	Sweep and Wet Mop (Per Restroom)	Daily	0.30	109.50
	Scrub with Floor Machine and Squeegee (Per 1,000 Square Feet)	4 Times Annually	0.50	2.00
Mirrors	Wipe Down	Daily	0.20	73.00
Partitions	Clean Fixtures With a Germicidal Detergent	Weekly	0.50	26.00
Sanitary Napkin Box	Clean Fixtures With a Germicidal Detergent	Weekly	0.30	15.60
Sinks	Clean Fixtures With a Germicidal Detergent	Daily	0.10	36.50
Toilets and Urinals	Clean Fixtures With a Germicidal Detergent	Daily	0.20	73.00

Saunas

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Hourly	0.10	547.50
	Cleaned and Disenfected	Daily	0.30	109.50

Trails and Crossings

Bridges and Crossings

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All	Safety and Maintenance Inspection	Monthly	0.3	3.6
Bridges	Miscellaneous Repairs	Every 2 Years	8.0	4.0
Low Water Crossings	General Maintenance and Cleaning	3 Times Annually	2.0	6.0

Trails

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
All Trails	Safety and Maintenance Inspection (Per 1,000 linear feet of trail)	Monthly	0.1	1.2
	Tree and Brush Pruning (Per 1,000 linear feet of trail)	Annually	2.0	2.0
	Snow and Ice Removal - Performed on select trails only. (Per 1,000 linear feet of trail)	Average of 3 Events Annually	1.0	3.0
	Leaf and Debris Removal (Per 1,000 linear feet of trail)	Annually	0.3	0.3
	Cleaning and Repair of Culvert Pipes (Per Pipe)	Annually	0.5	0.5
All Surfaced Trails (Asphalt, Concrete, Gravel, Wood Chip)	Mowing of Grass Along Trail - Class D (Per 1,000 linear feet of trail)	3 Mowings Annually (Spring, Summer, Fall)	0.5	1.5
Asphalt (Average 8' wide - 2,500' long)	Patch and Repair Holes (Average of 4 square feet per repair.)	Every 3 Years	1.5	0.5
	Repair Small Section (Average of 32 square feet per repair.)	Every 10 Years	4.5	0.5
	Repair Large Section (Average of 400 square feet per repair.)	Every 15 Years	8.0	0.6

Trails

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Concrete (Average 4' wide - 5,000' long)	Repair Small Section (Average of 18 square feet per repair.) (Contracted Service)	Every 10 Years	1.0	0.1
	Repair Large Section (Average of 240 square feet per repair.) (Contracted Service)	Every 20 Years	1.0	0.1
Gravel (Average 8' wide - 1,000' long)	Repair Small Section (Average of 32 square feet per repair.)	Annually	2.0	2.0
	Resurfacing Resurfacing of top 1"	Every 10 Years	6.0	0.6
Natural (Average 6' wide - 500' long)	Mowing - Class C (Per 500 linear feet of trail)	Monthly (Every 28 Days), 9 Times per Year (April - November)	0.2	1.8
	Repair Small Section (Average of 36 square feet per repair.)	Annually	2.0	2.0
	Resurfacing Resurfacing of top 1" or more	Every 5 Years	3.0	0.6
Trail Lighting	Safety and Maintenance Inspection	Weekly, 36 Times per Year (April - November)	0.1	3.6
	Lamp Replacment and Other Repairs (Contracted Service)	Annually	2	2.0

Trails

Description	Maintenance Task	Frequency	Labor Hours per Recurrence	Total Annual Labor Hours
Wood Chip (Average 8' wide - 500' long)	Repair Small Section (Average of 64 square feet per repair.)	Annually	1.0	1.0
	Resurfacing Resurfacing of top 1" or more	Every 7 Years	2.0	0.3

Summary

While it is important to identify the individual Maintenance Tasks associated with various facilities, it is also beneficial to summarize the tasks for each facility. The Summary section was developed to provide a quick reference guide showing the total annual labor requirements to maintain each facility.

Facility Type	Total Annual Labor Hours
Amenities	
Bench - Metal	0.5
Bench - Recycled	0.5
Bench - Wood	1.1
Bollard - Metal	0.8
Bollard - Removable	0.8
Fencing and Railing (Per 100')	1.4
Gates	0.9
Guardrail and Barricades - Metal (Per 500')	4.2
Guardrail and Barricades - Wood or Cable (Per 200')	2.3
Parking Lots - Asphalt (Average 25 Space Lot)	16.5
Parking Lots - Gravel (Average 25 Space Lot)	19.2
Parking Lot and Roadway Lighting	12.4
Roadways - Asphalt (Per 250 Linear Feet)	2.8
Roadways - Gravel (Per 250 Linear Feet)	4.6
Signage - Metal	0.5
Signage - Wood	1.8
Trash Receptacles - 55 Gallon Can with Dome	1.3
Trash Receptacles - 30 Gallon Can	0.1

Facility Type	Total Annual Labor Hours
Athletic Fields	
Level 1 Athletic Fields - Lighted and Irrigated	
Ball Diamonds	
60' or 70' - Grass Infield	601.0
60' or 70' - Skinned Infield	606.9
65' - Skinned Infield	606.9
90' - Grass Infield	644.1
90' - Skinned Infield	629.0
Rectangles	259.2
Level 2 Athletic Fields - Lighted or Irrigated (Not Both)	
Ball Diamonds	
60' or 70' - Grass Infield, Lighted	423.2
60' or 70' - Grass Infield, Irrigated	470.0
60' or 70 - Skinned Infield, Lighted	428.7
60' or 70' - Skinned Infield, Irrigated	475.5
65' - Skinned Infield, Lighted	428.7
65' - Skinned Infield, Irrigated	475.5
90' - Grass Infield, Lighted	462.5
90' - Grass Infield, Irrigated	528.5
90' - Skinned Infield, Lighted	450.8
90' - Skinned Infield, Irrigated	516.8
Rectangles with Irrigation	231.2
Rectangles with Lighting	175.2
Level 3 - Athletic Fields - Not Lighted or Irrigated	
Ball Diamonds	
60' or 70' - Grass Infield	376.7
60' or 70' - Skinned Infield	383.6
65' - Skinned Infield	383.6
90' - Grass Infield	417.4
90' - Skinned Infield	405.7
T-Ball	269.1
Rectangles	167.2
Level 4 - Athletic Fields - Synthetic Turf Fields	
Ball Diamonds	
60' or 70' - Lighted	276.8
60' or 70' - Non-Lighted	256.8
65' or Above - Lighted	375.2
65' or Above - Non-Lighted	355.2
Rectangles with Lighting	327.1
Rectangles	317.5
Turf Program	
Irrigated Athletic Fields (Per Acre)	12.5
Non-Irrigated Athletic Fields (Per Acre)	10.4

Facility Type	Total Annual Labor Hours
Buildings	
Building Envelop and Interior	
Doors Exterior	2.0
Electrical Load Center	1.0
Elevator (RECenters)	12.0
Emergency Lights	12.0
Exhaust Fans	1.0
Exit Lights	24.0
Exterior	70.0
Fire Alarm	3.0
Fire Alarm Pull Stations	12.0
Fire Extinguishers (per 10)	1.0
Interior Walls and Ceilings (Per 1,000 Square Feet)	62.0
Kitchen Exhaust Hood	1.0
Lights	2.0
Motors 1 to 75 hp	8.0
Roof	3.0
Roof Drains\Gutters	8.0
Security System	36.0
Sprinkler System	2.0
Sump Pump	2.0
Water Heater	1.0
Wheel Chair Lift (Historic sites)	12.0
Windows	2.0
Heating and Cooling Systems	
Boilers	17.0
Chillers	8.0
Cooling Towers	30.0
Geothermal	88.0
HVAC System Up to 5 Tons	8.0
HVAC System 5 Tons and Above	16.0
Water Supply and Sewer	
Backflow Preventer	2.0
Gravity Flow Septic System	0.3
Pumped Septic System	0.3
Sewer Ejector Pump	8.0
Well System	2.0

Facility Type	Total Annual Labor Hours
Farm and Equestrian Features	
Animal Barns	730.0
Dairy Cow	730.0
Livestock and Poultry	730.0
Pasture	163.0
Fencing (Per 100')	14.8
Horse Stalls	535.5
Indoor Riding Arenas	581.0
Outdoor Riding Arenas - Frying Pan Farm Park	1,045.0
Outdoor Riding Arenas - Turner Farm Park	213.0
Frying Pan Farm Park Buildings	678.5
Forested and Other Treed Areas	
Downed Trees	7.5
Miscellaneous Tree Work	
Flagging	14.0
Winching	4.0
Park Inspections	
Citizen Contact Follow Up	2.0
Developed Parks	1.3
Playgrounds	0.5
Tree Spoils	
Chipping of Brush	6.0
Debris Dispersion	3.0
Removal of Wood from Site	9.0
Stump Removal	4.0
Upright Trees	
Cabling Trees	3.0
Felling of Tree	3.0
Putting a Hand Line in Tree	1.0
Tree Pruning via Climbing	4.5
Tree Pruning from a Bucket Truck	3.0
Tree Removal From a Bucket Truck	4.5
Tree Pruning from the Ground	2.0
Tree Removal via Climbing	12.0
Tree Removal with Crane (Contracted Service)	6.0
Tree Removal without Crane (Contracted Service)	3.0
Golf Courses	
Driving Ranges (Average of 25 Stations)	2,043.1
Fairways (Per Acre)	294.5
General Course Maintenance	1,261.8
Greens	239.3
Power Carts & Pull Carts (Per 20 Cars)	110.7
Putting Greens	238.3
Roughs (*See Actual Standard for Details)	*
Sand Traps (Per 5,000 Square Feet)	34.8
Tees	117.8
Turf Maintenance (*See Actual Standard for Details)	*

Facility Type	Total Annual Labor Hours
Managed Landscapes	
Gardens and Landscape Beds	
Landscape Beds (Per 1,000 Square Feet)	13.6
Public Plots	34.6
General Grounds	
Trash Removal and Miscellaneous Work (Per Acre)	6.6
Mowing - Class A (Per Acre Staff Mowed)	57.8
Mowing - Class A (Per Acre Contract Mowed)	16.2
Mowing - Class B (Per Acre Staff Mowed)	27.4
Mowing - Class B (Per Acre Contract Mowed)	11.4
Mowing - Class C (Per Acre Staff Mowed)	17.4
Mowing - Class C (Per Acre Contract Mowed)	9.3
Meadows and Fields	6.2
Operating Equipment	
Large Engine Equipment	
Front End Loaders Loaders	35.0
Heavy Construction	43.0
Infield Conditioners	60.5
Off-Road Utility Vehicles	70.0
Outfront Mowers 6' and Below	97.5
Outfront Mowers 10' and Above	109.0
Reel Mowers	145.0
Tractors	25.0
Walkbehind Mowers	95.5
Ice Resurfacer	192.5
Small Engine Equipment	
Blowers	10.0
Chainsaw	96.5
Edger	4.5
Generators	6.0
Hedge Trimmers	6.5
Pole Saw	7.5
Sod Cutter	4.5
String Trimmers	24.0

Facility Type	Total Annual Labor Hours
Other Park Features	
Mason Amphitheater	31.5
Other Amphitheaters	28.9
Campgrounds	4,508.5
Carousels	299.8
Fitness Courses (Per Station)	7.1
Frisbee Golf Courses (Per Hole)	15.6
Marinas	
Lake	300.0
Launch Area	96.0
Paddle Boats (Per 10 Boats)	422.0
Row Boats (Per 10 Boats)	561.0
Canoes (Per 10 Boats)	166.0
Row Boats W/Trolling Motor	283.0
Miniature Golf Courses	370.5
Off-Leash Dog Areas	41.3
Outdoor Restrooms - Year Round	135.2
Outdoor Restrooms - Partial Year	101.4
Outdoor Swimming Pools	437.4
Picnic Areas (Capacity of 60)	51.0
Picnic Shelters (Capacity of 60)	61.6
Playground with Engineered Wood Fiber Surface	46.6
Playground with Rubber Surface	78.8
Skate Parks	457.0
Train - Engine and Cars	168.0
Train Track	128.0
Water Parks	1,077.3
Outdoor Courts	
Basketball	
Lighted	21.6
Non-Lighted	16.5
Horseshoe	21.6
Shuffleboard	6.4
Tennis	
Lighted	21.7
Non-Lighted	16.6
Practice Tennis	
Lighted	22.1
Non-Lighted	17.0
Volleyball	
Lighted	14.7
Non-Lighted	9.6

Facility Type	Total Annual Labor Hours
RECenters	
Fitness Equipment	
Cardiovascular (Small Center)	244.50
Cardiovascular (Medium Center)	453.0
Cardiovascular (Large Center)	870.0
Cybex Strength	517.0
Fitlinxx	423.0
Free Weights	52.0
Group Exercise	16.0
Spin Bikes	336.5
Fitness Rooms	709.3
Gyms	2,645.0
Ice Skating Arenas	2,081.0
Locker Rooms	913.2
Natatoriums	
Airshutes and Slides	16.4
Bleachers	202.1
Filter and Storage Rooms	52.0
Guard Chairs	85.0
Life Saving and Safety Equipment	158.0
Pools (25 Meter - w/tile)	2,072.8
Pools (50 Meter w/tile)	2,611.8
Pools (50 Meter w/cement)	2,502.3
Whirlpool / Spas	929.5
Offices, Lobbies, Halls, Miscellaneous Rooms (Each)	1,454.1
Restrooms	971.7
Saunas	657.0
Trails and Crossings	
Bridges	7.6
Low Water Crossings	9.6
Trails	
Asphalt (Per 2,500 Linear Feet)	10.0
Concrete (Per 5,000 Linear Feet)	8.7
Gravel (Per 1,000 Linear Feet)	11.1
Natural (Per 500 Linear Feet)	11.4
Wood Chip (Per 500 Linear Feet)	9.8
Trail Lighting	5.6

FAC 7523 Running Track

FY25 SUC:	$3,417.36 / EA
Source:	Set to FAC 7521, Cost Works Model

FAC 7524 Stadium

FY25 SUC:	$42,368.71 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Local Government Authority

Natural Grass Athletic Fields

It has become apparent that natural grass fields are being replaced with synthetic surfaces due to the belief that synthetic surfaces are less expensive and easier to maintain than natural surfaces. A properly maintained synthetic is not necessarily an effective replacement if lower maintenance costs are the goal. The primary reason natural grass fields are being replaced by synthetic is usually due to the lack of initial maintenance dollars. Proper construction and maintenance of a natural grass field will provide a safe playable surface that is natural and pleasing to players, parents, and coaches. Additionally, natural grass fields are often replaced by synthetic for aesthetic reasons, perhaps because the natural grass has a great deal of wear in the highly trafficked areas by the end of the season. However, one should not confuse aesthetics with playability because a worn field often still plays very well, plus, the natural grass can be restored if the right maintenance or strategies are employed. The following technical resource provides a detailed look into the benefits and cost effectiveness of maintaining natural grass fields.

Natural Grass Benefits

Environmental Benefits of Natural Grass Surfaces

I. Water Conservation

A major point of discussion with natural turfgrass systems is the amount of water required to irrigate. Quite simply, most sports field systems equipped with supplemental irrigation are overirrigated. Most water overuse is due to human error or miscalculation. Understanding and following proper irrigation practices will lead to water conservation. Water conservation can also be achieved by:

1. Using drought resistant turfgrass species and cultivars within species. Visit the Turfgrass Water Conservation Alliance website for species and varieties that are recommended for drought resistance in your area.
2. Allowing turfgrass to grow a little taller for deeper root development based on season and turfgrass species.
3. Allowing turfgrass to enter dormancy in drought situations.
4. Encouraging deeper rooting of turfgrass cultivars by watering deeply and infrequently. Apply only what your soil can infiltrate in one hour. Avoid puddles and runoff.
5. Using recycled water sources for irrigation.
6. Install rain sensors to shut down irrigation during a rain shower.
7. Installation of devices such as soil moisture probes or evapotranspiration pans will improve irrigation efficiency.

II. Groundwater preservation and recharge

1. Dense aboveground turfgrass biomass traps and holds water which reduces excess runoff and allows more water to infiltrate into the soil. Ten-thousand square feet can absorb up to 6000 gallons of water.
   a. A research study in Maryland compared surface water runoff losses between turfgrass and cultivated tobacco grown at the same site. During the tobacco-growing season (May-September), surface water runoff losses for the tobacco were 11 times greater than runoff losses from perennial turfgrass.
2. Extensive, fibrous turfgrass root system filters water percolating through the soil to enhance groundwater recharge.
3. Application of fertilizer has negligible potential for nutrient elements to pass through the rootzone into groundwater or be transported by runoff into surface water. Turfgrass roots are highly efficient at uptake of applied nutrients.
   a. A research study in Maryland followed total losses for nitrogen and phosphorus between turfgrass and cultivated tobacco grown at the same site. Runoff from the tobacco plantings had 195 times more N and 240 times more P than runoff from the turf.
4. Proper fertilizer and pesticide applications keep water safe. Product selection and characteristics, timing, and equipment used in the application can all greatly improve both the product performance and non-target effects on the environment. Turfgrass managers typically avoid applying these materials just before heavy rain, on to frozen soil, or on dormant turfgrasses because these situations can increase the potential for surface and groundwater contamination. Avoid getting fertilizer prills on any hardscape where runoff from rain or irrigation can carry fertilizer into drainage systems.
5. Current trends with turfgrass fertilization are toward low nutrient application rates on a more frequent basis (i.e. 'spoon feeding', with product often delivered through a spray system) and an expanded use of slow release nitrogen carriers. Both of these practices are environmentally friendly.
6. Properly managed turfgrass ecosystems support abundant earthworm populations, which contribute to increased macropore space in the soil, resulting in higher soil water infiltration rates, higher water-holding capacity, and improved soil structure.

III. Enhanced entrapment and biodegradation of synthetic organic compounds

1. Turfgrass systems catch and filter polluted runoff water.
2. Decaying turfgrass leaves, crowns, stems, roots, and thatch support large populations of microscopic decomposers that reside in the soil. Soil microbes also decompose pesticides, potentially noxious organic chemicals, and various bacteria producing bodily fluids such as blood, vomit, spit, and phlegm.

IV. Soil erosion control and dust stabilization

1. Turfgrass root systems and aboveground canopy are one of the most cost efficient ways to control water and wind erosion of soil and increase water infiltration into the soil.
2. Turfgrass functions as a vegetative filter that reduces the quantity of sediment entering surface streams and rivers.
3. High shoot density and root mass of turfgrass contributes to soil surface stabilization to reduce erosion. A high biomass matrix provides resistance to lateral surface water flow.
4. Turfgrasses act as a trap for dust and other particulate matter, improving air quality.

V. Improved atmospheric conditions

1. Turfgrass contributes to reductions in noise levels by absorbing, deflecting, reflecting, and refracting the various sounds. There are also reductions in discomforting glare and light reflection.

2. Turfgrass reduces atmospheric carbon dioxide and releases oxygen. Grass plants produce their own food through the process of photosynthesis. The plants take in carbon dioxide and convert it into simple sugars. As a result of photosynthesis and taking up of carbon dioxide, oxygen is released into the atmosphere.
   a. During an active growing season, 25 square feet of healthy turf will provide enough oxygen for one adult person for one day.

VI. Accelerated soil restoration

1. Improve soils through the addition of organic matter. As plant tissue dies, it is incorporated into the rootzone as organic matter.
2. Soil restoration of environmentally damaged areas (i.e. construction sites with topsoil stripped, burned-over land, garbage dumps, eroded rural landscapes, mining operations, and steep timber harvest areas) is accelerated when turfgrass is planted.

VII. Substantial heat dissipation-temperature moderation

1. Turfgrass dissipates high levels of radiant heat through the cooling process of transpiration.

Synthetic Surface Temperature Case Study

In spring 2002, Brigham Young University's athletic department installed a synthetic surface on half of its football practice field. The other half is sand-based natural turf. Complaints about the heat of the synthetic surface prompted researchers to take temperature measurements and compare them with natural turf, bare soil, asphalt and concrete. They recorded temperatures at the surface and 2 inches below the surface.

Temperatures of surfaces at BYU practice fields in June 2002. Average air temperature = 81.42°F

	Average surface temperature between 7:00 am and 7:00 pm		Average soil temperature between 7:00 am and 7:00 PM (two inch depth)		Average temperature between 9:00 am and 2:00 PM in the shade	
	Average	High	Average	High	Average	High
Soccer (synthetic)	117.38°F	157°F	95.33°F	116°F		
Football (synthetic)	117.04°F	156°F	96.48°F	116.75°F	75.89°F	99°F
Natural Turf	78.19°F	88.5°F	80.42°F	90.75°F	66.35°F	75°F
Concrete	94.08°F					
Asphalt	109.62°F					
Bare Soil	98.23°F		90.08°F			

Source: "Synthetic Surface Heath Studies," C. Frank Williams and Gilbert E. Pulley, Sports Turf Managers Association Annual Conference, January 2004.

The surface of the synthetic field averaged 117 degrees Fahrenheit while the natural grass surface averaged 78 degrees Fahrenheit and asphalt averaged 109 degrees Fahrenheit. Two inches below the synthetic turf surface, it was still 28 degrees hotter than the natural turf surface. Irrigation is installed on synthetic fields to help control surface temperatures. Researchers at Penn State University have found that temperature reductions last about 20 minutes. Researchers at BYU have found that irrigation cooled the synthetic surface from 174 degrees Fahrenheit to 85 degrees Fahrenheit, but during the summer in Utah, the surface could be back to 120 degrees Fahrenheit in five minutes.

These high temperatures make it dangerous for athletes as it increases the incidence of heat stroke, muscle cramping and overall fatigue.

Work conducted at the University of Missouri Turfgrass Research Center in 2010 regularly showed synthetic surface temperature increases of 50 to 70 degrees Fahrenheit over natural grass. Factors such as light, cloud cover, and breezes of 3 to 5 mph, reduced synthetic surface temperatures by 30 degrees. However, on clear, blue-sky days in mid-summer where air temperatures were at 98 degrees Fahrenheit with calm winds, temperatures would exceed 160 degrees Fahrenheit on synthetic surfaces. Natural grass under these conditions would range between 99 and 102 degrees.

VIII. Overall increase in human health

1. Closely mown areas of turfgrass reduce the number of nuisance pests that reside in taller grasses, such as ticks, which can carry Lyme disease and Rocky Mountain Spotted Fever.
2. Well maintained turfgrass areas are less likely to have weeds that are responsible for allergy-related pollens.
3. Fields with good quality turfgrass cover have higher traction, cushioning, and resiliency, and lower surface hardness, reducing the probability of injury in contact sports.
   a. Ball roll and bounce are influenced by the grass cover and its management, as are player movements, such as running, stopping, pivoting, dodging, jumping, landing, and walking.
4. Turfgrasses can offer a low cost, safe playing surface for athletes.
   a. Surface hardness is important when considering head injuries. Surface hardness is measured by dropping a weight (referred to as a missile) from a fixed height onto the playing surface. The missile contains an accelerometer that measures how fast the missile stops once it hits the surface. A numerical value, referred to as Gmax, is then generated. A high Gmax value means the missile stopped quickly and there is less absorption of force by the athletic surface and more absorption of force by the athlete, which indicates the surface is hard.

      Fields can be tested using a Clegg Impact Tester or F355 device. Gmax values taken from each of these devices are not interchangeable because the missiles are different weights and are not dropped from the same height. In other words, 100 Gmax measured with the Clegg is not the same as 100 Gmax measured with the F355.

      The NFL field testing program requires playing surface hardness of both natural and synthetic turf fields to be measured with the Clegg Impact Tester. Fields must be tested in multiple locations prior to every game and must be below 100 Gmax at all locations. If hardness levels begin to approach 100, steps must be taken to lower the Gmax value.

      The American Society for Testing and Materials (ASTM) standard (F1936) uses the F355 device to test surface hardness on natural and synthetic fields and sets an upper limit of 200 Gmax. According to ASTM Standards, a value greater than 200 Gmax qualifies for the expectation that life threatening head injuries may occur. At this point the surface should be repaired or replaced. The Synthetic Turf Council (STC) recommends Gmax does not exceed 164 when using the F355 device.

      Most synthetic fields upon completion measure Gmax in a range of 45 to 60 until the infill material settles in. In time, with use, relocation of crumb rubber, and separation of infill materials (those with sand and crumb rubber), increased Gmax readings can elevate to greater than 100 (using the Clegg Impact Tester). Gmax readings on synthetic fields are related to the thickness of the infill and proper grooming recommendations. Natural grass fields have several options to manage field hardness – increase soil moisture, mow taller, maintain good density, and add amendments. In a Penn State trial (2004), Gmax readings (using a Clegg Impact Tester) on a silt loam soil covered in Kentucky bluegrass ranged between 50 and 84 where traffic was applied and between 50 and 70 Gmax without traffic. Soil moisture ranged between 30 and 35 percent.

5. Aesthetics and recreational opportunities enhance physical and mental health of participants, relieve stress and contribute to enjoyment of life.
   a. Studies have been done to test the health benefits of nearby green spaces by testing blood pressure and heart rate of participants. Results show that views of open green spaces promote quicker recovery in hospital patients. Participants in another study had quicker and more complete recovery from induced stress when exposed to turfgrass and other landscape settings compared to those who were not.
6. Native soil fields hold less potential for injury.
   a. The most frequent injuries sustained on sports fields are those to the ankles and knees from rotating and changing directions on the field surface. A recent study at Michigan State University (Villwock et al., 2008) measured the effects that size and structure of infill materials would have on the rotational resistance of cleated shoes. Sixteen different surfaces were tested, including native soil and sand based fields, using testing methods conforming to the ASTM standard method for traction characteristics of an athletic shoe-surface interface. Cleated football shoes were mounted on a rigid foot-form and used on the surfaces. Results found that torque was significantly affected by field surface. Native soil fields reported the lowest torque overall.
7. Natural fields are the preferred playing surface among athletes. In 2010, a survey was conducted to evaluate what kind of playing surface NFL players preferred. 1619 players from all 32 teams participated in this survey.
   - 69% of the players preferred to play on natural grass fields
   - 14% preferred artificial infill
   - 9% had no preference

Players were also asked how they thought synthetic and natural grass surfaces affected their physical health:

	Artificial Infill Surface	Natural Grass Surface
Surface more likely to contribute to injury	82%	16%
Surface more likely to cause soreness and fatigue	89%	9%
Surface more likely to shorten career	89%	7%
Surface more likely to negatively affect quality of life after football	64%	4%

Natural Grass Limitations

I. Overuse

The overuse of many community sports facilities can push the limits of turfgrass to recover. Excessive traffic leads to compaction and bare areas, which can cause a surface to be unsafe and unplayable. Scheduling more events than a field can handle results in overuse.

To help prolong the life of natural fields:
- Rotate activities between fields.
- Limit use of fields to only necessary events, especially during rainy weather patterns.
- Change daily location of practices on the field.
- Shift fields of play to shift areas of concentrated wear.
- Buy portable goals and move them around the field for drills and practice, thus limiting wear in the area of the mounted goal posts.
- Have players do individual warm-ups off of the field.

- Execute team drills outside of painted numbers.
- Spread seed of climate and sport-appropriate, fast germinating grass species in wear areas before games and practices.
- Regularly educate field users regarding the importance of rotating traffic/use patterns around fields in order to maintain safety and optimum playability.

II. Standing Water

Inclement weather can lead to standing water and muddy conditions if the drainage system is not effective. This causes surfaces to be unsafe and unplayable.

To solve standing water problems, make sure there is a sufficient crown (i.e. slope) to move water off the field effectively. Regularly check to see that any installed collection basins and/or sub-surface drainage systems are operating effectively. If rain tarps are available, they can help keep water off of properly crowned fields and greatly improve field playability. Field managers should have the option to cancel events when inclement weather accelerates damage to the field.

Construction of Natural Grass Fields

The demise of many natural grass fields is in the initial construction or renovation work being done. Short-cuts due to budget constraints are temporary and will cost more in the long run. Well-constructed sports fields with proper maintenance will provide the type of playing surface so many parents, coaches and players desire.

Construction and renovation should begin with the selection of a knowledgeable contractor - someone with experience in sports field design and construction who carries a good portfolio with references and may be a certified field builder (CFB).

A good first step for field construction and renovation is ensuring the field has the correct crown and slope. This is where dollars should be spent in any project because if surface drainage is lacking, all else is lost. Crowns and slopes are equally important whether your field is constructed with native soils or modified soils or will have a sand-cap or sand-base. Drainage (surface and internal) is critical to a successful natural grass field.

Selection of the best growing medium for the turfgrass rootzone is also crucial for field health. The soil can be made up of native soil (modified or not) or a sand-based rootzone. The soil texture determines the degree of drainage (surface and internal), water holding capacity, and nutrient holding capacity.

Irrigation may or may not be a luxury and should be strongly considered for the durability and safety of natural grass fields. There are many different types of irrigation to consider, some being more efficient than others. Irrigation types and design should be based on the water source and pressure, number of fields or area, region of the country and type of turfgrass being grown. Regardless of the irrigation type, conduct regular irrigation audits to ensure distribution uniformity and be efficient with water usage. Mismanagement of irrigation will lead to other issues such as hot spots or diseases.

Turfgrass species selection is also an important component when constructing or renovating natural grass fields. Consider turfgrass varieties that offer good disease resistance and wear tolerance. The National Turfgrass Evaluation Program provides performance information on various turfgrass species and cultivars. If irrigation is not an option, select drought tolerant species of turfgrasses. The Turfgrass Water Conservation Alliance tests turfgrass species for drought tolerance and posts individual varieties that pass the test. Consideration of turfgrass species and varieties should always be made for good water conservation practices.

When constructing or renovating natural grass sports fields, it is important to follow the guidelines for field design and build. The end result will be a sports field that will perform as expected with proper maintenance. Parents, players and coaches can enjoy a playing surface that is natural and safe. Additional information on the construction and renovation of sports fields can be found in Sports Fields: A Manual for Design, Construction and Maintenance by Jim Pulhalla, Jeff Krans, and Mike Goatley or through your local sports field contractor or state extension office.

Construction Costs for Various Types of Sports Field Surfaces

For a more complete understanding of what is involved with construction cost of a natural or synthetic field, please view the STMA Guide to Synthetic and Natural Turfgrass for Sports Fields.

- **Natural with On-site Native Soil (no added top soil or sod) - $0.60-$0.90 per sq. ft.**
- **Natural Turfgrass with Native Soils - $1.25-$2.50 per sq. ft.**
- **Natural with Sand Cap - $2.60-$3.85 per sq. ft.**
- **Natural with Sand and Drainage - $4.25-$5.00 per sq. ft.**
- **Synthetic Infill Systems (carpet, infill, and base) - $4.50-$10.25 per sq. ft.**

Maintenance Requirements for Natural Grass Fields

Maintenance of natural grass fields is critical to their success. Maintenance is often lacking due to budget constraints. However, when individuals feel that natural grass fields have failed, the money is always there for a conversion to a synthetic surface. Instead of giving up on a natural grass surface, raise the funds to provide good maintenance practices for a safe natural grass surface. Annual inputs of $20,000 to $30,000 per field can go a long way in the maintenance and performance of a natural grass field.

STMA provides many resources and opportunities to assist in the maintenance of natural grass fields. Educational bulletins, webinars, and educational conferences provide the support and tools necessary to address natural grass maintenance practices.

Maintenance Comparison Case Studies between Natural Grass Fields at North Scott Community School District and a Synthetic Field at Michigan State University

Disclaimer: Material and labor costs are highly variable depending on region of the country and type of facility. The following costs are based off of North Scott Community School District and Michigan State University, and are meant to provide a realistic representation for costs involved with building and maintaining athletic fields.

Natural – North Scott Community School District

North Scott Community School District is located in Eldridge, Iowa. School grounds and sports turf requiring maintenance totals 115 acres. The District maintains a native soil baseball field, softball field, and 214,000 square feet of native soil practice fields. The school also has a football stadium field with a 4 inch sand cap and a new, sand based soccer field built to USGA specifications. All of the grounds maintenance is done in house by three full time and three summer seasonal staff members. John Netwal, CGCS, is the Director of Operations for North Scott Community School District and has provided the following information.

Natural Turf Maintenance Equipment*

Tractor-mount sprayer	$700
Utility tractor	$15,000
Front end loader attachment for utility tractor	$4,000
Broadcast spreader	$400-$1,200
Rotary-motion aerator attachment for tractor	$6,300
Drag mat	$300
Topdresser	$7,000
Field painting equipment	$8,400
Work Cart	$4,500
Reel Mower	$3,500-$22,000
Rotary Mower	$22,000-$35,000
Trimmers	$250-$600
Seeder	$250
Total	**$72,600-$105,250**

* With new tier 4 compliance regulations, equipment prices will likely increase 10-15% going into 2016-2017.

Native Soil Practice Area Field Maintenance Cost Estimates

Total Area: 214,000 square feet

Description of Activity	Man Hours	Man Hour Cost	Product	Product Cost	Total Activity Cost
33 Mowings / Season	97	1,912.84			1,912.84
Aeration, 5 times per year	45	887.40			887.40
Fertilizer @ 4.9 #s N / year	14	276.08	Fertilizer	2,295.00	2,571.08
Soil Amendments	3	59.16	Gypsum	551.04	610.20

Herbicide Applications	3	59.16	Herbicide	45.32	104.48
Pre-emergent					
Spot Spray Round-Up, 1 Time / Month			Round-Up		
10 Game Field Prep's, Soccer	15	295.80	Paint	1,060.50	1,356.30
16 Practice Field Prep's, Football	45	887.40	Paint	610.10	1,497.50
Overseeding	8	157.76	Seed	1,710.00	1,867.76
Growth Regulator, Apr, May, Jun, Jul, Aug	16	315.52	Primo	2,324.10	2,639.62
Pre-emergent Applications					
Insecticide Applications			Dylox		
Water, 1 Acre Inch Per Week	10	197.20	Water	9,213.00	9,410.20
Miscellaneous $25 / Month	10	197.20	Supplies	200.00	397.20
Totals		**$5,245.52**		**$18,009.06**	**$23,254.58**

Labor Cost: $16.44 x 20% benefits = $19.72 per hour

Bottom Line: North Scott Community School District's native soil practice fields (214,000 square feet) cost $23,254.58 per year to maintain. One native soil football practice field (57,600 square feet) costs $6,045 per year to maintain.

Football Stadium Field Maintenance Cost Estimates

Football field has 4 inch sand cap

Total Area: 70,000 square feet

Description of Activity	Man Hours	Man Hour Cost	Product	Product Cost	Total Activity Cost
33 Mowings / Season	50	986.00			$986.00
Aeration, 3 Times Per Year	15	295.80	Verti-Drain		$295.80
Sod Replacement Sidelines	12	720.00	Sod	1,000.00	$1,720.00
Fertilizer @ 4.9 #s M / year	8	157.76	Fertilizer	810.00	$967.76
Soil Amendments	1	19.72	Gypsum	183.68	$203.40
Herbicide Applications	1	19.72	Herbicide	14.28	$34.00
Pre-emergent Applications					
Growth Regulator (Apr, May, Jun, Jul, Aug)	5	98.60	Primo	762.60	$861.20
Game Field Prep's	60	1,183.20	Paint	378.75	$1,561.95
Over-Seeding	15	295.80	Seed	570.00	$865.80
Insecticide Applications			Dylox		
Water, 1 Acre Inch Per Week	10	197.20	Water	4,784.34	$4,981.54
Miscellaneous, $25.00 / Month	30	591.60	Supplies	200.00	$791.60
Stadium Preps	18	354.96			$354.96

Sports Lighting, 15 events @ 4 hours in length / season			Electricity	373.76	$373.76
Totals		**$4,920.36**		**$9,077.41**	**$13,997.77**

Labor Cost: $16.44 x 20% benefits = $19.72 per hour

Bottom Line: North Scott Community School District's sand capped football stadium field costs $13,997.77 per year to maintain.

Sand Based Soccer Field Maintenance Cost Estimates

Total Area: 114,000 square feet

Description of Activity	Man Hours	Man Hour Cost	Product	Product Cost	Total Activity Cost
50 Mowings / Season	113	2,228.36			$2,228.36
Growth Regulator, Once Per Month	12	236.64	Primo	1,227.60	$1,464.24
Topdressing, 5 Applications Per Year	31.5	621.18	Sand	1,987.50	$2,608.68
Water, 1 Acre Inch Per Week / 26 Weeks	6	118.32	City Water	5,440.50	$5,558.82
Fertilizer @ 6.1 #s N / Year	12	236.64	Fertilizers	1,548.00	$1,784.64
Paint, 6 Applications Per Season / 20-5 Gallon Pails	45	887.40	Paint	378.75	$1,266.15
Aeration, 3 Times Per Year	13.5	266.22	Verti-Drain		$266.22
Fungicide, Four Applications / Season	8	157.76	Disarm 480 SC	1,575.00	$1,732.76
Over-Seeding, Once Per Season	5	98.60	Seed	997.50	$1,096.10
Herbicide, One Application Per Season	2	39.44	Herbicide	22.66	$62.10
Fence-line Maintenance, 2 Apps. Per Year	8	157.76	Control Products	125.00	$282.76
Miscellaneous	50	986.00	Misc. Products	200.00	$1,186.00
Pre-emergent Applications	4	78.88	Drive 75 DF	360.18	$439.06
Insecticide Applications			Dylox		
Sports Lighting, 10 events @ 3 hrs in length per season			Electricity	402.60	$402.60
Totals		**$6,113.20**		**$14,265.29**	**$20,378.49**

Labor Cost: $16.44 x 20% benefits = $19.72 per hour

Bottom Line: North Scott Community School District's sand based soccer field costs $20,378.49 per year to maintain.

Synthetic – Michigan State University

Outside Contractor Maintenance Charges

Consultation and/or training	$1,200-$3,000 per day plus expenses
Repairs	$30-$70 per linear foot
Crumb Rubber	$.50-$1.00 per pound applied

Synthetic Turf Maintenance Equipment*

Boom Sprayer	$1,000-$35,000
Sweeper	$1,500-$20,000
Broom	$500-$3,000
Painter	$500-$3,000
Groomer	$1,500-$2,000
Cart (to tow equipment)	$2,500-$16,000
Field Magnet	$500-$1,000
Rollers	$250-$2,000
Total	**$8,250-82,000**

* With new tier 4 compliance regulations, equipment prices will likely increase 10-15% going into 2016-2017.

Maintenance Budget for Synthetic Infill Field with a three year old surface

Seam Repairs (outside contractor; $30 per linear foot)	$8,000
Apply Crumb Rubber (1 time per year; 20 hours per application; 10 tons of topdressing at $500 per ton)	$5,000
Spray Field (4 times per year; 3.5 oz rate per 1000 square feet; 3 hours each; 12 hours per year)	$216
Fabric softener at $7 per 64 oz container	$120
Disinfectant at $5 per gallon	$100
Sweep Field (Parker Sweeper; 4 times per year; 8 hours each; 32 hours per year)	$1,500
Broom	$500
Groomer	$2,800
Hand Pick (3 times per week; 1 hour each; 156 hours per year at $18 per hour)	$2,800
Paint Field (2 times per year; 30 hours each; 60 hours per year; 30-40 gallons per year at $25 per gallon)	$1,000

Total Straight Hourly Cost (Field only; 280 hours at $18 per hour; benefits not included)	$5,040
Total Supply Cost	$6,220
Total Equipment Cost	$3,500
Total Outside Contractor Repairs	$8,000
Total Maintenance Cost	**$22,760**

Bottom Line: Michigan State University synthetic field costs $22,760 per year to maintain.

Maintenance Comparison between a Professional Level Natural Grass Field and Synthetic Field at Paul Brown Stadium, Cincinnati, Ohio

Disclaimer: Material and labor costs are highly variable depending on region of the country and type of facility.

Paul Brown Stadium is located in Cincinnati, Ohio and is home to the Cincinnati Bengals Football Club. Darian Daily is the Sports Field Manager at Paul Brown Stadium and is responsible for managing both natural and synthetic fields for the team. The practice facility is natural grass with a sand-based rootzone and totals 100,000 square feet. The game field is synthetic turf with crumb rubber infill and totals 102,000 square feet. All of the grounds maintenance is done in house by three full time and four seasonal staff members. Daily has provided a realistic comparison of maintenance costs between the natural grass and synthetic fields he manages.

Natural Grass Field – Practice Facility

Natural Grass Field Maintenance Estimates

Product	Cost
Fertilizer	$6,000
Fungicides	$1,500
Herbicides	$2,000
Topdressing	$3,500
Paint	$4,000
Total Product Cost	**$17,000**

Labor	Man Hours
Mowing	600
Cultural Practices	70
Painting	200
Total Man Hours	**870**

Synthetic Field – Paul Brown Stadium Game Field

Synthetic Field Maintenance Estimates

Product	Cost
Crumb Rubber	$3,000 ($750 per ton)
Cleaning Products	$1,000
Deep Cleaning	$6,500
Paint/Paint Remover	$5,000
Total Product Cost	**$15,500**

Labor	Man Hours
Cleaning	180
Grooming	135
Repairs	40
Total Man Hours	**355**

The natural grass field used in the comparison was not overseeded or sprigged. However, sprigging of a different field cost $21,000.

Natural Grass Athletic Fields

Involving your STMA Sports Turf Manager

It is important to have a qualified professional to help with decision making and the gathering of information and costs. Hiring or involving a sports turf manager who can oversee construction and/or daily maintenance of a natural grass field is important for its success. If constructing a field, the sports turf manager can serve as a grow-in consultant to work with the architect and contractors (hiring a Certified Field Builder can assure quality construction and renovations when needed) to supervise the entire construction process. Mistakes during the construction phase often result in problems that sometimes can never be corrected or that will take years of management to overcome. A trained sports turf manager on staff will ensure that specifications are adhered to during construction. On a daily basis, your sports turf manager can oversee the care of the athletic fields, maintain the budget, manage staff, and communicate with users.

It is also important to invest in the continuing education of your sports turf manager to keep them current on industry trends and research. Make sure your sports field manager is involved with STMA for networking and continuing education opportunities. STMA also provides the opportunity to become certified through a rigorous training and testing program. Certified Sports Field Managers (CSFMs) are recognized in the industry for their professional development and knowledge of sport field construction and renovation.

Natural Grass Fields

The environmental and human health benefits alone make natural grass fields a desirable option when considering keeping or building an athletic field. The cost effectiveness of construction and annual maintenance only add to their appeal. It is important to have a complete understanding of the costs and benefits associated with both natural and synthetic surfaces when considering conversion from natural grass to a synthetic surface. Often times many of the benefits of natural grass systems are overlooked because of strong arguments and marketing efforts of synthetic turf companies.

Next Steps

To advocate the construction of a natural turfgrass surface or improve the quality of the current natural grass field:

- Involve your STMA Sports Turf Manager in decisions and gathering of information and costs.
- Organize a meeting to educate community, coaches, administration, athletes, and parents about the benefits of a natural turfgrass athletic field.
- Define resources needed to maintain a quality surface for your facility.
- Develop a budget.
- If constructing a field, meet with architects and contractors to find the best option for your situation.
- Schedule meetings to keep those involved updated on progress.
- Form committees to assist in logistics and fundraising.

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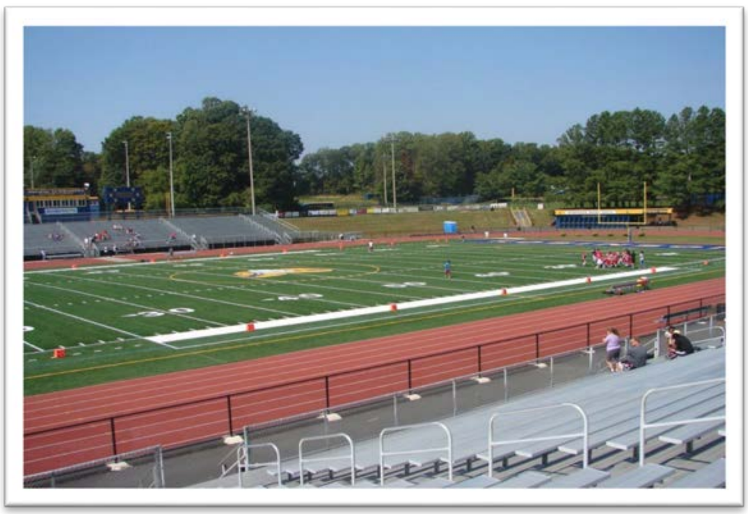
Mark Villwock, Eric Meyer, John Powell, Amy Fouty, and Roget Haut: Michigan State University: Football Playing Surface Components May Affect Lower Extremity Injury Risk http://archive.lib.msu.edu/tic/stnew/article/2008win12.pdf, 2008.

The cost is estimated as follows:

	Estimate Year	Estimate	SUC Inflation Multiplier	FY-17 Cost	Pro Rated %	Contributed Cost Share	Source
Natural Grass	2013	$17,556	1.0947	$ 19,219.13			Fairfax County Park Authority
Natural Grass (football)	2015	$13,997	1.0466	$ 14,648.66			Sports Turf Managers Assoc. "Benefits of Natural Grass"
Natural Grass (soccer)	2015	$20,378	1.0466	$ 21,326.74			Sports Turf Managers Assoc. "Benefits of Natural Grass"
Natural Grass soil based	2016	$33,522	1.0257	$ 34,384.61			UMass Lowell
Average Natural Grass				$ 22,394.79	66%	$ 14,780.56	
Synthetic Turf (football)	2015	$22,760	1.0466	$ 23,819.64			Sports Turf Managers Assoc. "Benefits of Natural Grass"
Synthetic Turf (incl environmental disposal of turf)	2016	$65,849	1.0257	$ 67,543.48			UMass Lowell
Average Synthetic				$ 45,681.56	33%	$ 15,074.91	
FY-17 Sustainment Unit Cost						**$ 29,855.47**	



Synthetic Turf Task Force

Overview, Findings, and Recommendations

July 2013

CONTENTS

Cover Photo: Oak Marr Park Synthetic Turf Field and Robinson Secondary School Stadium Field

Task Force Creation and Purpose

At the request of the Fairfax County School Board (School Board), in partnership with the Fairfax County Board of Supervisors (BOS) and the Fairfax County Park Authority Board (Park Board)[1], a joint Synthetic Turf Task Force was formed to develop recommendations on:

- The development of new synthetic turf fields, to include location recommendations for rectangular and diamond fields
- The funding of new synthetic turf fields, to include private and corporate partnership opportunities
- The planned replacement of existing and any new synthetic turf fields
- The regular on-going maintenance of existing synthetic turf fields

The task force was comprised of community leaders and county staff who had a direct connection to the current and future synthetic turf field efforts. (*Members are listed in Appendix I.)* The task force was charged with:

- Proposing recommendations that focus on ensuring fair and equitable access for all geographic areas of the county
- Providing a formal report on its findings and recommendations to the Fairfax County School Board, the Fairfax County Park Authority Board and Fairfax County Board of Supervisors for their collective review and action

Task Force Actions and Process

The Department of Neighborhood and Community Services (NCS) was designated as the lead agency for this effort. Staff members from the Park Authority and the Public Schools were appointed by their respective appointing authorities. School Board, BOS members, Park Authority Board members, and Athletic Council members were participated on the task force. Staff from the Department of Administration for Human Services was designated to provide project management support.

The task force met bi-weekly from August 2012 through June 2013. The task force conducted a review of existing fields, analyzed the financial support associated with the existing synthetic turf fields, and compiled an inventory. Policies and procedures from the participating organizations were reviewed. Data regarding funding sources, partnership agreements, project costs and other relevant information were gathered and reviewed. Supplemental research on other jurisdictions and relevant industry information was analyzed and discussed for its relevance to the Fairfax County community. The findings and recommendations included in this report reflect the combined efforts and consensus of all task force participants.

[1] Reference: Fairfax County School Board resolution, December 15, 2011; Letter from School Board Chair to Board of Supervisors Chairman Sharon Bulova, February 2012; and April 10, 2012 Board of Supervisors action. (*see Appendix II)*

Synthetic Turf Development and Financing History

Over the last decade, as youth and adults sports participation steadily increased, the inventory of athletic fields was recognized as insufficient to meet the increasing demand. A Needs Assessment commissioned by the Fairfax County Park Authority (Park Authority) in 2004 (http://www.fairfaxcounty.gov/parks/needs2004/pdf/needsassessment_final.pdf) identified a rectangular field shortage of 95 fields needed to accommodate requirements for adult and youth rectangular field users.

Both the cost of new field development and availability of locations were identified as challenges. In 2003, the Fairfax County Athletic Council (Athletic Council) advocated for the resurfacing of existing fields to a synthetic turf surface to increase the playability of fields. During this same period, the Park Authority analyzed possible benefits of synthetic turf fields on park lands; a study conducted by county staff reported that conversion of an existing lighted natural grass field to synthetic turf would increase capacity by an additional 62 percent of playable time, as a synthetic turf surface can be utilized year round and in inclement weather, both during and immediately following rain or other weather events.

In the succeeding decade, the Park Authority and Fairfax County Public Schools (FCPS), in cooperation with a variety of community partners, embarked on an ambitious effort to build additional synthetic turf fields by leveraging various funding partnership models. These included public-private partnerships that utilized private donations, public bond financing and development proffer funds to pay for synthetic turf field development. Public land was identified on both FCPS- and Park Authority-owned properties. The majority of private cash donations were provided through community sports organizations and school booster clubs.

In 2003, the Park Authority oversaw the construction of the first synthetic turf field playing surface in Fairfax County: Lewinsville Park in McLean. This was followed the next year by the construction of a synthetic turf field at EC Lawrence Park in Centreville. Construction of additional synthetic turf fields continued over the next five years at park and school sites. Portions of the community funding came through a combination of sources, including user fees, fundraising and donations.

*** A summary of all synthetic turf locations, funding sources, and costs can be found in Appendix VI.**

New Resources Increased Capacity

In 2005, additional funding was required to complete planned development of synthetic turf fields. In recognition of the overall community benefit for the resulting increased capacity, the Athletic Council advocated for, and the County Board of Supervisors adopted, the creation of a Turf Field Development Fund. This program utilized a portion of revenues from the Athletic Services Application Fee (commonly referred to as the “$5.50” fee) to offer annual mini-grants to spur development partnerships with community sports organizations. Of the current synthetic turf field inventory, 19 (28 percent) were partially funded by the Athletic Services Application Fee. The creation of the new Turf Field Development Fund and the concurrent financial support from the community helped to sustain the momentum of the synthetic turf field development effort until passage of the 2006 Park Bond referendum. That referendum specifically targeted synthetic turf field development and provided full funding for an additional 12 fields.

Implementation of the Two-Field Model at FCPS High School Sites

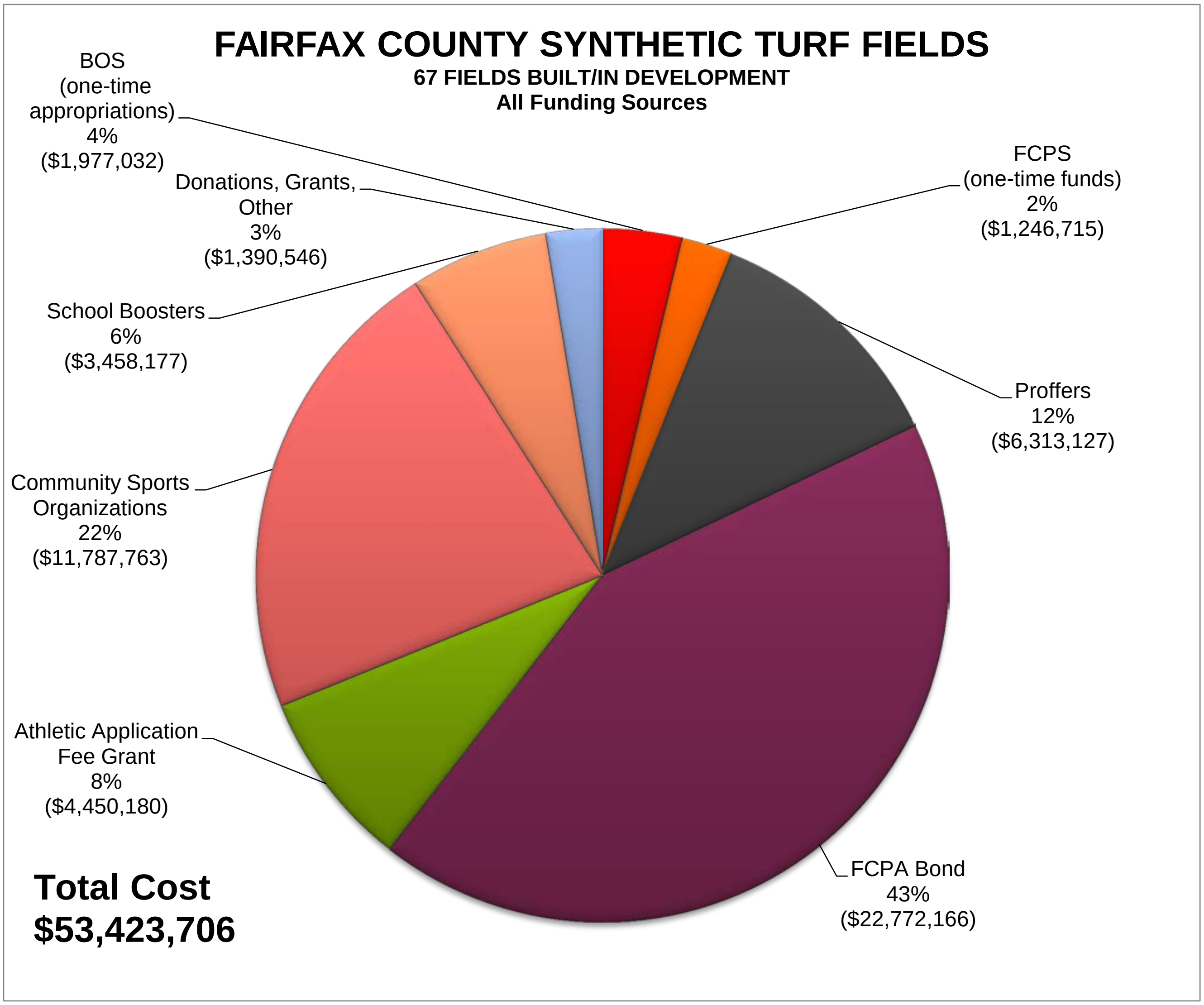
In 2009, Marshall High School became the first FCPS site that created a “two-field model.” The development was funded through proffer funds and contributions from community sports organizations. This became the new design model for synthetic turf field development at high schools, which included installation of synthetic turf surfaces on both the main stadium field and on a lighted auxiliary field on the school campus. The physical configuration of the two-field model increased the availability for field use by school athletic and physical education programs, as well as the surrounding community.

In 2010, Herndon High School became the first high school to successfully apply for mini-grant funds through the grant program administered by NCS, resulting in the county’s second two-field model. Nine of the county’s high schools have two-field models in place.

Partnership Efforts Accelerated Synthetic Field Turf Development

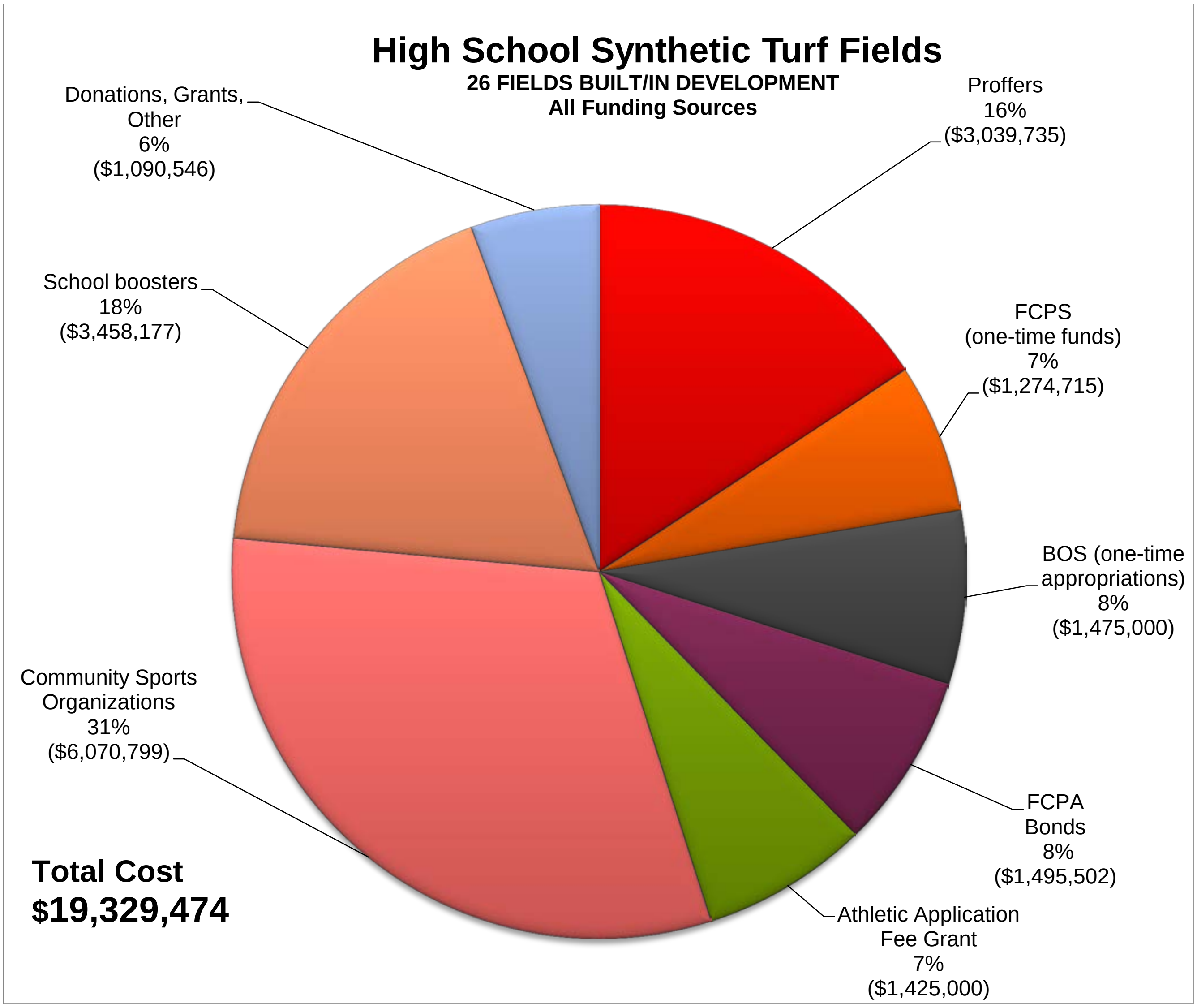
The current synthetic turf field inventory would not have been developed without the significant contributions in both leadership of and investment by members of community sports organizations, school booster clubs and community leaders. Identification of public land created opportunities to increase capacity for sports participation, for both community level and public schools programs. Development of synthetic turf fields on school properties for both community and school use, along with shared arrangements on county-owned park lands, has increased overall capacity.

As of spring 2013, Fairfax County has 67 synthetic turf fields of which 47 are currently in use and 20 are pending construction. County rectangular fields continue to be used by more than 130,000 sports participants *(duplicated count)* in athletic events and programs for cricket, field hockey, football, lacrosse, rugby and soccer. When the latest development phase is complete, Fairfax County will have the largest inventory of synthetic turf fields of all jurisdictions in the Washington, D.C., metropolitan area.



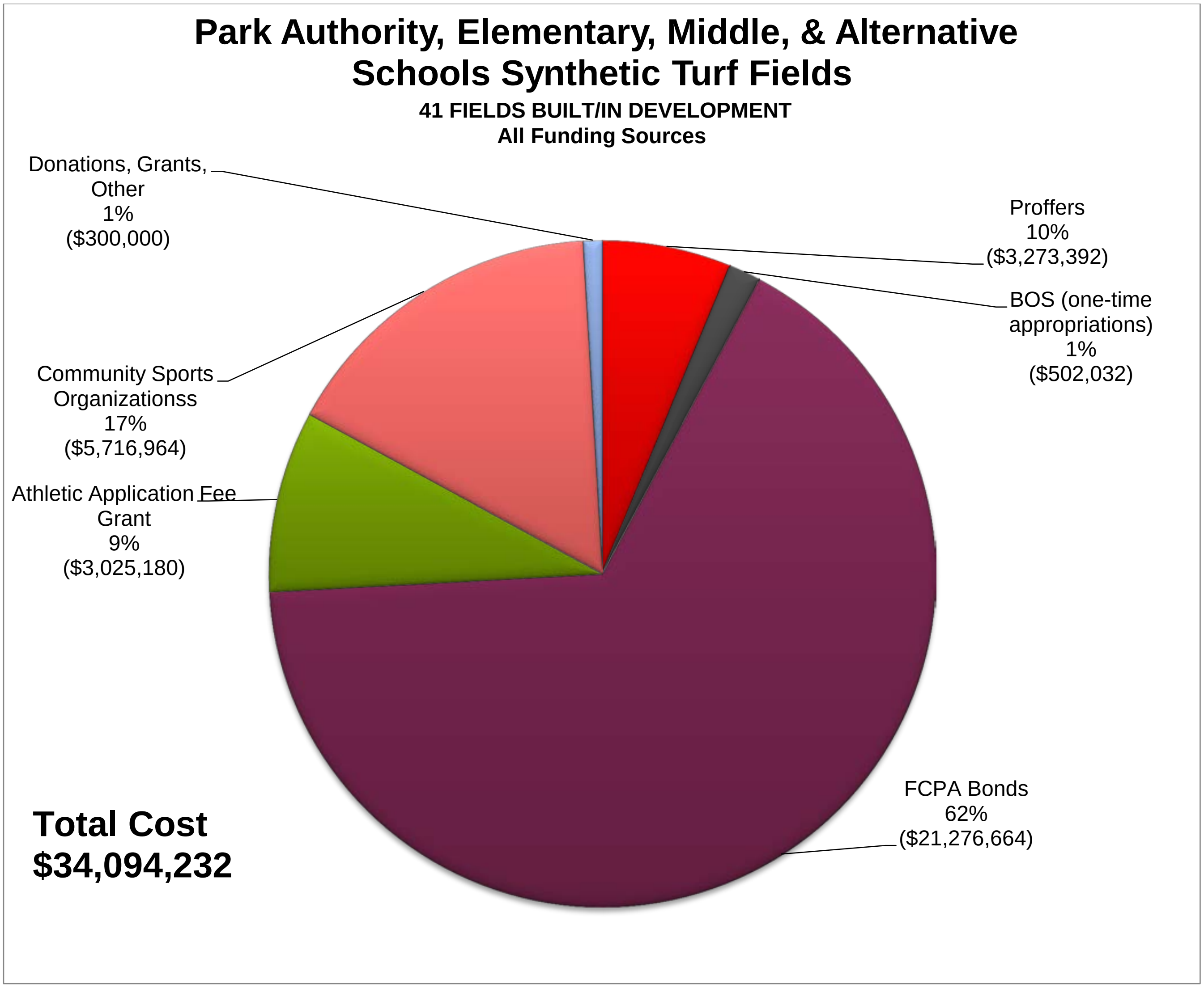
Significant funding from the community was leveraged to create the 67 synthetic turf fields built and in development.

*** A summary of all synthetic turf locations, funding sources, and costs can be found in Appendix VI.**



Community sports organizations and school booster clubs funded almost half of the cost for high school synthetic turf fields.

*** A summary of all synthetic turf locations, funding sources, and costs can be found in Appendix VI.**



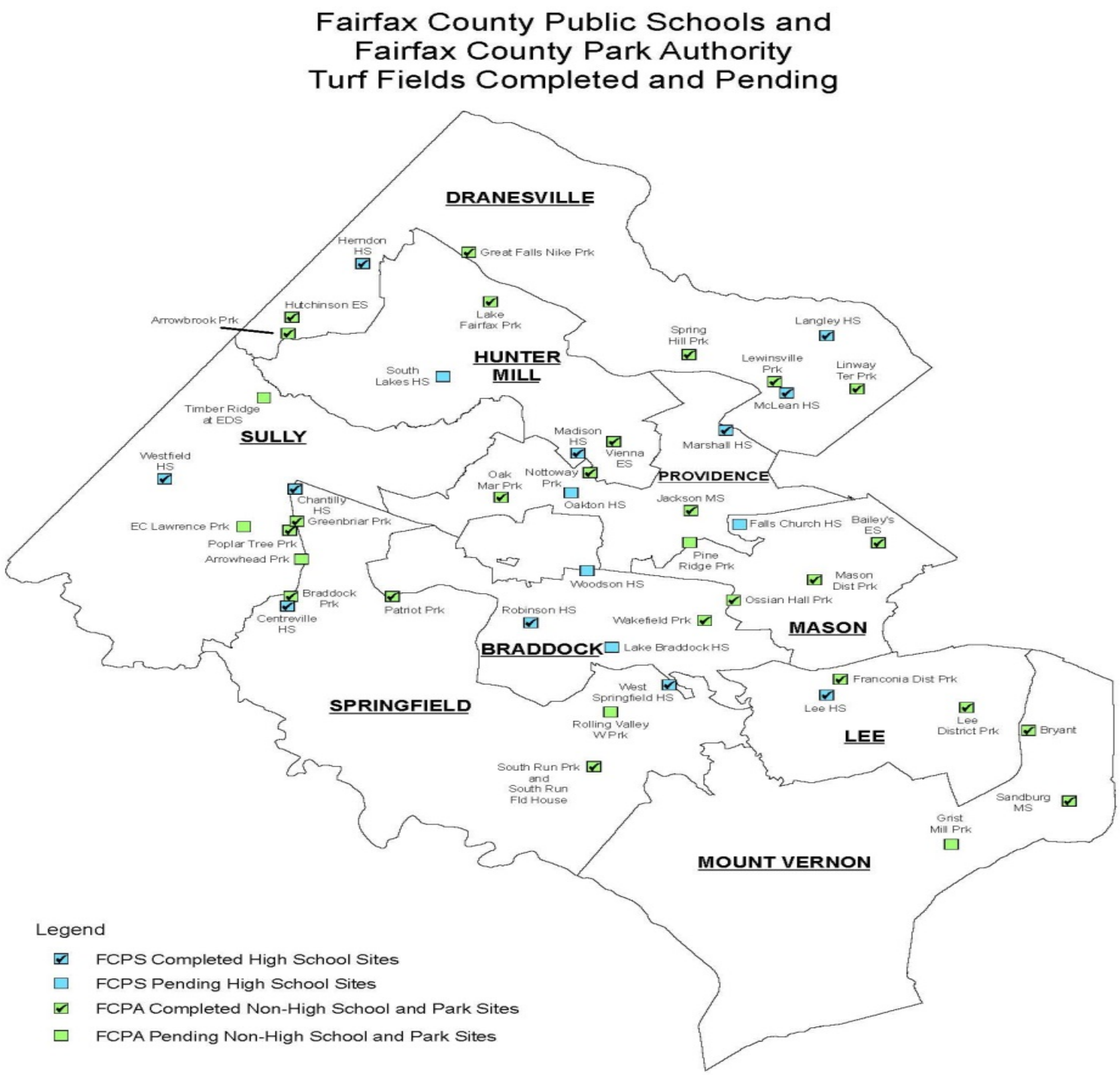
> *Park Authority Bond Funds funded the majority of the cost for park and other school synthetic turf field sites.*

*** A summary of all synthetic turf locations, funding sources, and costs can be found in Appendix VI.**

Development – Analysis and Findings

Where are the fields located?

Park and School synthetic turf fields are scattered throughout Fairfax County. The task force analyzed location by supervisory district. The following map identifies exact locations of the county's inventory of 67 synthetic turf fields built and in development:



Task Force Analysis – Background Questions and Responses

The following section provides information resulting from the analysis of the current environment on the history of the synthetic turf movement within the County and a summary of Task force findings.

Why build synthetic turf fields?

FINDING 1: **Converting natural grass fields to synthetic turf fields provides a solution to the increased countywide demand for use of outdoor fields**. As the Park Authority Needs Assessment pointed out in 2004, Fairfax County had a significant rectangular field shortage of 95 fields needed to accommodate requirements for adult and youth rectangular field users. The conversion to synthetic surfaces allows for year-round play and in most weather conditions which significantly increases the amount of playable time and thus affords the opportunity to help address the shortage of available field space.

2004 Park Authority Needs Assessment identified a rectangular field shortage of 95 fields. Conversion of natural grass fields to synthetic surfaces helps address that shortage.

What is the best field configuration? How can the county maximize community sports organizations' use and school's use for physical education instruction and high school athletic and other school program use?

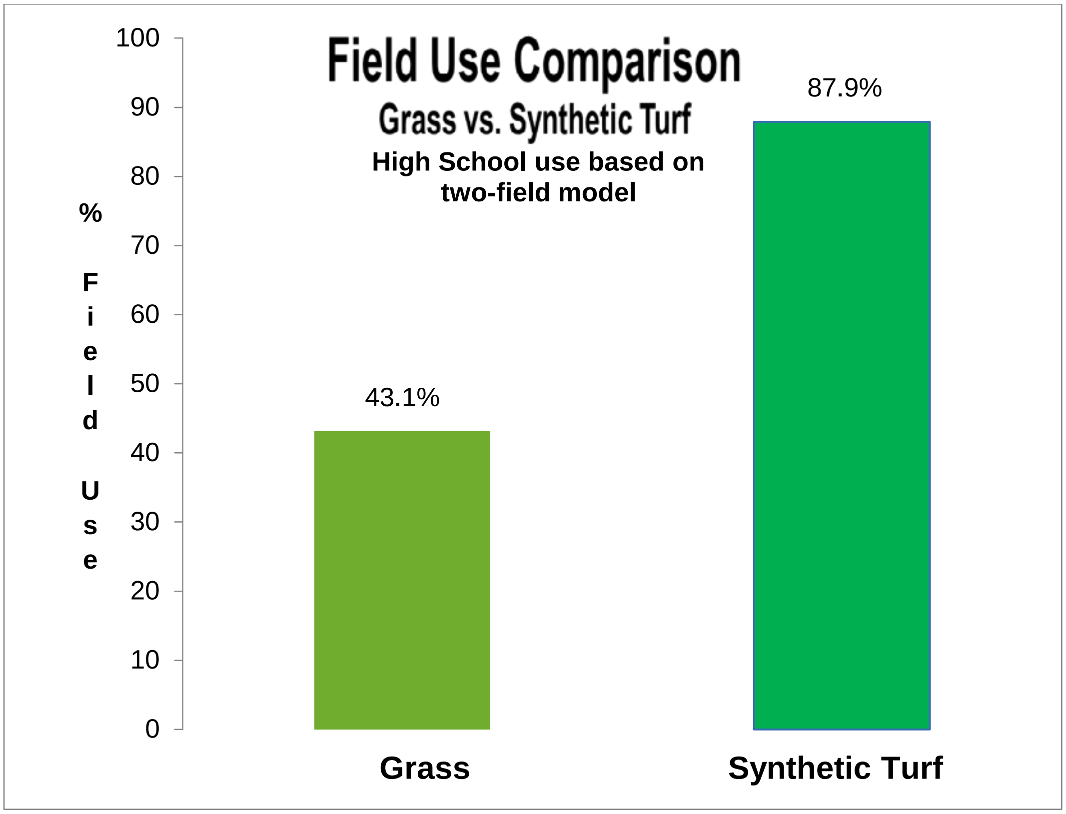
FINDING 2: **The optimal use of resources in the creation of synthetic turf fields on all sites (parks and schools) is a minimum two-field rectangular, or more, model.** Including a diamond field (where physically possible), the following financial benefits exist for establishing a standard minimum two-field rectangular model at all sites:

- Land purchases are costly, and limited opportunities exist for stand-alone development throughout the county
- There is some flexibility with land at middle and elementary schools to leverage existing resources to maximize use
- Cost savings can be achieved through economy of scale of field construction and operations

- Opportunities exist for two-field models on park-owned properties at sites throughout the county, thereby increasing accessibility to more users

FINDING 3: **In a two-field rectangular synthetic turf model at high schools, overall usage capacity is significantly increased, with both FCPS programs and community use equally benefitting.**, This provides community access to FCPS athletic fields that were previously not scheduled to the public through the field allocation process/system. A two-field model has the following benefits:

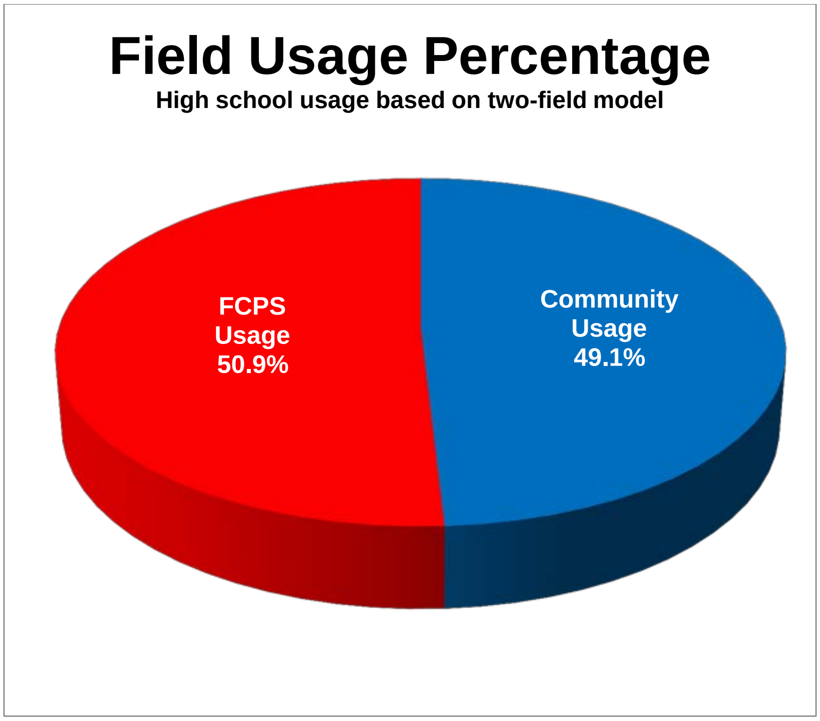
- Allows for increased use during the school day for physical education classes
- Avoids transportation issues for after-school practices to nearby middle and elementary schools and parks
- Increases field use time for community sports organizations during peak community use hours
- Best utilizes land available at school sites for community use
- Benefits the community sports organizations by the existence of a second, non-stadium field on school campus sites. The stadium field is heavily used by the FCPS sports teams and as such has a much more limited use for the community.
- Adds new fields to the public access inventory which were previously not available for scheduling
- Affords greater opportunity for community programs to use school fields
- Affords FCPS high school teams earlier practice times, makes more time available for community use of high school synthetic turf fields, and allows FCPS year-round use of FCPA synthetic turf fields from 3 – 5 p.m. on weekdays for practice



*** A summary of grass versus synthetic turf usage can be found in Appendix VII.**

Available field-use time is doubled, benefiting both school and community users.

Capacity is significantly increased at school sites using a two-field model and lighted fields.



Who benefits in a two-field model:

- Public Schools instructional programs
- Physical education
- Interscholastic athletics
- Intramural and after school programs
- Community sports organizations

*** A detailed breakdown on usage analysis can be found in Appendix VII.**

Are synthetic turf fields safe?

FINDING 4: Synthetic turf fields have been installed and used throughout the region, the nation and internationally. The health and safety aspects of synthetic turf have been reviewed and addressed by many national and state organizations, including the U.S. Environmental Protection Agency, the Centers for Disease Control and Prevention, and numerous state agencies in California, Connecticut, New Jersey, and New York. They generally conclude that these fields do not pose a serious public health concern. A fact sheet was prepared and publicly published in consultation with the Fairfax County Health Department, Fairfax County Risk Management Division, Fairfax County Public Schools and Fairfax County Park Authority to provide information on research conducted by numerous state and national organizations who have studied these issues. (See Appendix IV.)

What is the average cost to build a synthetic turf field?

FINDING 5: **Synthetic turf field and natural grass field development requirements are site specific**. Development costs for full and oversized rectangular turf fields have ranged from approximately $600,000 to $900,000. Cost variances are attributed to the varying sizes of the fields, specific site design requirements, and incorporation of project-related amenities required for each project. Examples of site specific design features include those that address environmental factors, geotechnical findings, engineering layout, onsite/offsite storm water drainage/best management practice requirements, earthwork balancing, and related infrastructure improvements. Project-specific ADA accommodations and amenities may include creation of accessible trails, parking spaces, bleacher/players bench accessible pads, purchase and assembly of bleachers/benches, side-field goals for youth soccer, protection fencing, and community-requested landscape buffer enhancements. Any combination of these site-specific design features may contribute to the variances between the overall total costs of individual projects.

Are the Park Authority and FCPS methodologies for project development similar? Are there any efficiencies or cost savings that can be applied to future development?

FINDING 6: Project Definition: FCPS and Park Authority total project costs commonly include professional design service fees, permitting fees, and construction development costs. There are, however, significant variances in project related amenities incorporated into FCPS and Park Authority development projects. Additionally, Park Authority total project development costs include a standard staff salary recovery expense, calculated at 8 percent of the design and construction development cost for capital improvement projects. FCPS previously did not charge staff salaries to project development costs, but will implement a $35,000 per-site fee for field development administrative costs in the summer of 2013.

FINDING 7: Competitive Pricing: Both the Park Authority and FCPS use the Fairfax County and Virginia State Procurement Regulations/guidelines, which include provisions for the use of National Cooperative State, Local and Municipal Contracts offering nationwide competitive pricing and competitive sealed bidding processes for the procurement of construction services.

FINDING 8: Contracting Efficiencies and Purchasing Practices: The Park Authority and FCPS have in the past identified opportunities for joint cooperative contract arrangements when in the best interest of the county. In 2008, staff partnered on joint contracting through U.S. Communities, a nationwide cooperative procurement program. Standards for the industry, price comparisons and other information sharing is routine and will continue on future synthetic turf field development efforts to maximize purchasing power and oversight of synthetic turf field development.

What is the capital investment for a synthetic turf field? Can bond funds be used?

FINDING 9: Synthetic turf field installations are permanent infrastructure investments. The capitalized investment for a synthetic turf field could be considered as permanent infrastructure, with components requiring replacement on an 8- to 10-year life cycle, assuming conformance to regular maintenance consistent with manufacturing product warranties. Similar to other capital construction investments, fields must be scheduled for routine, ongoing maintenance, and complete component replacement, each effort designed to prolong its use life cycle. Renovations will typically include carpet and fill materials replacement.

Park Authority bond funds have been utilized to finance development projects at 29 sites. To date, FCPS school bond funds have not been used for the development of synthetic turf fields.

Are the county's synthetic turf fields in the right locations? Do some communities have fewer than needed?

The task force analyzed the location of the 67 synthetic turf fields in existence or in development to assess whether the distribution and location allows for equal access and fair usage across the county for public schools athletic and community sports organizations. The Task force examined this information on three levels:

- **Utilization by major youth group participants**
- **Total population**
- **Location of high schools without synthetic turf fields (16 have turf; 8 do not)**

Shortages of synthetic turf fields exist in some parts of the county, in large part as a result of reliance on community funding for development of synthetic turf fields.

FINDING 10: Based on its review of synthetic turf field location and utilization, the task force identified significant comparative shortfalls in available synthetic turf fields in the Mount Vernon and Lee Supervisory Districts. These areas of the county should be considered for the next opportunities for development of rectangular synthetic turf fields to address the shortfalls. Shortfalls were identified through analysis of several different data sources: overall numbers of sports participants in youth leagues and high school athletic programs, total population, and placement of synthetic turf fields at high schools within each respective supervisory district. The analysis revealed community shortfalls in available synthetic turf fields, as well as comparative uneven distribution at high school sites across the county. (See detailed analysis on page 16 and comparison used to assess adequacy of field distribution across the county.)

The task force concludes that the shortfalls in these districts are not the result of a conscious or deliberate plan; the history of the development of the synthetic turf fields across the county clearly shows that fields were developed when a combination of opportunities met with:

- Community interest
- Site availability (with full size field and lighting infrastructure in place)
- Funding availability (through large community or private sector financial donations and/or development proffer funds

Typically, it was only **after one or more of these opportunities were under consideration** that public financing to supplement community resources was even considered to support the development projects. The ultimate allocation of public funding also was influenced by the stated need for a particular community. Were there unmet field requests experienced as part of the county's management of countywide field scheduling and use policies? Did communities applying for grant funding to partially support synthetic turf field development provide justification for the placement of the field? In most of the synthetic turf fields developed in the county, funding sources (including those appropriated or recommended by the Park Authority, the Athletic Council and/or the Board of Supervisors) were leveraging significant investments for specific identified sites and completed the financing package to allow the projects to move forward.

CURRENT SYNTHETIC TURF FIELD INVENTORY

	Synthetic Turf Field (STF) Inventory				2010 Census Total Population - Fairfax County		Rectangular Field Major Youth Group Sports-Community Use and High School Participants	
	FCPA & Non-HS School fields	FCPS High School Fields	Total Turf Fields	% of turf fields *	% of Total Population *	Differential from STF Inventory	% of Sports Participants *	Differential from STF Inventory
Braddock	1	6	7	10.4%	10.6%	-0.2	9.9%	0.5
Dranesville	9	4	13	19.4%	11.1%	8.3	16.3%	3.1
Hunter Mill	3	3	6	9.0%	11.4%	-2.4	11.3%	-2.3
Lee	2	1	3	4.5%	11.1%	-6.6	9.7%	-5.2
Mason	5	2	7	10.4%	10.8%	-0.4	10.6%	-0.2
Mount Vernon	3	0	3	4.5%	11.2%	-6.7	9.0%	-4.5
Providence	4	5	9	13.4%	11.2%	2.2	10.3%	3.1
Springfield	6	4	10	14.9%	11.0%	3.9	11.2%	3.7
Sully	8	1	9	13.4%	11.6%	1.8	11.6%	1.8
	41	26	67	100.0%	100.0%		100.0%	

**Totals may not equal 100% due to rounding*

What were the original guidelines regarding placement of synthetic turf fields?

FINDING 11: The Park Authority adopted criteria to identify fields that would be priority candidates for conversion to synthetic turf. The fields to be selected would be those that

most closely meet the program criteria. The approved criteria, adopted by the Park Board on July 26, 2006, are:

- Existing rectangular field**
- Minimum playing surface size of 370' X 190'
- Currently lighted or master plan approval for lights exists
- Conversions that would require minimal site work and/or amenity improvements
- Permit approval by Department of Public Works and Environmental Services through a minor site plan or rough grading permit (RGP)
- Fields geographically distributed throughout the county
- Reduction of rectangular field deficiencies identified in the 2004 Park Authority Needs Assessment

**Any construction of synthetic turf fields on property owned by Fairfax County Public Schools will require a long-term agreement that addresses the construction, community use, maintenance and eventual replacement of the field.

Are other types of synthetic turf fields needed in the community for other sports?

FINDING 12: The 2004 Park Authority Needs Assessment identified a diamond field shortage of 13 fields. Diamond-configured synthetic turf fields are in the development stages for Fairfax Countywide use. Two current synthetic turf fields exist (Nottoway Park and Waters Field) and two future sites are identified in the Park Authority Master Plan for the Laurel Hill Sports Plex and Patriot Park. In 2005, when the Board of Supervisors directed the use of Athletic Services Application Fee revenue into specific sports-related projects (such as rectangular synthetic turf field development), the diamond field community advocated for the use of available funds to significantly enhance the maintenance program on their existing natural grass diamond fields. The Park Authority is currently conducting an updated needs assessment that will be completed in 2014, the results of which should be used to guide community engagement for future diamond synthetic turf field needs.

How should synthetic turf fields be funded in the future?

FINDING 13: Community sports organizations provided significant funding and leadership to create the inventory in place today. However, the success of the synthetic turf field development program did not come without some unintended consequences. As the economy dipped into recession in 2008, increased reliance upon an already significantly leveraged program caused some disparity in development opportunities. For instance, on high school sites where synthetic turf fields were successfully completed, over half of the funding was raised by community sports organizations and school booster clubs in those communities. Geographic areas of the county without groups able to contribute at similar levels were left (and remain) without synthetic turf fields.

An additional issue identified by the task force is the capacity for some community sports organizations that borrowed funds to finance construction of synthetic turf fields. This has allowed their community to obtain such facilities in a timeframe that would not otherwise have been possible. However, this arrangement is reported to have left some of the organizations with significant loan debt. It will be important to assure that future arrangements forecast capacity to also contribute to maintenance and/or replacement needs on the field in question and the other natural grass fields on which they play.

FINDING 14: **Community sports organizations have continued, and should continue, to play a significant role in the development of synthetic turf fields**. To date, community sports organizations have contributed approximately 30 percent ($16 million) of all funds for development through direct financial contributions and payment of the "$5.50" fee. These contributions both leverage and reduce the county taxpayer funding investment for school children playing sports, physical education classes and community use for athletic league play for both children and adults.

FINDING 15: Reliance upon leveraged partnerships helped to create the inventory that exists today. Some communities will continue to have limited access to funding sources that other neighborhoods have had available. New strategies will need to be employed to overcome these challenges to ensure access for all county residents.

FINDING 16: Each school site has unique site capacity, a variety of community sports organizations and funding opportunities. Many contributing factors require individualized field development plans; for example, some sites are limited in size and could only be developed with a one-field model. A completely uniform development approach is not advantageous if community sports organizations' opportunities can be leveraged to reduce taxpayer costs.

Are development proffer funds available to support synthetic turf field development?

FINDING 17: Development proffer funds have been used in specific past efforts, contributing approximately 12 percent of the total cost of all synthetic turf field development to date. However, proffer funds cannot be relied upon as an assumed "standard" source of funding for development or replacement of synthetic turf fields. Availability of proffers is dependent on land use patterns. Proffers will be variable and should not be factored into a standard formula for development of synthetic turf fields as they may or may not be available for a particular development effort. Development proffer funds were made available to support 7 of 16 high schools for synthetic turf field development (Madison, Marshall, Lee, Westfield, McLean, Oakton and Woodson High Schools). Funds totaled $3.04 million for

11 synthetic turf fields, and represented approximately 16 percent of total high school sites development costs of $19.3 million; however, 9 high schools were built through other funds sources. Timing of synthetic turf field construction, location and development activity in the community were all factors in determining applicability and appropriateness for use.

What is the justification for use of school general fund or bond financing for synthetic turf fields on school property?

FINDING 18: Synthetic turf fields are not included in the existing FCPS school construction education specifications, thereby excluding the development of synthetic turf fields in new school construction or renovation projects. To date, no FCPS bond funds have been used to pay for installation of synthetic turf fields, as the fields were not included in the school education specifications. However, should the School Board choose to do so, bond funding, including new or undesignated funds, as well as use of general FCPS operating funds, appear to be viable funding sources.

How have other jurisdictions financed synthetic turf fields?

FINDING 19: The task force reviewed various development and maintenance strategies of localities throughout the nation. A select listing of these jurisdictions is shown on the next page. In reviewing the data, it is clear that Fairfax County residents have created one of the largest synthetic turf field inventories and are at the forefront of communities addressing the sharing of public resources, long-term capacity and need, maintenance, and financing strategies for synthetic turf fields.

Other Locality Practices for Development, Maintenance and Replacement of Synthetic Turf Fields				
Jurisdiction	**# of Fields**	**Development**	**Maintenance**	**Replacement**
Fairfax County, VA	67 (41 parks and non-HS, 26 HS)	Bond financing BOS FCPS one-time funds Donations, grants, other Athletic application fee grant Proffers School boosters Community sports organizations	FCPA: General maintenance fund FCPS: Local school responsibility	Athletic booster clubs (15k/year), community field use agreements, turf field replacement fund ($150k/year), FCPA Tournaments for Turf, County general fund appropriations ($350k/year)
Montgomery County, MD	4 (2 schools, 2 parks)	Inclusion on high school renovation capital improvement plans New Construction: booster club, private donations Parks: tax, grant reimbursement, program open space grant	G-max testing done by manufacturers Annual cleaning of infill	Revenue replacement fund – user fee based
Loudoun County, VA	5 schools	School bond funds Private funding from athletic groups	Contracted project management and construction	Private funds through user fees
Arlington County, VA	10 (3 schools, 7 parks)	Included in capital expenditure budget	Weekly inspection. G-max tested by contract. General Operating Budget	General Obligation bonds, pay-as-you-go, rental fees, possible partnerships
Prince William County, VA	9 parks	Public-private partnerships – government and sports leagues	Maintained by Parks as part of regular operating. Weekly clearing, monthly sweeping and grooming. Done by public/private partnerships	Under discussion. One field is licensed directly to a league; they carry responsibility to replace. Use fees and fund raising under consideration.
Aberdeen, MD	6 schools	Capital Improvement program, appropriated funds	Weekly inspection and grooming as needed. General Operating Budget	Under discussion; Money from grass maintenance re-directed to turf replacement.
Miami-Dade County, FL	9 parks	Public funds included in Capital Improvement Plan	Privately maintained, G-max tested twice per year. General Operating Budget	Under discussion
Asheville, NC	5 parks	Capital funds and partnerships	Soccer association purchased equipment; Park staff maintains and does work	Under discussion

Synthetic Turf Field Development Recommendations

Two charges were given to the task force regarding the development of new synthetic turf fields: recommendations for the location of rectangular and diamond fields; and funding recommendations for development of new synthetic turf fields. In response, the Task force recommends the following actions:

Recommendation 1: Synthetic turf fields and lights within school sites should be standard components in new school construction and future capital improvement renovation schedules. At high school sites, the two-field model should be standard for rectangular sports use.

Recommendation 2: The diamond sports community should be engaged to determine interest in expanding the conversion of natural grass softball and baseball fields to synthetic surfaces. The completion of the next Park Authority Needs Assessment should be used to guide that discussion to include gauging the desire of the diamond sports community to redirect a portion of the Athletic Services Application Fee (currently used for maintenance) to this effort and/or increase the fees for diamond sports participation.

Recommendation 3: Future synthetic turf field development should be guided by recommendations in this report for oversight, locations, development schedule and share of public funding allocations.

Recommendation 4: Install the two-field model at all high schools that currently do not have synthetic turf fields. Complete the 8 school sites to include 15 total synthetic turf fields within a three-year cycle–by 2016. BOS and School Board review options and adopt a variety of funding strategies to fund the development of turf fields for these 8 sites.

Convert rectangular stadium and auxiliary natural grass fields to synthetic turf at each of the following eight high schools:

- Annandale High School
- Edison High School
- Hayfield Secondary School
- Mount Vernon High School
- South County High School
- JEB Stuart High School (1 rectangular field per space constraints)
- Thomas Jefferson High School for Science and Technology
- West Potomac High School

Rationale:

1. Conversion of these eight school sites will provide 15 rectangular fields for both community and school athletic use. The purpose of this strategy is to resolve the equity issues that now exist in schools that do not have synthetic turf fields or will not receive synthetic turf fields in 2013.

2. This strategy will further address overall community use shortages in several identified areas of the county. Building these synthetic turf fields will increase the playability of fields located in the supervisory districts where demand exceeds availability. These fields will address the significant shortages identified in the Mount Vernon and Lee Districts.

3. Targeting the high schools:
   - is a prudent utilization of existing space and amenities (parking, lighting, bleachers and other infrastructure)
   - benefits the greatest number of county residents participating in public schools and community programs

Addition of 15 fields at High School Sites – Improvement by Supervisory District				
	FCPA & Non-HS School Synthetic Turf Fields	**FCPS High School Synthetic Turf Fields**	**Total Synthetic Turf Fields**	**Proposed New Synthetic Turf Fields**
Braddock	1	6	7	No change
Dranesville	9	4	13	No change
Hunter Mill	3	3	6	No change
Lee	2	5	7	+4
Mason	5	7	12	+5
Mount Vernon	3	6	9	+6
Providence	4	5	9	No change
Springfield	6	4	10	No change
Sully	8	1	9	No change
	41	**41**	**82**	**15**

Adding synthetic turf fields at the 8 recommended high school sites addresses the significant comparable shortages the task force identified in the southeast part of Fairfax County.

Recommendation 5: Continue to support community partnership opportunities directed at future synthetic turf field development, maintenance, and replacement.

Recommendation 6: **Modify construction standards to incorporate new storm water management requirements and develop consistent guidelines for promotion of the county's adoption of the use of green construction.**

Recommendation 7: Establish an oversight committee to oversee and periodically meet to monitor joint collaborative efforts for synthetic turf field development. Members should establish procedures consistent with the findings and recommendations in this report as a guide for their analysis. Members of the committee should include representatives from the following organizations:

- **Park Authority**
- **Fairfax County School Board**
- **Fairfax County Board of Supervisors**
- **Fairfax County Athletic Council**
- **Staff representation from the County (FCPA and NCS) and FCPS**

Synthetic Turf Field Development Funding Options

The task force reviewed several additional options for financing the development costs. Based on an estimated average of $800,000 for synthetic turf field development, adding 15 synthetic turf fields to the existing inventory will cost approximately $12.0 million. **Options to finance the development include the following:**

Funding Source Options	Funds Generated over a 3 year period
Mini-Grants - Redirect Community Services Turf Field Mini-grant Program funds for targeted development of the 8 high school sites (suspending the mini-grant program)	$1,050,000
Ability to Pay Expectation – Require community contribution for all eight schools from athletic booster clubs and community sports groups for field development. Tier 1: Require 25 percent contribution for 2 of 8 schools. (Calculation based on average field cost of $800,000). Schools recommended for tier 1 participation: Thomas Jefferson and South County. Tier 2: Require 12.5 percent for Hayfield High School. Tier 3: Require 6.25 percent contribution ($100,000 – or $50,000 per field). Schools recommended for tier 3 participation: Annandale, Edison, Mount Vernon, West Potomac, JEB Stuart. **(See Table 1, p. 25 for further detail)**	Tier 1: $800,000 Tier 2: $200,000 Tier 3: $450,000
Increase the Athletic Fee from $5.50 per rectangular sports participants (lacrosse, soccer, football, cricket, rugby, field hockey), per season to $8. Increases would be dedicated to development costs for the 15 new synthetic turf fields for the three-year development period.	$750,000
Subtotal: (community support)	**$3,250,000**
BOS: Direct all available and appropriate development proffer funding.	TBD
FCPS: Direct FCPS bond funds.	TBD
BOS: Development of a line item appropriation to create annual allocation or direct one-time appropriation of carryover funds in the county budget.	TBD
FCPS: Development of a line item appropriation to create annual allocation or direct one-time appropriation of carryover funds in the FCPS budget.	TBD
Balance for consideration by FCPS School Board and the BOS:	**$8,750,000**

Synthetic Turf Field Development: School Boosters/Adult-Youth Groups Contribution

It is the expectation that school booster clubs and community sports organizations will, collectively and to their best ability to pay, contribute up to twenty-five percent (25%) toward the development costs of a two-field synthetic turf field project. The ability to pay criteria will include, but may not be limited to, a school's percentage of students eligible for the FCPS High School Free and Reduced Lunch Program. This program serves as one indicator on the economic viability of the student body and community.

Currently the development costs of a two-field synthetic turf field project are estimated at $1.6M. The following table depicts the ability to pay scale and its application to the development of a two-field turf model:

Table 1. School Booster Clubs/Community Sports Organizations' Ability to Pay on Development Costs of Two-Field Synthetic Turf Model

Percent Free/Reduced Lunch Student Body	Ability to Pay Expectation for Athletic Booster Club and Athletic Groups	Estimated Two-Field Synthetic Turf Project Costs $1.6M	Impact of Ability to Pay Scale on (8) Remaining Schools (% at F/R) to be Turfed
33% or Greater	6.25%	$100,000	▪ Stuart HS * (55.2%) ▪ Mount Vernon HS (54.1%) ▪ Annandale HS (44.7%) ▪ West Potomac HS (38.1%) ▪ Edison HS (34.3%)
21% - 32%	12.50%	$200,000	▪ Hayfield Secondary (27.4%)
20% or Less	25.00%	$400,000	▪ South County HS (15.9%) ▪ Thomas Jefferson HS (2.2%)

*Stuart HS would be a one-field model (based on available space). As such, their contribution expectation would be $50,000.

Replacement of Synthetic Turf Fields

Each synthetic turf field development project increases our community's expertise and provides additional learning opportunities for improvement. Similarly, the first replacement efforts are underway in the summer of 2013 for the first two synthetic turf fields developed in Fairfax County, Lewinsville Park in McLean, and EC Lawrence Park in Centreville.

Most manufacturers provide an eight-year warranty for a properly maintained synthetic turf field; it has been a generally accepted practice to assume a life expectancy of the synthetic turf field at no longer than 10 years. For planning purposes, Fairfax County adopted a budget estimate of a little more than half the installation funding, a generally accepted practice for the industry.

Based on a projected ten-year replacement cycle, the current 67 field inventory replacement requirements are already a regular financial commitment. Planning considerations include analysis of individual field playability, based on the differing levels of use, the nature of the Northern Virginia climate, and the importance of required maintenance efforts.

Current Funding for Synthetic Turf Field Replacement

FINDING 20: Preliminary planning for funding synthetic turf field replacement began in 2007. Total estimated available annual funding of $740,000 is currently provided through the following funding sources:

- **Athletic Booster Clubs** - FCPS required booster clubs at schools where synthetic turf fields were installed to commit $15,000 annually as a set-aside for future synthetic turf field replacement.
- **Community Field Use Agreements** – FCPA and FCPS developed community use agreements that allowed community partners to maintain their priority use benefits in exchange for contributions to replace synthetic turf fields at the end of the fields' life cycle.
- **Synthetic Turf Field Replacement Fund** – Established in FY 2012, funding for this purpose was redirected ($150,000) from the Synthetic Turf Field Development Fund. A portion of athletic participation fees charged to rectangular field users, the "$5.50 fee," was allocated for synthetic turf field replacement requirements.
- **Tournaments for Turf -** The Park Authority initiated a Tournaments for Turf Program, in which tournaments are held for the purpose of generating additional revenue for the Synthetic Turf Field Replacement Fund.
- **County General Fund Appropriations** – The BOS approved use of a dedicated line item totaling $350,000. When combined with the "$5.50" fee redirected funds, total annual replacement funding, administered by NCS, is $500,000. Currently, this funding leverages monies provided by existing community partners continuing to participate in the priority use agreements, for all synthetic turf field replacement requirements.

These efforts are not sufficient to fully fund future replacement needs, for either the existing inventory or for the task force recommended expansion to 82 synthetic turf fields. Including the recommended additional 8 high schools in future development would increase this requirement by a total of **$2.16 million** annually.

Fairfax County – Estimated Synthetic Turf Field Replacement Needs

Total Synthetic Turf Field Replacement - By Year and Location		**FCPS Stadium**	**FCPS Non-Stadium & Park Authority**	**Total Current Field Inventory**	**Revised Total Including Recommended 8 New HS Sites**
		16	51	67	82
Total replacement	Estimated $450k each	$7,200,000	$22,950,000	$30,150,000	$36,900,000
Replacement fund (10 yr. est.)	School athletic booster funds $15k per HS site per year = **$240k annually** FXCO = **$500k annually** ($350k GF /$150k app. fees)	$2,400,000	$5,000,000	$7,400,000	$8,600,000
Cumulative Shortage		$4,800,000	$17,950,000	$22,750,000	$28,300,000
10 yr. average replacement		$480,000	$1,795,000	$2,275,000	$2,830,000
Community contribution - Percentage of monies contributed to each by community group	Youth and adult community sports organizations – amounts are based upon percentages provided during synthetic turf field developmental phase	($223,200)	($390,150)	($613,350)	($669,600)
Annual Shortage		**$256,800**	**$1,404,850**	**$1,661,650**	**$2,160,400**

Assumptions:

- ✓ Synthetic turf field life cycle = 10 years
- ✓ Synthetic turf field replacement cost = $450k
- ✓ Community contributions remain at least at initial percentage level of development commitments

Recommendation 8: Identify an ongoing funding source to fund the scheduled replacement of synthetic turf fields on Park Authority and FCPS sites.

Options to Fund Synthetic Turf Field Replacement Shortfall:

Option	Additional Annual Funding Generated
Annual replacement shortage	$2,160,400
Redirect additional Synthetic Turf Field Development Program monies into the Synthetic Turf Field Replacement Fund.	$150,000
Increase Athletic User fee charged to rectangular field users from $5.50 to $8 (per sport, per season).	$250,000
Increase booster club responsibility from $15,000 annually to $20,000 annually	$120,000
Tournament Field Rental User Fee - Increase field rental user fee from $15 to $50 for county teams and $100 for non-county teams for post regular season rectangular field sports program tournaments. (Assumes approximately 625 teams from out of county, generating an additional $53,000 annually and 1875 in-county teams generating an additional $65,000 annually)	$118,000
Subtotal—community funding in support of Synthetic Turf Field Replacement	**$638,000**
Remaining annual additional funding requirement	$1.53 million

Recommendation 9: Continue administration of the synthetic turf field replacement fund by NCS in support of future synthetic turf field replacement projects at FCPS and FCPA sites. Utilize project funding as directed by staff membership of the oversight committee proposed for establishment in Recommendation 6.

Maintenance of Synthetic Turf Fields

The task force reviewed current maintenance activities for FCPS and Park Authority natural grass and synthetic turf fields. The purpose was to determine who paid for the maintenance, analysis of the financial impact of increasing the inventory of synthetic turf fields and the implications for the community in the contributions made through boosters, community sports organizations, and other volunteers in the labor contributed to the upkeep of synthetic turf fields, as well as the financial capacity of various community sports organizations in support of the cost of maintaining synthetic turf fields. The Park Authority maintenance of the synthetic turf fields is centralized and managed with Park Authority staff. Fairfax County Public Schools' maintenance is decentralized and conducted by a combination of high school staff and contractors. The two approaches to managing the maintenance should be further reviewed to see if efficiencies can be achieved.

What are the current practices for synthetic turf maintenance?

FINDING 21: **Park Authority staff currently maintains synthetic turf fields at county parks and fields located on elementary and middle schools, as well as other non-high school FCPS sites. With the conversion of natural grass fields to synthetic turf, the Park Authority has found that the total annual operating cost of a synthetic turf field, including maintenance and utility costs, is comparable to a lighted and irrigated natural grass field because of the nature of year-round use.**

- Natural grass field operating costs include a basic turf grass program with seeding, aerating, fertilizer and pesticides applications, soil testing and amendments.
- Synthetic turf fields operating costs include regular grooming, debris removal, minor carpet repairs and adding rubber infill to high use areas, and unique reconditioning requirements that include brushing, de-compaction, deep cleaning, repair of inlaid field lines and adding crumb rubber to low or high use areas. The synthetic turf fields are also annually G-max tested by a certified engineer to help ensure their safety.

Maintenance activities for both field types include trash collection, inspections, field lining, maintenance and repairs of lighting, bleachers, benches, goals and signage. The costs associated with these tasks are year-round or 12 months a year for synthetic turf fields and only 8 months a year for a natural grass fields. Natural grass fields have additional mowing costs.

Utility expenses are also similar for both field types. Natural grass fields require lighting and water for the 8-month playing season. While the synthetic turf fields don't require watering, savings from reduced water usage are redirected to cover the increased electricity requirements for athletic field lighting resulting from the increased use capacity to 12 months.

Park Authority synthetic turf fields are maintained to all manufacturers recommendations and recognized industry standards. The natural grass fields are maintained to a budget. The maintenance standards for the natural grass fields have been adjusted as the available funding remained constant. The adjustments were necessary as staff and utility costs increased and additional lighting and irrigations systems were added without associated increases in operating budgets.

FINDING 22: Due to the decentralized nature of the maintenance activities at each FCPS school sites, any achieved savings from natural grass maintenance to synthetic turf maintenance should be redirected to specific site operations, to include the maintenance and replacement of the synthetic turf fields.

Natural grass fields at high schools are maintained at various levels, depending on the use. Rectangular, stadium game fields and 90' and 60' game diamonds are maintained at a higher level than grass fields used primarily for practices. The number of fields, both game and practice, varies by campus. Additionally, athletic fields with Bermuda grass surfaces require a significantly higher level of care than cool season grasses.

The annual cost to maintain a natural grass, stadium rectangular field is between $20,000 to $40,000 per school. The variance is influenced by type of grass, size and configuration of the field, volume of usage, frequency of maintenance, impact of weather, cost of labor, and the use of field lights. The expenses associated with school athletic field maintenance are not covered by the operating budget. Athletic field maintenance, to include supplies, labor and materials, is paid for by athletic event gate receipts, booster donations, fundraising, and donated labor. The equipment used to maintain grass fields can include tractors, mowers, sweepers, groomers, aerators, seeders, and/or trimmers. While individual schools do have some field maintenance equipment, the inventory is often supplemented by equipment purchased by the community funding sources. There are some schools that are able to contract for athletic field maintenance; these services are paid for by the same community contributions.

Recommendation 10: Park Authority and FCPS should adopt a consistent maintenance program for synthetic turf fields utilizing agreed upon best practices in order to maximize use of equipment, staffing and other resources.

Recommendation 11: Create a joint FCPS and Park Authority field maintenance work group, tasked with meeting to address ongoing maintenance needs to include recurring operating budget requirements.

Appendix I. Task Force Members

Fairfax County Board of Supervisors

Michael Frey, Supervisor, Sully District
Michael Coyle, Administrative Aide, Sully District

Fairfax County Public Schools

Megan McLaughlin, Braddock District Representative, School Board
Lee Ann Pender, Director, Administrative Services
Bill Curran, Director, Student Activities and Athletics
Bob Cordova, Property Management Coordinator

Fairfax County Athletic Council

Harold Leff, Chairman
Mark Meana, Vice Chairman

Fairfax County Park Authority

William G. Bouie, Chairman
Ken Quincy, Providence District Representative
Todd Johnson, Director, Park Operations Division
Deborah Garris, Manager, Synthetic Turf Branch

Neighborhood and Community Services

Chris Leonard, Director
Karen Avvisato, Manager, Athletic Services & Community Use Scheduling
Paul Jansen, Branch Manager, Athletic Services & Community Use Scheduling

Project Team

Brenda Gardiner, Policy and Information Manager, Department of Administration for Human Services
Steve Groff, Analyst, Athletic Services & Community Use Scheduling
Jason Shelton, Administrative Assistant, Athletic Services & Community Use Scheduling

Appendix II. Board Actions/Resolutions

County of Fairfax, Virginia

MEMORANDUM

DATE: JUN 2 2 2012

TO: Board of Supervisors

FROM: Edward L. Long Jr.
County Executive

SUBJECT: County/Schools Joint Task on Synthetic Turf Athletic Fields

The Fairfax County School Board passed a resolution at its December 15, 2011, meeting recommending the creation of a County/Schools Joint Task Force on Synthetic Turf Athletic Fields. In February 2012, Fairfax County School Board Chairman Jane K. Strauss sent a letter to Board of Supervisors Chairman Sharon Bulova and Fairfax County Park Authority Board Chairman William G. Bouie requesting support for this effort. At the April 10, 2012, Board of Supervisors (BOS) meeting, Board members affirmed their collective interest in working with the School Board and Park Board in this effort and referred the issue to staff to determine task force participation.

In the past few years, and in response to increased demand for athletic playing fields, Fairfax County, Fairfax County Public Schools, and the Fairfax County Park Authority have identified funds and partnered with local community groups and each other to develop more than 30 synthetic playing surfaces. The need for more fields continues to grow, and converting natural grass fields to synthetic surfaces provides the best solution to the county's need for more playing time on outdoor surfaces.

Staff from the Department of Neighborhood and Community Services (NCS) has met with staff from the Fairfax County Park Authority (FCPA) and the Fairfax County Public Schools (FCPS) to discuss this initiative. Subsequent to those discussions, it is the recommendation of all entities that the effort to convene and direct the task force be led by NCS staff as the community use scheduler of both park and school fields.

Under the direction of NCS, the joint task force will be responsible for developing recommendations to the BOS and the School Board on:

- the development of new synthetic fields, to include location recommendations
- the funding of new synthetic fields, to include private and corporate partnership opportunities
- the regular, on-going maintenance of existing synthetic fields
- the eventual replacement of developed synthetic fields

Throughout each of these recommendations, guidelines and processes will be reviewed with a focus on ensuring fair and equitable access for all geographic areas of the county.

Board of Supervisors
County/Schools Joint Task on Synthetic Turf Athletic Fields
Page 2

The task force will be comprised of community leaders and staff that have a direct connection to the current and future synthetic turf field efforts, including:

- Fairfax County Public Schools
  Megan McLaughlin, Braddock District School Board Representative
  Lee Ann Pender, Director, Administrative Services
  Bill Curran, Director, Student Activities and Athletics

- Fairfax County Athletic Council
  Harold Leff, Chairman
  Mark Meana, Vice Chairman

- Fairfax County Park Authority
  William G. Bouie, Chairman, Park Board
  Ken Quincy, Providence District Park Board Representative
  John Dargle, Director, FCPA
  Todd Johnson, Director, Park Operations Division, FCPA
  Deborah Garris, Synthetic Turf Fields Branch, FCPA

- Neighborhood and Community Services
  Chris Leonard, NCS Director
  Karen Avvisato, Athletic Services Program Manager, NCS
  Paul Jansen, Athletic Services Program, NCS

It is anticipated that official reporting of the task force's findings will be presented at a future joint School Board/Board of Supervisors meeting.

For further information, please contact Chris Leonard, NCS Director, at 703-324-5501.

c: Jane K. Strauss, Chairman, Fairfax County School Board
Jack D. Dale, Superintendent, Fairfax County Public Schools
William G. Bouie, Chairman, Fairfax County Park Authority
Harold Leff, Chairman, Fairfax County Athletic Council
Patricia D. Harrison, Deputy County Executive
Robert A. Stalzer, Deputy County Executive
Christopher A. Leonard, Director, Neighborhood and Community Services
John W. Dargle, Director, Park Authority

THE FAIRFAX COUNTY SCHOOL BOARD

8115 GATEHOUSE ROAD, SUITE 5400, FALLS CHURCH, VA 22042

Fairfax County
Public Schools

571.423.1075
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February 9, 2012

The Honorable Sharon Bulova
Chairman
Fairfax County Board of Supervisors
12000 Government Center Parkway, Suite 530
Fairfax, VA 22035

Mr. William G. Bouie
Chairman
Fairfax County Park Authority Board
Herrity Building - Suite 927
12055 Government Center Parkway
Fairfax, VA 22035

Dear Chairman Bulova and Chairman Bouie:

On December 15, 2011, the School Board approved a resolution recommending that the Board of Supervisors and the Park Authority Board create a joint task force to make recommendations on the development of turf fields in the future. All Fairfax County citizens would benefit from a multi-agency approach to the development and maintenance of turf fields across the county.

This joint task force would examine the need for additional rectangular and diamond turf fields, the requirements for ongoing field maintenance, and funding requirements for future field replacement. This joint effort between the Board of Supervisors, the Park Authority, and the School Board would be comprised of representatives from the Fairfax County Neighborhood Community Services, the Park Authority, Fairfax County Public Schools, and the Fairfax County Athletic Council. The joint task force would report on their recommendations by September 2012, to the Board of Supervisors, the School Board, and the Park Authority.

I hope the Board of Supervisors and the Park Authority will welcome this initiative to work collaboratively so that athletes and citizens across Fairfax County can equally enjoy the many benefits of turf fields.

Sincerely,

Jane K Strauss

Jane K. Strauss
Chairman
Dranesville District

JKS/kfp

Attachment

cc: School Board Members
Jack D. Dale

Agenda Item Details

Meeting	Dec 15, 2011 - Regular Meeting No. 10
Category	2. Meeting Opening - 7 p.m.
Subject	2.10 Resolution Recommending Joint Task Force on Turf Fields
Type	Action

RESOLUTION RECOMMENDING
JOINT TASK FORCE ON TURF FIELDS

WHEREAS, Fairfax County citizens benefit from the installation of artificial turf fields at County parks and schools through increased available playing time; and

WHEREAS, progress has been made in installing such fields at over 30 locations in Fairfax County to include both Park Authority and Fairfax County Public Schools fields; and

WHEREAS, it is important to ensure that all geographic areas of the County enjoy equal access to such fields by installing additional fields in the future, to include all Fairfax County public high schools; and

WHEREAS, it is important that both existing and future fields are maintained appropriately to ensure their continuing quality and maximum useful life for citizens and county high school students; and

WHEREAS, it is important that funds be identified to install new turf fields and replace all fields when the useful life is exhausted; and

NOW, THEREFORE, BE IT RESOLVED that the School Board recommends to the Board of Supervisors and the Park Authority Board the creation of a joint task force to examine and report by September 2012 to the Fairfax County School Board, the Fairfax County Park Authority Board, and the Fairfax County Board of Supervisors on the need for additional rectangular and diamond turf fields, the requirements for ongoing field maintenance, and funding requirements for future field replacement; and

FURTHERMORE BE IT RESOLVED that the School Board recommends that the joint task force be comprised of representatives from Fairfax County Neighborhood Community Services, Fairfax County Park Authority, Fairfax County Public Schools, and the Fairfax County Athletic Council.

I hereby certify the above Agenda Item 2.10 was adopted by the County School Board of Fairfax County, Virginia, at a regular meeting held on December 15, 2011, at Luther Jackson Middle School, Falls Church, Virginia.

Pamela Goddard

Pamela Goddard, Clerk
County School Board of
Fairfax County, Virginia

FAIRFAX COUNTY PARK AUTHORITY

12055 Government Center Parkway, Suite 927 • Fairfax, VA 22035-1118
703-324-8700 • Fax: 703-324-3974 • www.fairfaxcounty.gov/parks

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DIRECTOR OF NEIGHBORHOOD
AND COMMUNITY SERVICES

February 22, 2012

Ms. Jane K. Strauss, Chairman
Fairfax County School Board
8115 Gatehouse Road, Suite 5400
Falls Church, VA 22042

Dear Chairman Strauss:

I am very pleased to learn of the School Board's recent recommendation for the creation of a joint task force by the Fairfax County Board of Supervisors and the Fairfax County Park Authority Board in order to make recommendations on the development of synthetic turf fields in Fairfax County. The Park Authority Board recognizes the wisdom and benefits of collaboration at all levels and has supported vital partnerships since the field turf program's inception nearly a decade ago.

We applaud this opportunity to further explore the appropriate placement of new synthetic turf fields, the challenges of funding both new and replacement turf fields and our ongoing maintenance needs for rectangular and diamond turf fields. The need for synthetic turf fields continues to grow as both youth and adult leagues, and school sports draw ever increasing participation. I believe that the Department of Neighborhood and Community Services would be another important participant in this venture. Working together, ensuring that all stakeholders have a say, I am certain we can equitably meet the needs of the community.

The Park Authority Board stands ready to begin this process and will endeavor to meet the relatively short timeframe for the drafting of recommendations. I will discuss the specifics of the initiative with Board of Supervisors Chairman Sharon Bulova to seek her consensus how best to move forward with this proposal.

Sincerely,

William G. Bouie
Chairman

Copy: Sharon Bulova, Chairman, Board of Supervisors
Anthony H. Griffin, County Executive
Chris Leonard, Director, Department of Neighborhood and Community Services

Appendix III. FCPS High School Free and Reduced Lunch Percentage

October 2012 Division #	School #		School Typ	Low Grade	High Grade	SNP Membershi	FREE Eligibile	FREE Percentage	REDUCED Eligibile	REDUCED Percentage	TOTAL F/R Eligible	TOTAL F/R Percentage
029	1070	STUART HIGH	SCH-HIGH	9	12	1,749	811	46.37%	155	8.86%	966	55.23%
029	0420	MOUNT VERNON HIGH	SCH-HIGH	9	12	1,885	799	42.39%	221	11.72%	1,020	54.11%
029	1100	FALLS CHURCH HIGH	SCH-HIGH	9	12	1,673	687	41.06%	170	10.16%	857	51.23%
029	1020	LEE HIGH	SCH-HIGH	9	12	1,813	674	37.18%	171	9.43%	845	46.61%
029	0660	ANNANDALE HIGH	SCH-HIGH	9	12	2,414	819	33.93%	261	10.81%	1,080	44.74%
029	0900	WEST POTOMAC HIGH	SCH-HIGH	9	12	2,255	709	31.44%	151	6.70%	860	38.14%
029	1270	EDISON HIGH	SCH-HIGH	9	12	1,695	458	27.02%	123	7.26%	581	34.28%
029	0032	HERNDON HIGH	SCH-HIGH	9	12	2,168	508	23.43%	128	5.90%	636	29.34%
029	1800	HAYFIELD SECONDARY	SCH-COMI	7	12	2,831	555	19.60%	221	7.81%	776	27.41%
029	1990	SOUTH LAKES HIGH	SCH-HIGH	9	12	2,321	484	20.85%	116	5.00%	600	25.85%
029	0020	FAIRFAX HIGH	SCH-HIGH	9	12	2,650	471	17.77%	184	6.94%	655	24.72%
029	0200	CENTREVILLE HIGH	SCH-HIGH	9	12	2,385	342	14.34%	162	6.79%	504	21.13%
029	2228	WESTFIELD HIGH	SCH-HIGH	9	12	2,785	430	15.44%	129	4.63%	559	20.07%
029	1290	MARSHALL HIGH	SCH-HIGH	9	12	1,654	209	12.64%	62	3.75%	271	16.38%
029	2241	SOUTH COUNTY HIGH	SCH-HIGH	9	12	2,008	227	11.30%	93	4.63%	320	15.94%
029	0131	CHANTILLY HIGH	SCH-HIGH	9	12	2,634	359	13.63%	51	1.94%	410	15.57%
029	0090	LAKE BRADDOCK SECONDA	SCH-COMI	7	12	4,000	408	10.20%	181	4.52%	589	14.72%
029	1610	WEST SPRINGFIELD HIGH	SCH-HIGH	9	12	2,279	193	8.47%	80	3.51%	273	11.98%
029	1960	ROBINSON SECONDARY	SCH-COMI	7	12	3,882	286	7.37%	135	3.48%	421	10.84%
029	1710	OAKTON HIGH	SCH-HIGH	9	12	2,162	176	8.14%	43	1.99%	219	10.13%
029	1260	WOODSON HIGH	SCH-HIGH	9	12	2,224	144	6.47%	57	2.56%	201	9.04%
029	0790	MCLEAN HIGH	SCH-HIGH	9	12	2,081	121	5.81%	58	2.79%	179	8.60%
029	1060	MADISON HIGH	SCH-HIGH	9	12	1,986	114	5.74%	42	2.11%	156	7.85%
029	1371	THOMAS JEFFERSON HIGH	SCH-HIGH	9	12	1,842	24	1.30%	17	0.92%	41	2.23%
029	1460	LANGLEY HIGH	SCH-HIGH	9	12	1,949	31	1.59%	3	0.15%	34	1.74%

*Source: VA Department of Education (2012 Data) http://www.doe.virginia.gov/support/nutrition/statistics/index.shtml

Appendix IV. Synthetic Turf Fact Sheet

Fact Sheet on Synthetic Turf Used in Athletic Fields

Synthetic turf fields using crumb rubber have been installed and used in many athletic and playing fields throughout Fairfax County, the United States and the world. Currently Fairfax County Public Schools and Parks have 48 rectangular athletic fields composed of synthetic turf material. Questions have been raised about potential health, safety, and environmental effects from the use of synthetic turf. This fact sheet was prepared in consultation with the Fairfax County Health Department, Fairfax County Risk Management Division, Fairfax County Public Schools and Fairfax County Park Authority to provide information on research conducted by numerous state and national organizations who have studied these issues.

Q: Why is synthetic turf used in Fairfax County?

A: Starting in the early 2000's the Park Authority along with other organizations in the County that provide athletic facilities began looking at alternatives to natural turf fields to meet the growing demand for use of athletic fields throughout the County.

Synthetic turf is a man-made product and is mostly installed in fields that are heavily used. Synthetic turf fields are used in Fairfax County because they:

- Provide even playing surfaces
- Provide similar playing conditions to natural turf fields
- Need no watering or mowing
- Use no fertilizers or pesticides
- Can be used year-round and in most weather
- Do not need to be closed to protect or re-sod grass
- Have a significant life cycle with reduced maintenance

Q: What are synthetic turf fields made of?

A: Synthetic turf fields installed in Fairfax County have been constructed using a synthetic carpet material that mimics natural grass along with a crumb rubber infill or sand/crumb rubber infill mixture and subsurface drainage systems. Synthetic turf fields are made of the following materials:

- A subsurface drainage layer composed of crushed stones with plastic tubing for drainage.
- A top layer composed of plastic mesh with soft, plastic strands that resemble blades of grass.

- Crumb rubber infill, made from recycled tires, is added to the top layer to provide padding and keep the grass upright. Sand is sometimes mixed with the crumb rubber.

Q: What chemicals can be found in the synthetic turf crumb rubber?

A: The crumb rubber used in synthetic turf is mainly composed of recycled tires, which contain man-made and natural rubber. Based on the review of research studies and reports, certain chemicals have been identified in crumb rubber. These include small amounts of polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and heavy metals such as zinc, iron, manganese and lead.

Q: Can people be exposed to the chemicals found in crumb rubber?

A: To date, studies on the release of chemicals from crumb rubber have reported very low concentration of chemical exposure. Although the potential for health effects due to exposure to chemicals in crumb rubber is very low, there are three possible ways for people to have contact with these chemicals on artificial turf fields:

- Accidentally ingesting small amounts of crumb rubber by putting fingers in the mouth or not washing hands before eating after playing on the fields
- Breathing in dust and vapors while playing on the fields. Crumb rubber may become dust as it wears and the rubber may give off some vapors.
- Direct skin contact with the crumb rubber.

Q: Are any health effects associated with these chemicals found in synthetic turf crumb rubber?

A: The health and safety aspects of synthetic turf have been reviewed and addressed by many national and state organizations, including the U.S. Environmental Protection Agency, the Centers for Disease Control and Prevention, and numerous state agencies in California, Connecticut, New Jersey, and New York. They generally conclude that health effects are unlikely from exposure to the levels of chemicals found in synthetic turf and that these fields do not pose a serious public health concern. Specifically, a review of the available information on crumb rubber by the New York Department of Health indicates that ingestion, dermal, or inhalation exposures to chemicals in or released from crumb rubber do not pose a significant public health concern. A multi-agency report from the State of Connecticut concluded that the use of outdoor and indoor artificial turf fields is not associated with elevated health risk. Studies and reviews conducted by the California Office of Environmental Health Hazard Assessment found that synthetic turf fields do not represent a serious human health risk with regard to the inhalation of chemicals or particulates above these fields. These studies indicate that at much higher levels, these chemicals can cause serious health effects. Some PAHs may pose a cancer risk for people exposed to high levels for long periods. VOCs can cause eye, nose, throat, and skin irritation. In young children, exposure to lead may cause learning and behavioral problems and lowered intelligence.

Q: Can people be exposed to these chemicals from other sources?

A: The PAHs and VOCs found in crumb rubber are very common in the urban environment. People can be exposed by breathing or eating or by getting dirt or dust on their skin. Rubber dust from car tires is a source of urban air pollution and soil pollution. PAHs are present in exhaust, smoke, soot, urban soil and char-broiled foods. VOCs are released into the air from gasoline, paint, building materials and many other sources. Lead is commonly found in soil and dust in the urban environment because, in the past, it was used in paint, gasoline and many other products.

Q: Does the heat generated by synthetic turf pose a health risk to users?

A: Like asphalt, the crumb rubber in synthetic turf fields absorbs heat from the sun and gets hotter than dirt or natural grass. On hot days, some synthetic turf fields may be too hot to play on. To protect yourself from the heat, health officials have recommended that you take the following precautions: drink lots of water, wear light and loose fitting clothes, always wear shoes, take breaks often, and exercise moderately. If you experience symptoms of heat related illness, such as dizziness, weakness, headache, nausea, vomiting or muscle cramps, move to a shaded area, drink water and rest. Seek medical attention if you do not feel better. It is especially important that adults supervising children take precautions on hot days.

Q: Are people who play on synthetic turf fields at risk of bacterial skin infections?

A: Bacterial skin infections, such as methicillin-resistant S. aureus (MRSA), have not been shown to be caused by synthetic turf fields. A multi-agency report to the California state legislature stated that the number of skin abrasions suffered on synthetic turf fields was greater than on natural turf fields, but the severity of the abrasions did not differ. The report found synthetic turf fields to harbor fewer bacterial species and a smaller number of live bacteria than natural turf fields.

MRSA has not been proven to be caused by synthetic turf field contact. Bacterial skin infections among athletes are due mainly to physical contact and sharing contaminated towels or sports equipment. Coaches and players should be aware of the potential for MRSA transmission and infection among athletes. All skin cuts or abrasions should be washed with soap and water and covered immediately. School athletic departments and sports leagues, should use good hygienic practices and prohibit the sharing of towels and equipment that rubs against bare skin.

Q: Should people continue to use synthetic turf fields with crumb rubber?

A: Regular physical activity is one of the most important parts of a healthy lifestyle. Synthetic turf fields allow access to open spaces for sports and physical activities. After any outdoor activity health organizations recommend that people should wash their hands before eating or drinking. On very hot days, users should limit activities, take rest breaks and drink water.

Q: What preventive measures can be taken to further reduce potential health and safety concerns of synthetic turf fields?

A: Hand-washing after using the field, especially before eating; discouraging eating while on the field; and monitoring for potential heat-related illness are recommended measures for minimizing potential risks associated with synthetic turf fields.

Q: Where can I get more information?

A: The following links provide additional information and details on the health assessment of synthetic turf fields:

- New York City Department of Health Artificial (Synthetic) Turf Fact Sheet: http://www.nyc.gov/html/doh/html/eode/eode-turf.shtml
- New York City Department of Health Air Quality Survey Of Synthetic Turf Fields: http://www.nyc.gov/html/doh/downloads/pdf/eode/turf_aqs_report0409.pdf
- New York City Department of Health Review of the Potential Health and Safety Risks From Synthetic Turf Fields: www.nyc.gov/html/doh/downloads/pdf/eode/turf_report_05-08.pdf
- Connecticut Department of Public Health Human Health Risk Assessment of Artificial Turf Fields: www.ct.gov/dep/lib/dep/artificialturf/dph_artificial_turf_report.pdf
- New York State Health Department Crumb-Rubber Infilled Synthetic Turf Athletic Fields Fact Sheet: http://www.health.ny.gov/environmental/outdoors/synthetic_turf/crumb-rubber_infilled/fact_sheet.htm
- Connecticut Academy of Science and Engineering Committee Report: Peer Review of an Evaluation of the Health and Environmental Impacts Associated with Synthetic Turf Playing Fields: www.ct.gov/dep/lib/dep/artificialturf/case_artificial_turf_review_report.pdf
- California Department of Resources Recycling and Recovery Report to the Legislature on Health Impacts of Outdoor Artificial and Natural Turf Fields: http://www.calrecycle.ca.gov/publications/documents/tires/2011007.pdf

Appendix V. FCPA Synthetic Turf Operation/Maintenance Cost

Lighted Rectangle Field Annual Operational Costs - FY2013
Level 1 Natural Grass Field

WORKING DRAFT
As of 6/18/2013

Task Description	Frequency		Per Recurrence	Labor Hours	Hourly Shop Rate (Direct/Indirect Cost)	Labor Cost	Material Cost	Contracted Services	Total Task Cost Per Field
MAINTENANCE									
Remove Ground Trash and Empty Receptacles	3 Times Per Week (April - November) 1 Time Per Week (December - March)	116	0.2	23.20	$52	$1,206	$73		$1,279
Off Season Maintenance	Annually	1	13	13.00	$52	$676	$279		$955
Mowing	2 Times per Week (April - November)	64	0.8	51.20	$52	$2,662			$2,662
Amenity Inspections, Maintenance and Repair (Benches, Bleachers, Goals, Signage)	As Needed			8.60	$52	$447	$138		$585
Field Lining	2 Times Per Year	2	2.5	5.00	$52	$260	$82		$342
Irrigation Maintenance and Repairs	2 Times Per Year	2	8	16.00	$52	$832	$580	$350	$1,762
Lighting Inspections	Weekly	32	0.2	6.40	$52	$333			$333
Lighting Maintenance and Repairs	2 Times Per Year	2	2.2	4.40	$52	$229		$800	$1,029
Maintenance Total									**$8,947**
Turf Program									
Fertilizer Applications	4 Times Per Year	4	1.2	4.80	$52	$250	$1,000		$1,250
Aeration	2 Times Per Year	2	2.7	5.40	$52	$281			$281
Pesticide Application	2 Times Per Year	2	3	6.00	$52	$312	$400		$712
Over Seeding	Annually	1	3.5	3.50	$52	$182	$400		$582
Soil Amendments	Every 3 Years	0.33	3.6	1.19	$52	$62	$102		$164
Soil Sampling	Every 3 Years	0.33	1	0.33	$52	$17	$10		$27
Field Inspections	Annually	1	1.2	1.20	$52	$62			$62
Turf Program Total									**$3,078**
UTILITIES									
Electricity	Annually								$3,429
Water	Annually								$2,102
Utilities Total									**$5,531**
Natural Grass Per Field Total				**127.0**		**$6,605**	**$3,064**	**$800**	**$17,556**
(FCPA currently manages 15 lighted natural grass rectangle fields, which include 4 rectangle overlay fields.)									

*Labor, Material, and Contracted Services costs are supported with monies from General Fund and County Construction Fund-Athletic Field Maintenance

Appendix VI. Synthetic Turf Financing Chart

Fairfax County Synthetic Turf Field Project Financing

	Site Name	District	Number of Fields	Lights	BOS[1] (one-time appropriation)	FCPS (one-time funds)	Donations, Grants, Other	FCPA Bond	NCS[2]	Proffers	School Boosters[3] (cash/loans)	Community Sports Organizations (cash/loans)	All Sources
Fairfax County Park Authority and Fairfax County Elementary Schools, Middle School and Alternative High Schools	Arrowbrook Park	Dranesville	1	Y						$750,000			$750,000
	Baileys ES	Mason	1	N				$721,221					$721,221
	Braddock Park	Springfield	1	Y					$849,000				$849,000
	Bryant Alternative HS	Mount Vernon	1	Y				$812,310					$812,310
	EC Lawrence Park	Sully	1	Y				$650,000					$650,000
	Franconia Dist. Park	Lee	1	Y				$841,000					$841,000
	Great Falls Nike Park	Dranesville	1	Y				$250,000	$150,000			$425,000	$825,000
	Greenbriar Park	Springfield	1	Y				$898,000					$898,000
	Hutchison ES	Dranesville	1	Y				$900,000					$900,000
	Jackson MS	Providence	1	Y				$257,550	$549,779	$682,500			$1,489,829
	Lake Fairfax Park	Hunter Mill	2	Y				$1,596,000					$1,596,000
	Lee District Park	Lee	1	Y				$908,000					$908,000
	Lewinsville Park	Dranesville	1	Y				$267,365				$500,000	$767,365
	Linway Terrace Park	Dranesville	1	N					$150,000			$687,766	$837,766
	Mason District Park	Mason	1	Y	$166,533				$324,467			$250,000	$741,000
	Nottoway Park	Providence	1	Y				$200,000		$340,892			$540,892
	Oak Marr Park	Providence	2	Y				$1,709,000					$1,709,000
	Ossian Hall Park	Mason	1	N				$600,000					$600,000
	Patriot Park	Springfield	1	Y				$1,100,000					$1,100,000
	Pine Ridge Park	Mason	1	Y				$685,000					$685,000
	Poplar Tree Park	Sully	2	Y				$1,520,000					$1,520,000
	Sandburg MS	Mount Vernon	1	Y	$2,433			$820,718					$823,151
	South Run Park	Springfield	2	Y				$1,348,000					$1,348,000
	Spring Hill Park	Dranesville	1	N					$150,000			$761,198	$911,198
	Spring Hill Park	Dranesville	2	N								$1,783,000	$1,783,000
	Wakefield Park	Braddock	1	Y	$166,533				$243,467			$400,000	$810,000
	Vienna ES	Hunter Mill	1	Y	$166,533		$100,000		$258,467			$425,000	$950,000
		In-Service Fields-Subtotal:	32		$502,032	$0	$100,000	$16,084,164	$2,675,180	$1,773,392	$0	$5,231,964	$26,366,732
Pending Non-High School Projects	Arrowhead Park	Sully	2	Y				$1,647,500					$1,647,500
	EC Lawrence Park	Sully	1	Y				$825,000					$825,000
	Lewinsville Park	Dranesville	1	Y				$150,000	$175,000			$485,000	$810,000
	Grist Mill Park	Mount Vernon	1	N			$200,000	$950,000	$175,000				$1,325,000
	Timber Ridge @ EDS	Sully	2	Y						$1,500,000			$1,500,000
	Pine Ridge Park	Mason	1	Y				$810,000					$810,000
	Rolling Valley West Park	Springfield	1	Y				$810,000					$810,000
		Pending Fields-Subtotal:	9		$0	$0	$200,000	$5,192,500	$350,000	$1,500,000	$0	$485,000	$7,727,500
		SUBTOTAL:	41		$502,032	$0	$300,000	$21,276,664	$3,025,180	$3,273,392	$0	$5,716,964	$34,094,232
	CPA/FCPS NON- HS FIELDS - PERCENT SHARE OF ALL SOURCES OF FUNDING-TOTAL:				1%	0%	1%	62%	9%	10%	0%	17%	100%
Fairfax County Public High/Secondary Schools	Centreville HS	Springfield	2	Y	$275,000		$168,432		$175,000		$339,320	$300,000	$1,257,752
	Chantilly HS	Springfield	1	Y			$135,000		$150,000		$200,000	$200,000	$685,000
	Herndon HS	Dranesville	2	Y				$400,000	$150,000		$392,308	$392,128	$1,334,436
	Langley HS	Dranesville	1	Y	$175,000						$542,800		$717,800
	Lee HS	Lee	1	Y						$780,979			$780,979
	Madison HS	Hunter Mill	1	Y						$458,018	$100,000	$250,000	$808,018
	Marshall HS	Providence	2	Y						$991,190	$10,476	$608,000	$1,609,666
	McLean HS	Dranesville	1	Y	$175,000					$200,000	$186,085	$100,000	$661,085
	Robinson SS	Braddock	2	Y	$150,000				$175,000		$407,188	$498,000	$1,230,188
	West Springfield HS	Springfield	1	Y			$40,114					$795,671	$835,785
	Westfield HS	Sully	1	Y			$42,000			$350,000	$75,000	$350,000	$817,000
		In-Service Fields-Subtotal:	15		$775,000	$0	$385,546	$400,000	$650,000	$2,780,187	$2,253,177	$3,493,799	$10,737,709
Pending HS/SS Projects	Falls Church HS	Mason	2	Y		$1,274,715			$260,000				$1,534,715
	Lake Braddock SS	Braddock	2	Y	$175,000		$200,000		$85,000		$500,000	$500,000	$1,460,000
	Oakton HS	Providence	3	Y	$175,000		$250,000	$115,387	$260,000	$68,878	$250,000	$1,400,000	$2,519,265
	South Lakes HS	Hunter Mill	2	Y	$175,000		$180,000	$849,603	$85,000		$115,000	$177,000	$1,581,603
	Woodson HS	Braddock	2	Y	$175,000		$75,000	$130,512	$85,000	$190,670	$340,000	$500,000	$1,496,182
		Pending Fields-Subtotal:	11		$700,000	$1,274,715	$705,000	$1,095,502	$775,000	$259,548	$1,205,000	$2,577,000	$8,591,765
		SUBTOTAL:	26		$1,475,000	$1,274,715	$1,090,546	$1,495,502	$1,425,000	$3,039,735	$3,458,177	$6,070,799	$19,329,474
	PERCENT SHARE OF ALL SOURCES OF FUNDING-TOTAL:				8%	7%	6%	8%	7%	16%	18%	31%	100%
	GRAND TOTALS		**67**		**$1,977,032**	**$1,274,715**	**$1,390,546**	**$22,772,166**	**$4,450,180**	**$6,313,127**	**$3,458,177**	**$11,787,763**	**$53,423,706**
	PERCENT SHARE OF ALL SOURCES OF FUNDING-GRAND TOTAL:				**4%**	**2%**	**3%**	**43%**	**8%**	**12%**	**6%**	**22%**	**100%**

1. use of one-time funding at carryover or quarterly reviews
2. funding source: athletic services application fee
3. athletic and band boosters

7/3/2013

Turf Fields: Grass vs. Synthetic Turf Usage

Legend
- FCPS-Instructional Use
- Fx Cnty-Community Use
- FCPS-Practice Use

Stadium Field - Grass Field Model

Hrs/Day	Time	Mon	Tue	Wed	Thr	Fri	Sat	Sun	Total Hrs/Wk	Total Hrs/Year*
1	08a									
	09a									
2	10a									
3	11a									
4	12p									
5	01p									
6	02p									
7	03p									
8	04p									
9	05p									
	05:30p									
10	06p									
11	07p									
12	08p			FCPS - Practice Use						
13	09p									
14	10p									
15	11p									
Total Capacity:		**15.0**	**15.0**	**15.0**	**15.0**	**15.0**	**15.0**	**15.0**	**105.0**	**2,520.0**

	Mon	Tue	Wed	Thr	Fri	Sat	Sun	Hrs/Wk	Hrs/Year	
FCPS Usage:	3.0	3.0	3.0	3.0	3.0	0.0	0.0	15.0	360.0	100.0%
Cmnty Usage:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
Total Usage:	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**0.0**	**0.0**	**15.0**	**360.0**	**14.3%**

* Total hours per year is based on a Fall and Spring season of 12 weeks each (24 weeks total) multiplied by the total hours per week.

% Field Capacity Usage

Practice Field - Grass Model

Hrs/Day	Time	Mon	Tue	Wed	Thr	Fri	Sat	Sun	Total Hrs/Wk	Total Hrs/Year*
1	08a						FCPS Pract. Use			
	09a									
2	10a									
3	11a			FCPs - 50% Effective Instructional Use						
4	12p									
5	01p									
6	02p									
7	03p									
8	04p			FCPS - Practice Use			Community Use			
9	05p									
	05:30p									
10	06p									
11	07p									
12	08p									
13	09p				Field Not In Use....No Lights					
14	10p									
15	11p									
Total Capacity:		**12.0**	**12.0**	**12.0**	**12.0**	**12.0**	**12.0**	**12.0**	**84.0**	**2,016.0**

	Mon	Tue	Wed	Thr	Fri	Sat	Sun	Hrs/Wk	Hrs/Year	
FCPS Usage:	8.5	8.5	8.5	6.5	6.5	3.0	0.0	41.5	996.0	62.4%
Cmnty Usage:	0.0	0.0	0.0	2.0	2.0	9.0	12.0	25.0	600.0	37.6%
Total Usage:	**8.5**	**8.5**	**8.5**	**8.5**	**8.5**	**12.0**	**12.0**	**66.5**	**1,596.0**	**79.2%**

* Total hours per year is based on a Fall and Spring season of 12 weeks each (24 weeks total) multiplied by the total hours per week.

% Field Capacity Usage

Stadium Field - Synthetic Model

Hrs/Day	Time	Mon	Tue	Wed	Thr	Fri	Sat	Sun	Total Hrs/Wk	Total Hrs/Year*
1	08a									
	09a									
2	10a			FCPS-Instructional Use						
3	11a									
4	12p									
5	01p									
6	02p									
7	03p									
8	04p									
9	05p			FCPS-Practice Use						
	05:30p									
10	06p						Community Use			
11	07p									
12	08p	Community Use								
13	09p									
14	10p									
15	11p									
Total Capacity:		**15.0**	**15.0**	**15.0**	**15.0**	**15.0**	**15.0**	**15.0**	**105.0**	**2,520.0**

	Mon	Tue	Wed	Thr	Fri	Sat	Sun	Hrs/Wk	Hrs/Year	
FCPS Usage:	10.0	10.0	13.0	13.0	13.0	5.0	0.0	64.0	1,536.0	66.0%
Cmnty Usage:	4.0	4.0	0.0	0.0	0.0	10.0	15.0	33.0	792.0	34.0%
Total Usage:	**14.0**	**14.0**	**13.0**	**13.0**	**13.0**	**15.0**	**15.0**	**97.0**	**2,328.0**	**92.4%**

* Total hours per year is based on a Fall and Spring season of 12 weeks each (24 weeks total) multiplied by the total hours per week.

% Field Capacity Usage

Practice Field - Synthetic Model

Hrs/Day	Time	Mon	Tue	Wed	Thr	Fri	Sat	Sun	Total Hrs/Wk	Total Hrs/Year*
1	08a									
	09a									
2	10a									
3	11a			50% FCPs - Effective Instructional Use						
4	12p									
5	01p									
6	02p									
7	03p									
8	04p			FCPS-Practice Use						
9	05p									
	05:30p									
10	06p									
11	07p									
12	08p				Community Use					
13	09p									
14	10p									
15	11p									
Total Capacity:		**15.0**	**15.0**	**15.0**	**15.0**	**15.0**	**15.0**	**15.0**	**105.0**	**2,520.0**

	Mon	Tue	Wed	Thr	Fri	Sat	Sun	Hrs/Wk	Hrs/Year	
FCPS Usage:	6.0	6.0	6.0	6.0	6.0	0.0	0.0	30.0	720.0	34.3%
Cmnty Usage:	5.5	5.5	5.5	5.5	5.5	15.0	15.0	57.5	1,380.0	65.7%
Total Usage:	**11.5**	**11.5**	**11.5**	**11.5**	**11.5**	**15.0**	**15.0**	**87.5**	**2,100.0**	**83.3%**

* Total hours per year is based on a Fall and Spring season of 12 weeks each (24 weeks total) multiplied by the total hours per week.

% Field Capacity Usage

SUMMARY TABLES

Field Utilization Grass vs. Synthetic Turf	Field Capacity (Hrs/Year)	Field Usage (Hrs/Year)	% Field Capacity Usage
- Stadium Field - Grass	2,520	360	14.3%
- Stadium Field - Synthetic Turf	2,520	2,328	92.4%
- Practice Field - Grass	2,016	1,596	79.2%
- Practice Field - Synthetic Turf	2,520	2,100	83.3%
- Combined - Grass	**4,536**	**1,956**	**43.1%**
- Combined - Synthetic Turf	**5,040**	**4,428**	**87.9%**

FCPS and Community Usage	Field Useage (Hrs/Year)	% Field Usage
Stadium Field - Grass		
- FCPS Useage	360	100.0%
- Community Use	0	0.0%
Total:	360	100.0%
Stadium Field - Synthetic Turf		
- FCPS Useage	1,536	66.0%
- Community Use	792	34.0%
Total:	2,328	100.0%
Practice Field - Grass		
- FCPS Useage	996	62.4%
- Community Use	600	37.6%
Total:	1,596	100.0%
Practice Field - Synthetic Turf		
- FCPS Useage	720	34.3%
- Community Use	1,380	65.7%
Total:	2,100	100.0%
Two-Field Useage - Grass		
- FCPS Useage	1,356	69.3%
- Community Use	600	30.7%
Total:	1,956	100.0%
Two-Field Useage - Synthetic Turf		
- FCPS Usage	**2,256**	**50.9%**
- Community Use	**2,172**	**49.1%**
Total:	**4,428**	**100.0%**

Synthetic Turf Increased Usage Over Grass		
- FCPS Usage	**900**	**36.4%**
- Community Use	**1,572**	**63.6%**
Total:	**2,472**	**100.0%**

Athletic Playing Fields and Artificial Turf: Considerations for Municipalities and Institutions

Municipalities, universities, schools and other institutions frequently need to make decisions about maintenance and installation of athletic playing fields. This may include choosing between natural grass and synthetic turf. Factors that may be considered include cost of installation and maintenance, number of days the field can be used, likelihood of player injuries, temperature of the playing environment, and athletes' exposure to chemicals.

The Massachusetts Toxics Use Reduction Institute (TURI) at UMass Lowell has worked with municipalities and other institutions to facilitate the adoption of turf management practices that are cost-effective and preferable for human health and the environment. This fact sheet introduces some of the considerations that are relevant to evaluating natural grass and artificial turf alternatives. TURI is also developing an alternatives assessment for sports turf, which will provide a detailed assessment of these factors.

Principles of toxics use reduction

TURI's work is based on the principles of toxics use reduction (TUR). The TUR approach focuses on identifying opportunities to reduce or eliminate the use of toxic chemicals as a means to protect human health and the environment. Projects to reduce the use of toxic chemicals often have additional benefits, such as lower life-cycle costs.

Children's environmental health

People of all ages benefit from a safe and healthy environment for work and play. However, special concerns exist for children. Children are uniquely vulnerable to the effects of toxic chemicals because their organ systems are developing rapidly and their detoxification mechanisms are immature. Children also breathe more air per unit of body weight than adults, and are likely to have more hand-to-mouth exposure to environmental contaminants than adults.[1] For these reasons, it is particularly important to make careful choices about children's exposures.

Artificial turf: chemicals in infill

Artificial turf is composed of several elements, including drainage materials, support and backing materials, synthetic fibers to imitate grass blades, and an infill that takes the place of soil. A number of concerns exist regarding chemicals in the artificial grass blades and infill. Here, we briefly review issues related to chemicals in infill. Toxic chemicals such as lead are also found in the artificial grass blades in some cases.[2]

Crumb rubber infill made from recycled tires. Crumb rubber made from recycled tires, also referred to as styrene butadiene rubber (SBR) infill, is currently the most widely used type of infill. This type of infill contains a large number of chemicals that are known to be hazardous to human health and the environment. These include polyaromatic hydrocarbons (PAHs); volatile organic compounds (VOCs); metals, such as lead, mercury, manganese, and zinc; and other chemicals. Some of the chemicals found in crumb rubber are known to cause cancer.[3] Because of the large number of chemicals present in the infill, as well as the health effects of individual chemicals, crumb rubber made from recycled tires is the option that presents the most concerns related to chemical exposures.

Other synthetic materials. Other synthetic materials used to make artificial turf infill include EPDM rubber, thermoplastic elastomers (TPE), and Nike Grind (a proprietary rubber product made from recycled athletic shoes). These alternatives are sometimes marketed as safer alternatives. Relatively little information is available on the chemicals present in, or emitted from, these infills. Preliminary information suggests that these materials do contain some hazardous chemicals, but that they generally pose less of a concern than crumb rubber made from recycled tires.[4] There is an urgent need for more information on these alternatives.

Mineral-based and plant-derived materials. Other materials used as infill can include sand, cork, and coconut hulls, among other materials. Again, these materials are likely to contain fewer hazardous chemicals than crumb rubber infill made from recycled tires, but the materials have not been well characterized or studied thoroughly.

Artificial turf and heat stress

In sunny, warm weather, artificial turf can become much hotter than natural grass, raising concerns related to heat stress for athletes playing on the fields.[5] Research indicates that all synthetic turf reaches higher temperatures than natural grass, regardless of the infill materials.[6]

- A report by the New York State Department of Environmental Conservation found that surface temperatures on a synthetic turf field were 35^{o}F to 42^{o}F higher than those on natural grass.[7]
- Another study found that the highest temperature measured on synthetic turf was 60.3^{o}F greater than that observed on natural grass.[8]
- In another study, artificial turf fibers reached temperatures of 156^{o}F under direct sunlight, while the crumb rubber infill reached 101^{o}F.[9]
- Measurements taken by sports managers at Brigham Young University found that the surface temperature of synthetic turf was 37^{o}F higher than asphalt and 86.5^{o}F hotter than natural turf. The hottest surface temperature recorded during the study was 200^{o}F on a 98^{o}F day. Even in October, the surface temperature reached 112.4^{o}F.[10]

Irrigation can lower field temperature for a short time. A study by Penn State's Center for Sports Surface Research found that frequent, heavy irrigation reduces temperatures on synthetic turf, but temperatures rebound quickly under sunny conditions.[11] Another study found that irrigation could lower temperatures by 10 to 20 degrees, for a period of at least 20 minutes.[12] Another found that irrigation lowered the surface temperature from 174^{o}F to 85^{o}F; however, the temperature rebounded to 164^{o}F after 20 minutes.[13]

Heat-related illness can be a life-threatening emergency. Experts note that athletic coaches and other staff need to be educated about heat-related illness and understand how to prevent it, including cancelling sport activities when appropriate.[14]

Injuries

Injury rates can be affected by a variety of factors, including the type and condition of the playing surface as well as equipment used and type and level of sport. Studies show variable outcomes in the rates and types of injuries experienced by athletes playing on natural and on artificial turf.[15]

One particular concern is increased rates of turf burns (skin abrasions) associated with playing on artificial turf. For example, a study by the California Office of Environmental Health Hazard Assessment found a two- to three-fold increase in skin abrasions per player hour on artificial turf compared with natural grass turf.[16] These study authors noted that these abrasions are a risk factor for serious bacterial infections, although they did not assess rates of these infections among the players they studied.

Environmental concerns

Environmental concerns include loss of wildlife habitat and contaminated runoff into the environment. A study by the Connecticut Department of Environmental Protection identified concerns related to a number of chemicals in stormwater runoff from artificial turf fields. These include both metals and organic compounds. They noted high zinc concentrations in stormwater as a particular concern for aquatic organisms. They also noted the potential for leaching of high levels of copper, cadmium, barium, manganese and lead in some cases. The top concerns identified in the study were toxicity to aquatic life from zinc and from whole effluent toxicity (WET).[17] WET is a methodology for assessing the aquatic toxicity effects of an effluent stream as a whole.[18]

Current federal and state studies

A number of studies have examined the chemicals present in synthetic turf, with a particular focus on chemicals found in crumb rubber made from recycled tires. However, federal and state officials have identified a need for additional information. At the time of publication of this fact sheet, two key government studies are under way.

The California Office of Environmental Health Hazard Assessment (OEHHA), an office within the California Environmental Protection Agency, is conducting a three-year study of the potential health effects of exposure to synthetic turf as well as playground mats made from recycled waste tires. The project began in June 2015 and will be completed in June 2018. In the study, OEHHA will review the existing literature on chemicals in synthetic turf and playground mats; analyze samples of new and used synthetic turf and playground mats; develop exposure scenarios; and publish a risk assessment based on this information. OEHHA will also develop plans for a possible future study that would examine people's actual exposures through measurement of biological specimens or use of personal monitors.[19]

Three federal agencies have also recently begun a one-year assessment of potential health effects of exposure to synthetic turf. The agencies working on the study are the U.S. Environmental Protection Agency (EPA), the Consumer Product Safety Commission (CPSC), and the Agency for Toxic Substances and Disease Registry (ATSDR) within the Centers for Disease Control. Working with experts at OEHHA and elsewhere, the federal agencies will identify chemicals of concern found in crumb rubber made from recycled waste tires, as used in artificial turf fields and playgrounds; consider exposure scenarios; and identify areas for future study. The agencies will issue a draft status report by the end of 2016.[20] As background on the need for this study, the EPA website notes that, "Limited studies have not shown an elevated health risk from playing on fields with tire crumb, but the existing studies do not comprehensively evaluate the concerns about health risks from exposure to tire crumb."[21]

Natural grass

Natural grass fields can be the safest option for recreational space, by eliminating many of the concerns noted above. Natural grass can also reduce overall carbon footprint by capturing carbon dioxide.
Grass fields may be maintained organically or with conventional or integrated pest management (IPM) practices. Organic turf management eliminates the use of toxic insecticides, herbicides and fungicides.

Organic management of recreational field space

Organic management of a recreational field space requires a site-specific plan to optimize soil health and minimize long-term costs. Over time, a well-maintained organic field is more robust to recreational use due to a stronger root system than that found in a conventionally managed grass field. Water needs also decrease over time. Key elements of organic management include the following steps.[22]

- **Field construction**: Construct field with appropriate drainage, layering, grass type, and other conditions to support healthy turf growth. Healthy, vigorously growing grass is better able to out-compete weed pressures, and healthy soil biomass helps to prevent many insect and disease issues.
- **Soil maintenance**: Add soil amendments as necessary to achieve the appropriate chemistry, texture and nutrients to support healthy turf growth. Elements include organic fertilizers, soil amendments, microbial inoculants, compost teas, microbial food sources, and topdressing as needed with high-quality finished compost.
- **Grass maintenance**: Turf health is maintained through specific cultural practices, including appropriate mowing, aeration, irrigation, and over-seeding. Trouble spots are addressed through composting and re-sodding where necessary.

It is important to note that organic turf management requires proper training. Conventional turf management may follow a similar protocol each year; organic turf managers make adjustments based on changing conditions.

Installation and Maintenance Costs: Comparing Artificial Turf with Natural Grass

In analyzing the costs of artificial vs. natural grass systems, it is important to consider full life-cycle costs, including installation, maintenance, and disposal/replacement. Artificial turf systems of all types require a significant financial investment at each stage of the product life cycle. In general, the full life cycle cost of an artificial turf field is higher than the cost of a natural grass field.

Cost information is available through university entities, turf managers' associations, and personal communications with professional grounds managers. Information is also available on the relative costs of conventional vs. organic management of natural grass.

Installation. According to the Sports Turf Managers Association (STMA), the cost of installing an artificial turf system may range from $4.50 to $10.25 per square foot. For a football field with a play area of 360x160 feet plus a 15-foot extension on each dimension (65,625 square feet), this yields an installation cost ranging from about $295,000 to about $673,000. These are costs for field installation only, and full project costs may be higher. Costs for a larger field would also be higher.

In one site-specific example, information provided by the town of Natick, Massachusetts shows that the full project budget for the installation in 2015 of a new artificial turf field (117,810 square feet), along with associated landscaping, access and site furnishings, totaled $1.2 million.[23]

For natural grass, installation of a new field may not be necessary. For communities that do choose to install a new field, costs can range from $1.25 to $5.00 per square foot, depending on the type of field selected. For the dimensions noted above, this would yield an installation cost ranging from about $82,000 to about $328,000.[24]

Maintenance. Maintenance of artificial turf systems can include fluffing, redistributing and shock testing infill; periodic disinfection of the materials; seam repairs and infill replacement; and watering to lower temperatures on hot days. Maintenance of natural grass can include watering, mowing, fertilizing, replacing sod, and other activities. In both cases, specialized equipment is needed. Communities shifting from natural grass to artificial turf may need to purchase new equipment for this purpose. According to STMA, maintenance of an artificial turf field may cost about $4,000/year in materials plus 300 hours of labor, while maintenance of a natural grass field may cost $4,000 to $14,000 per year for materials plus 250 to 750 hours of labor.[25]

Fifteen acres of playing fields in Marblehead, MA are managed organically. Annual maintenance costs are $2,400-$3,000 per 2-acre playing field, not including mowing costs. Mowing costs for a 2-acre field were estimated in 2010 to be $10,000 annually. Thus, total maintenance costs per 2-acre field are $12,400 to $13,000 annually.[26]

Natural grass maintenance: Conventional vs. organic costs. Organic turf maintenance can be cost-competitive with conventional management of natural grass. One study found that once established, an organic turf management program can cost 25% less than a conventional turf management program.[27]

Disposal/replacement. Artificial turf also requires disposal at the end of its useful life. STMA estimates costs of $6.50 to $7.80 per square foot for disposal and resurfacing.[28] Those estimates yield $426,563 - $511,875 for a 65,625 square foot field and $552,500 - $663,000 for an 85,000 square foot field.

Annualized costs. In 2008, a Missouri University Extension study calculated annualized costs for a 16-year scenario. The calculation included the capital cost of installation; annual maintenance; sod replacement costing $25,000 every four years for the natural fields; and surface replacement of the synthetic fields after eight years. Based on this calculation, a natural grass soil-based field is the most cost effective, followed by a natural grass sand-cap field, as shown in the table below.[29] Another study, conducted by an Australian government agency, found that the 25-year and 50-year life cycle costs for synthetic turf are about 2.5 times as large as those for natural grass.[30]

Table 1: Comparison of annualized costs

Field type	16-year annualized costs
Natural soil-based field	$33,522
Sand-cap grass field	$49,318
Basic synthetic field	$65,849
Premium synthetic field	$109,013

Source: Brad Fresenburg, "More Answers to Questions about Synthetic Fields – Safety and Cost Comparison." University of Missouri.

The Toxics Use Reduction Institute is a multi-disciplinary research, education, and policy center established by the Massachusetts Toxics Use Reduction Act of 1989. The Institute sponsors and conducts research, organizes education and training programs and provides technical support to help Massachusetts companies and communities to reduce the use of toxic chemicals.

In response to information requests from municipalities, TURI is currently developing a detailed alternatives assessment for sports turf. Preliminary sections of the assessment will be published in the order in which they are developed, and will be available on TURI's website at www.turi.org.

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FAC 7531 Pavilion

FY25 SUC:	$0.70 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7532 Outdoor Theater

FY25 SUC:	$7,495.06 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 7541 Recreational Camp and Trailer Park

FY25 SUC:	$23,014.19 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	New estimate for V13, FAC Composite

FAC 7541 Unit Calculations & Assumptions

FAC Description	Unit of Measure	FAC #	Measurement Assumptions
Public Restroom/Shower	SF	7385	1 male and 1 female facility, each with 2 WC, 3 lav, 2 shower, plus 2 urinal; each 20' x 15' = 300 SF, total 600 SF
Vehicle Parking, Surfaced	SF	8521	60 spaces x 15 x 20 FT = 18000 SF
EUPH Tent Pad	SF	7251	30 spaces x 10 x 10 = 3000 SF
Electric Power Line UG	LF	8123	{60 spaces x 50 ft frontage each X 50% (back to back) x 125% (accounting for home runs)} x .67 (2 wire vice 3) = 1256 LF
Electric Power Transformer	KV	8133	60 spaces x (100% @ 20 A + 20% @ 50 A + 70% @ 30A) + (30 tent sites @ 20 A) per NEC 551.71 = 500 KVA
Electric Lighting, Pole	EA	8122	200 ft spacing: 60 RV spaces @ 50 FT = 3000/200 = 15 poles; tents: 30 pads / 5 pads per light = 6, total 21
Water Distribution Line	LF	8421	same as electric line
Sewer and Industrial Waste Line	LF	8321	same as electric line
Sewage Lift Station	EA	8316	1 each

750 COMMUNITY FACILITIES - MORALE, WELFARE AND RECREATION (OUTDOOR)

750-1 GENERAL. The Navy's Outdoor Recreation Program introduces Sailors and their families to lifetime outdoor recreation activities, and provides them with participation opportunities. The associated values and benefits of participating in outdoor-related activities effectively contribute to Navy quality of life and retention efforts. Outdoor recreation has long lasting, broad scope effects on other areas of a participant's life. Benefits include increased self-esteem, overall happiness and general well being. The Outdoor Recreation Program promotes physical fitness, teamwork, leadership, skill development and environmental ethics. Examples of human powered outdoor recreation programs include:

Backpacking	Nordic Skiing	White Water Rafting
Canoeing	Rock Climbing	Scuba Diving
Sea Kayaking	Hiking	Orienteering
Snowshoeing	Mountain Biking	Surfing
Fishing	Camping	Alpine Skiing
Snowboarding	Rope Courses	Urban Bicycling
Adventure Races	In-line Skating	Adventure Travel
Skateboarding	BMX Biking	

The Outdoor Recreation Program also includes traditional outdoor recreation activities such as:

Golf	Basketball	Tennis
Volleyball	Baseball	Softball
Football	Soccer	Track and Field
Swimming	Sailing	

The extent and type of Outdoor Recreation Program depends on the Installation location, local geography, and patron interest. The 750 Series of Navy Category Codes provides for the various types of facilities that may be required to support the above programs. Facilities should be attractive, clean, uncluttered, and well maintained. Space should be available to support all core program activities.

750-1.1 **Morale Welfare and Recreation (MWR), Navy Personnel Command (NPC) Role:** The involvement of MWR representatives in the planning process is required, especially for all Category C business-based projects, in order to ensure a match between program needs, and the types and sizes of spaces to be provided. MWR programs are funded by a combination of nonappropriated funds (NAFs) and appropriated funds (APFs). MWR activities are divided into three categories following DoD policy on funding and function:

- **Category A** operations are authorized full APF funding and directly support mission essential requirements. Examples are gymnasiums, fitness centers, and sports programs.

- **Category B** operations are mission enhancing community support programs and are authorized significant APF support. Examples are outdoor recreation, child development, hobby shops, ITT, community pools, school age care, and youth development programs.

- **Category C** operations are business-based activities and are authorized minimal APF (such as SRM, environmental compliance, security, and health and safety support; interior renovation and new construction/additions are NAF funded) except at isolated/remote and OCONUS installations where Category C operations are treated the same as Category B operations. Examples are food and beverage operations, bowling centers, cottages, RV parks, slip rental marinas, and golf courses.

For Category B and C facilities an initial market survey and financial analysis or pro forma is required to determine if the facility will be self-sustaining or profitable, in the case of Category C operations. Once the Installation has completed their analysis, the proposal will be submitted via the regional command to NPC (after 1 October 2004, CNI Field Support Activity) through an Internal Needs Validation Study (INVS). If the project earns sufficient points through the INVS, it will move on to the Project Validation Assessment stage where the demand and scope will be confirmed through independent review.

750-1.4 **Overseas Adjustment:** For overseas activities the net to gross factor (typical net to gross is 1.25 or 25%) will increase as necessary to meet host nation building codes.

750-2 USING THE CRITERIA.

750-2.1 Size to Accommodate Demand

The below criteria provide the current approach for determining allowances for Morale, Welfare and Recreational (MWR) facilities. Facility allowances are sized to accommodate the projected demand for the anticipated functions. The projected demand will be estimated using a Market Survey approach. Existing Navy wide surveys (under 2 years old), MWR Pulse Point Surveys, and other local surveys can be used to determine the demand. Existing community facilities will be considered in the Market Analysis approach. The facility capacity requirements will be estimated using industry standards and comparable existing facilities, Navy, DoD, municipal, or commercial.

In addition to the above criteria, attention should be given to relevant planning information in the Base Master Plan, Regional or Functional Plan (RSIP), existing Unified Facilities Criteria (UFC) as developed, Design Manuals, Military Handbooks or Instructions for the specific facility type.

For **Marine Corps Installations** results of the **MWR Construction Program Patron Survey** will be used to provide Marine Corps specific patron desires. Construction Program Patron Survey data is available from the **Commandant of the Marine Corps (MW).**

750-2.2 **Space Allowance Flexibility**

750-2.2.1 **Aggregate Space Allowances.** For many of these criteria, usage demand, capacity requirements and space allowances are calculated separately for component function-areas of the facility, and then totaled to derive overall facility space allowances. This procedure is designed to respond to local variations in the set of activities and spaces provided, and the relative demand for different activities depending on the needs of the installation population. This approach can also accommodate diverse existing facility situations, when considering additions or complementary new facilities.

750-2.2.2 **Space Programs versus Facility Allowances**. These criteria are used to determine the total space allowance for a facility. Even though area calculations for functional components of the facility are used in deriving the overall allowance, this does not fix the space sizes of the component program areas of the facility. Local installation decisions, in the space programming and design process, should determine the appropriate allocation of areas for each function-space within the total facility allowance. Any such decisions should be fully justified to the regional and CNI MWR program management to ensure compliance with Navy and DoD standards.

750-2.2.3 **Local Variation**
Local demand for program activities may depend on a variety of factors, in addition to the overall installation population, including

- Proportion and relative participation of different user groups among the population.
- Specific program of activities provided.
- Competing on-base and off-base facilities providing similar programs.
- Geographic distribution and accessibility of the user populations.

- Local climate conditions and operating seasons.
- Overseas situations and local customs.
- Installation geography.

750-2.3 **Population Basis for Demand Calculations**

See Chapter 1 of this instruction for general information on population definitions and base loading data.

750-2.4 **Recreational Planning Context**

Planning for MWR facilities should involve consideration of the individual facility in relationship to a comprehensive recreational program and facilities plan for the installation and the region. Consider the following factors, in addition to those relationships specifically indicated in the criteria for each facility:

- If other MWR facilities serving the same user population provide the same program activities, reduce the allowed capacity of the proposed facility by the capacity provided elsewhere at the installation or other nearby regional installations.
- Consider collocating the facility with other recreational facilities providing complementary programs, to provide the users with the increased convenience and attractiveness of clustered activities, and to take advantage of potential savings in support space requirements and operating costs.
- Size and locate an individual facility appropriately to the target population and geographical area its particular function is designed to serve. Convenient access for users should be considered in balance with the need for efficient facility operation and avoidance of duplicate facilities. Consider the DoD INST 1015.15 (Enclosure 3, Attachment 1) requirement for the use of appropriated funds (APF) for site development costs, archeological and ammunition clearances, water purification, demolition, excessive utility connections, and road service when selecting sites.
- Consider local community facilities. If the local community has a robust program and facilities for outdoor recreational activities consider partnerships with the local community for services, and/or other Public Private Venture initiatives.

750 10 OUTDOOR PLAYING COURTS (EA)

Design Criteria: Military Handbook (MIL-HDBK-1037/3) -- Outdoor Sports and Recreation Facilities

75010-1 **GENERAL**. See introduction to 750 series category codes for General Instructions regarding facility allowance planning procedures.

75010-2 **DEFINITION**. Outdoor Playing Courts provide facilities and support services to meet the individual physical fitness and recreation needs of military personnel. The facilities may also serve dependents, retirees and authorized civilians. Activities that may be accommodated in Outdoor Playing Courts include: basketball, tennis, volleyball, skate/skateboard parks, and outdoor skating/roller hockey rink

75010-3 **RELATED FACILITIES**. Consideration should be given to collocating the Outdoor Playing Courts with the following recreational facilities in order to (i) take advantage of potential savings in space requirements and operating costs, and (ii) provide users with the increased convenience of clustered facilities:

- 740 44 Indoor Physical Fitness Center (Gym)
- 740 45 Fitness Room
- 740 84 Indoor Playing Courts
- 750 20 Playing Fields
- 740 55 Youth Center

75010-4 **DEMAND AND ALLOWANCES**. Demand, market analysis and survey information, as well as the number of existing leagues/teams if applicable determine the number of Outdoor Playing Courts provided at each installation. Provision of lighted courts is recommended where there is a high demand and/or climate warrants later usage by patrons. Youth Outdoor Playing Courts will be provided as needed. They should be sized and located for the youth population, i.e. near the youth center if there is one. The Courts will be sized in accordance with industry standards for the youth age group or adult age group as appropriate.

750 20 PLAYING FIELDS (EA)

Design Criteria: Military Handbook (MIL-HDBK-1037/3) -- Outdoor Sports and Recreation Facilities

75020-1 **GENERAL**. See introduction to 750 series category codes for General Instructions regarding facility allowance planning procedures.

75020-2 **DEFINITION**. Playing Fields provide facilities and support services to meet the individual physical fitness, coordination, skills development, training and recreation needs of military personnel. The facilities may also serve dependents, retirees and authorized civilians. Activities which may be accommodated in Playing Fields include: baseball, football, soccer, softball, track and field, etc.

75020-3 **RELATED FACILITIES**. Consideration should be given to collocating the Playing Fields with the following recreational facilities in order to (i) take advantage of potential savings in space requirements and operating costs, and (ii) provide users with the increased convenience of clustered facilities:

- 740 44 Indoor Physical Fitness Center (Gym)
- 740 45 Fitness Room
- 740 53 Indoor Swimming Pool
- 750 10 Outdoor Playing Courts.
- 740 55 Youth Center

75020-4 **DEMAND AND ALLOWANCES**. Demand, market analysis and survey information, as well as the number of existing leagues/teams if applicable determine the number of Outdoor Playing Fields provided at each installation. Provision of lighted fields is recommended for expanded usage. Provision of lighted fields and use of artificial turf or installed sprinkler systems may serve to reduce the total requirement for filds by allowing extended playing hours, extended play without the need for field maintenance/recovery. Youth Outdoor Playing Fields will be provided as needed. They should be sized and located for the youth population, i.e. near the youth center if there is one. The Fields will be sized in accordance with industry standards for the youth age group or adult age group as appropriate.

750 21 BATTING CAGE (EA)

75021-1 Batting cages may be provided at Installations where there is a demand, where a MWR survey supports the requirement, and there is no convenient local alternative. Size according to industry standards.

750 22 JOGGING TRACK (KM/MI)

75022-1 Jogging tracks are provided and sized as required.

750 23 GO-CART TRACK (KM/MI)

75023-1 Go-Cart Tracks may be provided as a Category C facility where they are determined to be profitable enterprises. Market analysis for this facility must be provided by MWR. Size according to demand and industry standards.

750 30 OUTDOOR SWIMMING POOL - INSTALLATION (SQ.M./SF)

75030-1 (Use CC 740 53 SWIMMING POOL - INDOOR for sizing standards). With appropriate demand analysis, outdoor pools may include water park features and spray parks.

750 33 POOL PUMP/FILTER/TREATMENT FACILITY - REMOTE (EA)

75033-1 This code is for inventory purposes and only in those cases where such facilities are located in a structure remotely situated from the swimming pool proper.

750 34 WADING POOL/SPLASH POOL (EA)

75034-1 Wading pools normally are planned as adjuncts to main pools (see CC 740 53 Swimming Pool—Indoor). This code is for inventory purposes and only in those cases where wading pools are detached from the main facility.

750 35 ACTIVITY TV RECEIVER ANTENNA (EA)

75035-1 This Category Code Number is provided for inventory purposes only.

750 36 TV DISTRIBUTION SYSTEM (EA)

75036-1 Category Codes 750 35 and 750 36 are for inventory purposes only. Such facilities are provided only at remote installations where central TV reception and local distribution systems can be individually justified.

750 37 OUTDOOR ADVENTURE AREA (EA)

75037-1 Includes Ropes Courses, Natural Recreation Features (rock climbing, hiking trails, mountain bike trails, paintball ranges, motocross/BMX areas). Requirement is based on local availability (geography) and local demand. Size according to industry standards.

750 38 OUTDOOR MWR EQUIPMENT RENTAL STORAGE (SQ.M./SF)

75038-1 Outdoor fenced area with lighting for storage of MWR rental equipment (not enclosed). Facility should be co-located with the Outdoor Recreation Center CCN 740-37, if there is one.

750 39 MWR VEHICLE/RV/BOAT STORAGE COMPOUND (SQ.M./SF)

75039-1 Vehicle/RV/Boat Storage Compounds may be provided as Category C facilities where they are determined to be profitable enterprises. Markey analysis for this facility must be provided by MWR. Size according to demand and industry standards. Covered spaces may be included where justified by demand.

750 40 GOLF COURSE (EA)

Design Criteria: Military Handbook (MIL-HDBK-1037/3) -- Outdoor Sports and Recreation Facilities

75040-1 **GENERAL**. See introduction to 750 series category codes for General Instructions regarding facility allowance planning procedures.

75040-2 **DEFINITION**. Golf Courses are recreational facilities which may accommodate: recreational golfing, practice, instruction, tournaments, exhibitions, special events, and winter recreational activities such as cross-country skiing, ice skating, sledding and tobogganing. In addition to the Golf Course, space permitting, the facility may include a driving range, practice hole, chipping green with sand trap, and putting green(s). A Golf Course is a Category C MWR facility.

75040-3 **RELATED FACILITIES**. The Golf Course must be collocated with the following recreational facilities in order to (i) take advantage of potential savings in space requirements and operating costs, and (ii) provide users with the increased convenience of clustered facilities:

- 740 80 Golf Club House (including golf maintenance building/storage compound, chemical/fertilizer/pesticide storage and mixing building, and cart storage facilities).
- 750 56 Golf Driving Range.

75040-4 **DEMAND**. The Golf Course will be sized in accordance with a market survey approach. As a Category C facility the Golf Course must be profitable and a financial analysis or pro forma will be provided as well as the NPC Internal Needs Validation Study (INVS), and finally the Project Validation Assessment. The Planner will accomplish the initial demand investigation and review along with local MWR personnel. If project is financially sound it will be forwarded via the region to NPC (after 1 October 2004, CNI Field Support Activity) for INVS scoring and possible Project Validation Assessment.

75040-5 **FACILITY ALLOWANCE.** The Golf Course will be sized in accordance with industry standards. One resource for sizing criteria is the National Golf Foundation (NGF). Siting, water availability, and existing land area available will be the key considerations when planning a new Golf Course.

750 50 OUTDOOR THEATER (EA)

75050-1 No planning factors are available. If an outdoor theater (either seat- type or drive-in) is provided, the requirements for theaters (Code 740 56) must be reduced accordingly.

750 52 SKEET AND/OR TRAP RANGE (EA)

75052-1 Skeet and/or Trap Ranges may be provided as Category C facilities where they are determined to be profitable enterprises. Market analysis for this facility must be provided by MWR. Size according to demand and industry standards. In addition, suitable land must be available, and the activity must have a military population over 100. If a range building is authorized, see Category Code 740 52 for criteria. Table 75052-1 gives the corresponding land requirements. This facility must be self-sustaining.

Table 75052-1 Land Requirements for Skeet and Trap Ranges Land Area

Military Population (1)	Skeet Range	Trap Range
Up to 100	None	None
101 to 10,000	335m x 732m /1100' x 2400'	335m x 549m / 1100' x 1800'
10,001 to 15,000	335m x 732m /1100' x 2400'	335m x 576m / 1100' x 1890'
15,001 to 20,000	335m x 732m /1100' x 2400'	335m x 604m / 1100' x 1980'
20,001 to 25,000	335m x 732m /1100' x 2400'	335m x 631m / 1100' x 2070'
25,001 to 30,000	335m x 732m /1100' x 2400'	335m x 658m / 1100' x 2160'
30,001 to 40,000	335m x 777m /1100' x 2550'	335m x 686m / 1100' x 2250'
Over 40,000	335m x 823m / 1100' x 2700'	335m x 713m / 1100' x 2340'

(1) Military population consists of active duty military supported by the installation.

750 54 BAND STAND (EA)

75054-1 No planning factors are available. Requests for this facility will require individual justification.

750 56 GOLF DRIVING RANGE (EA)

75056-1 Installations, where the necessary land is already available, and the facility will be profitable as a Category C facility, are authorized a golf driving range. See Category Code 750-40

750 57 MWR OPERATED RECREATION GROUNDS (EA)

75057-1 No specific guidance is available. Local conditions usually will govern the development of any parks, playgrounds, or picnic areas. Recreation Pavilions (Code 740 78) are authorized in conjunction with these facilities.

750 58 RECREATIONAL CAMPGROUND-TENT (SQ.M./SF)

75058-1 Please see CCN 750-59 for general description of campground. This CCN will be used for tent camping vs. RV's. No vehicle pads are required. See Table 75059-1 for sanitary facilities requirements for tent campgrounds.

750 59 RECREATION CAMPGROUND - RV (SQ.M./SF)

Project Review: Base MWR representatives, EFD, NAVFAC HQ, BUPERS (Pers-656D)
Design Criteria: *(Military Handbook is not currently available)*

75059-1 **GENERAL**. See General Notes to 750 series category codes for General Instructions regarding facility allowance planning procedures.

75059-2 **DEFINITION**. Recreational Campgrounds provide the military community with outdoor recreation opportunities at locations with attractive natural resources. To complement the camping experience, and depending on location, Recreational Campgrounds may offer activities such as boating, canoeing, fishing, hiking, hunting, skiing and swimming. Facilities should be designed to take advantage of the natural features of the site, from vegetation to good views to unusual topography. At the same time, development should be environmentally appropriate, and not threaten the preservation of the natural heritage and scenic resources.

The planning criteria in this Category Code addresses only the camping sites and patron support facilities such as showers, toilets and laundromats. Other campground support facilities (particularly in relatively remote locations) such as an on-site manager's office, community room, kitchen, and convenience stores are not included in this Category Code. See CCN 740-92. Recreational campgrounds are encouraged to make use of the Camp Host concept to assist in the management of the campground. Space allowances for MWR Rental Cabins are addressed under Category Code 740 81.

Dump stations should generally be provided at campgrounds that accommodate RV's.. (CCN 750 59). The sizing and design of dump stations will vary according to local conditions (such as topography, soil conditions, proximity to water sources, etc.). All dump station facilities must comply fully with all applicable environmental regulations.

75059-3 **RELATED FACILITIES**. Where such locations are adjacent to the sea or other body of water, support facilities such as marinas, boat ramps and RV/vehicle/boat storage compounds maybe sited in close proximity to Recreational Campgrounds.

75059-4 **SPACE ALLOWANCE**. The total number of camping and/or RV sites provided at a location is primarily determined by two considerations:

- The Recreational Campground will be sized in accordance with a market survey approach. As a Category C facility the Campground must be profitable and a financial analysis or pro forma will be provided as well as the NPC Internal Needs Validation Study (INVS), and finally the Project Validation Assessment. The Planner will accomplish the initial demand investigation and review along with local MWR personnel. If the project is financially sound it will be forwarded via the region to NPC (after 1 October 2004, CNI Field Support Activity) for INVS Scoring and possible Project Validation Assessment.

- Capacity of the location to accommodate the proposed facilities at a recommended level of use density, and other site planning requirements for access and provision of utilities.

75059-4.1 The number of campsites which may be accommodated per acre will vary depending on the natural features (topography, geology, vegetation, etc.) of the proposed location and the desired degree of privacy between individual sites. Development of as few as 2.4 sites per hectare (6 sites per acre) to a maximum of 5.7 sites per hectare (14 sites per acre) is recommended as a planning guideline. However, this guideline may be modified by the financial analysis, which may, for example, indicate that 2.4 sites per hectare (6 sites per acre) may be too low to justify the investment required to provide the necessary infrastructure (paths, roads, patron support facilities, utilities, etc.). Furthermore, the financial analysis may also indicate a total minimum number of sites required to justify the investment in this recreational resource and the corresponding support building (CCN 740-92). RV Campsites should be planned with a vehicle pad 20 feet by 40 feet. Minimum separation between campsites should be 37 feet. It is recommended that, where financially feasible, the RV Campground include a mix of back-in and pull-through sites.

75059-4.2 Once the total number of campsites at a location has been determined, the required patron support facilities may be selected from the criteria in Table 75059-1.

Table 75059-1 Sanitary Facilities Requirements for Recreational Campgrounds

#Tent/Trailer	#Water Closets (M/F)	#Lavatories (M/F)	#Showers (M/F)	#Urinals
1-15	1/1	1/1	1/1	1
16-30	1/2	2/2	1/1	1
31-45	2/2	3/3	1/1	1
46-60	2/3	3/3	2/2	2
61-80	3/4	4/4	2/2	2
81-100	3/4	4/4	3/3	2

Notes for Table 75059-1:

(1) For recreational areas having more than 100 tent/trailer/camper/RV sites, provide one additional water closet and lavatory per each additional 30 sites, and one additional urinal per each additional 60 sites.

(2) For laundry facilities, provide one washer and one dryer for every increment of 12 sites or portion thereof.

75059-4.3 All facilities, which have the potential for causing environmental contamination—for example, dumpsters and dump stations—, must comply fully with all applicable local, state and federal regulations. The planning of Recreational Campgrounds located in areas under the jurisdiction of other agencies such as State

Parks and Forests Divisions, the U.S. Forest Service and the National Park Service, must adhere to all applicable development guidelines and review procedures.

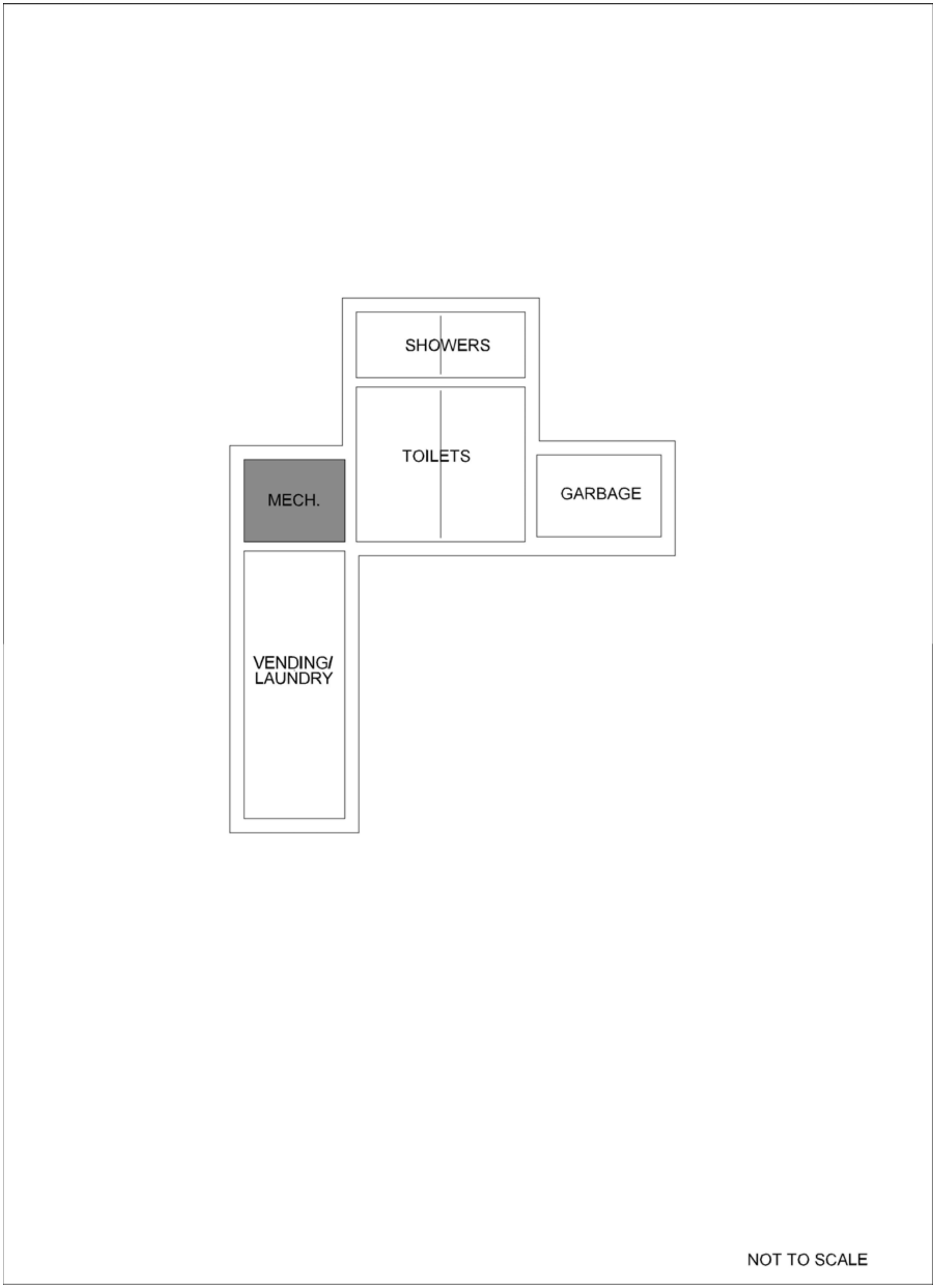

Figure 75059-1   Recreational Campground – Medium Size Support Facility

750 60 MARINA (EA)

75060-1 This facility requires special considerations and must be developed based on local conditions and supported by a detailed analysis. As a Category C facility, the Marina must be profitable and a financial analysis or pro forma will be provided as well as the NPC Internal Needs Validation Study (INVS), and finally the Project Validation Assessment. The Planner will accomplish the initial demand investigation and review along with local MWR personnel. If the project is financially sound it will be forwarded via the Region to NPC (after 1 October 2004, CNI Field Support Activity) for INVS Scoring and possible Project Validation Assessment. For a Category B sailing program marina, it is necessary to document the demand and to ensure that APF will be available to support operation of the sailing program. A marina support building or boathouse is authorized in conjunction with a marina and should be programmed as a part of the project nomination and validation process.. See Code 740 87 for marina support building criteria. There are two categories of Marina: Category B is the MWR sailing program and Category C is the rental slips operation.

750 61 RECREATIONAL PIER (EA)

75061-1 This CCN is used for stand-alone recreational pier facilities (e.g. fishing piers) where there is no existing Marina.

FAC 7541 Recreational Camp and Trailer Park

FAC 7541 Description: "Trailer parking sites/pads or tent pads, with associated facilities for recreational trailers, vehicles or tents. SUC based upon an area providing **100 camping sites.**"

There are 255 recreational camps and trailer parks in the inventory for FMM 11.2. (Note that this does not include facilities covered under FAC 7542, Miscellaneous Outdoor Recreation Facility).

Related FACs are:

- 7120 Family Housing Trailer/Relocatable
- 7130 Family Housing Trailer Site

These parks are frequently co-located with other outdoor MWR facilities, (marina, beach, athletic courts) and/or on installations with access to commissary, exchange, laundry, eating facility, and other commercial support.

Components in this FAC may include:

- Paved roads with adequate turn-around area
- Paved parking for rv plus vehicle
- Privacy screens for sites
- Trails and sidewalks
- Utilities: water, electricity, sewer, cable tv, telephone at pad/site
- Exterior lighting
- Restroom/latrine
- Shower facilities
- Laundry facility
- Outdoor shelter
- Pavilion or picnic area w/barbeque pits
- Tent sites may have electricity or water
- Signs
- Management/check-in building for larger sites
- Community building (with kitchen) for group events

A separate excel file provides a numerical sample of the number of rv pads, cabins, tents and mix of services on which to base cost estimates.

Sites with details on individual locations are:

- http://old.armymwr.com/portal/travel/paths/
  http://old.armymwr.com/portal/travel/travelresources/lodgingcampingrv.asp
- http://www.4militaryfamilies.com/militaryvacationspots.htm
- www.**military**campgrounds.us

- http://www.militarycampgrounds.us/ info on all campgrounds and rv parks

Background information available from these websites:

- http://www.fs.fed.us/r8/rrac/horse_camp.pdf.pdf
  http://www.mobilehomeparks101.org/developorbuyexisting.htm
- http://www.rversonline.org/RVParkAnalysis.html
- http://www.housing.navy.mil/navfacpubs/p930/chap13.pdf 1999
- http://www.army.mil/usapa/epubs/pdf/r420_1.pdf 2008 mobile home park maintenance cost pg 128-133

Tent camp area – North Carolina (Ft Fisher)
Picnic pavilion – NC rec center

RV Family Camp

Canyon cabin and park pavillion

FAC 7541 SUC FY16v18 - Recreational Camp and Trailer Park
UM: EA
Design Size: 1
ESL 25

Assume 60 vehicle parking spots with utilities and 30 tent pads and shower amenities

Composite of FACs

FAC Component	Modeled Units
Vehicle Positions	SF
Tent Positions	SF
Underground Power Lines	LF
Transformer	KV
Pole Lights	EA
Water Distribution Line	LF
Sewer Line	LF
Sewage Lift Station	EA
Restroom / Shower Facility	SF

<u>References</u>
DoD Real Property Categorization System (RPCS) FY2015
FY 2014 Real Property Assets Database
RS Means "CostWorks" FMR 2015Q3
R&K Solutions Research Paper on DoD Recreational Camps

Model as	Reference FAC / Assembly
Vehicle Parking, Surfaced	8521
UEPH Tent Pads	7251
Electrical Power Distribution Line, Underground	8123
Electrical Power Transformer	8133
Exterior Lighting, Pole	8122
Water Distribution Line, Potable	8421
Sewer and Industrial Waste Line	8321
Sewage Lift Station	8316
Latrine/Shower Facility	7234

Quantity	Unit Cost (FY16)	Component Cost
18000	0.16	2900.00
3000	0.16	480.00
1256	0.69	866.64
500	7.00	3500.00
21	43.80	919.80
1278	0.69	881.82
1278	1.02	1303.56
1	1256.48	1256.48
600	6.17	3702.00
	SUC	**$ 15,810.30**

750 COMMUNITY FACILITIES - MORALE, WELFARE AND RECREATION (OUTDOOR)

750-1 GENERAL. The Navy's Outdoor Recreation Program introduces Sailors and their families to lifetime outdoor recreation activities, and provides them with participation opportunities. The associated values and benefits of participating in outdoor-related activities effectively contribute to Navy quality of life and retention efforts. Outdoor recreation has long lasting, broad scope effects on other areas of a participant's life. Benefits include increased self-esteem, overall happiness and general well being. The Outdoor Recreation Program promotes physical fitness, teamwork, leadership, skill development and environmental ethics. Examples of human powered outdoor recreation programs include:

Backpacking	Nordic Skiing	White Water Rafting
Canoeing	Rock Climbing	Scuba Diving
Sea Kayaking	Hiking	Orienteering
Snowshoeing	Mountain Biking	Surfing
Fishing	Camping	Alpine Skiing
Snowboarding	Rope Courses	Urban Bicycling
Adventure Races	In-line Skating	Adventure Travel
Skateboarding	BMX Biking	

The Outdoor Recreation Program also includes traditional outdoor recreation activities such as:

Golf	Basketball	Tennis
Volleyball	Baseball	Softball
Football	Soccer	Track and Field
Swimming	Sailing	

The extent and type of Outdoor Recreation Program depends on the Installation location, local geography, and patron interest. The 750 Series of Navy Category Codes provides for the various types of facilities that may be required to support the above programs. Facilities should be attractive, clean, uncluttered, and well maintained. Space should be available to support all core program activities.

750-1.1 **Morale Welfare and Recreation (MWR), Navy Personnel Command (NPC) Role:** The involvement of MWR representatives in the planning process is required, especially for all Category C business-based projects, in order to ensure a match between program needs, and the types and sizes of spaces to be provided. MWR programs are funded by a combination of nonappropriated funds (NAFs) and appropriated funds (APFs). MWR activities are divided into three categories following DoD policy on funding and function:

- **Category A** operations are authorized full APF funding and directly support mission essential requirements. Examples are gymnasiums, fitness centers, and sports programs.

- **Category B** operations are mission enhancing community support programs and are authorized significant APF support. Examples are outdoor recreation, child development, hobby shops, ITT, community pools, school age care, and youth development programs.

- **Category C** operations are business-based activities and are authorized minimal APF (such as SRM, environmental compliance, security, and health and safety support; interior renovation and new construction/additions are NAF funded) except at isolated/remote and OCONUS installations where Category C operations are treated the same as Category B operations. Examples are food and beverage operations, bowling centers, cottages, RV parks, slip rental marinas, and golf courses.

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750-1.4 **Overseas Adjustment:** For overseas activities the net to gross factor (typical net to gross is 1.25 or 25%) will increase as necessary to meet host nation building codes.

750-2 USING THE CRITERIA.

750-2.1 Size to Accommodate Demand

The below criteria provide the current approach for determining allowances for Morale, Welfare and Recreational (MWR) facilities. Facility allowances are sized to accommodate the projected demand for the anticipated functions. The projected demand will be estimated using a Market Survey approach. Existing Navy wide surveys (under 2 years old), MWR Pulse Point Surveys, and other local surveys can be used to determine the demand. Existing community facilities will be considered in the Market Analysis approach. The facility capacity requirements will be estimated using industry standards and comparable existing facilities, Navy, DoD, municipal, or commercial.

In addition to the above criteria, attention should be given to relevant planning information in the Base Master Plan, Regional or Functional Plan (RSIP), existing Unified Facilities Criteria (UFC) as developed, Design Manuals, Military Handbooks or Instructions for the specific facility type.

For **Marine Corps Installations** results of the **MWR Construction Program Patron Survey** will be used to provide Marine Corps specific patron desires. Construction Program Patron Survey data is available from the **Commandant of the Marine Corps (MW).**

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750-2.2.1 **Aggregate Space Allowances.** For many of these criteria, usage demand, capacity requirements and space allowances are calculated separately for component function-areas of the facility, and then totaled to derive overall facility space allowances. This procedure is designed to respond to local variations in the set of activities and spaces provided, and the relative demand for different activities depending on the needs of the installation population. This approach can also accommodate diverse existing facility situations, when considering additions or complementary new facilities.

750-2.2.2 **Space Programs versus Facility Allowances**. These criteria are used to determine the total space allowance for a facility. Even though area calculations for functional components of the facility are used in deriving the overall allowance, this does not fix the space sizes of the component program areas of the facility. Local installation decisions, in the space programming and design process, should determine the appropriate allocation of areas for each function-space within the total facility allowance. Any such decisions should be fully justified to the regional and CNI MWR program management to ensure compliance with Navy and DoD standards.

750-2.2.3 **Local Variation**
Local demand for program activities may depend on a variety of factors, in addition to the overall installation population, including

- Proportion and relative participation of different user groups among the population.
- Specific program of activities provided.
- Competing on-base and off-base facilities providing similar programs.
- Geographic distribution and accessibility of the user populations.

- Local climate conditions and operating seasons.
- Overseas situations and local customs.
- Installation geography.

750-2.3 **Population Basis for Demand Calculations**

See Chapter 1 of this instruction for general information on population definitions and base loading data.

750-2.4 **Recreational Planning Context**

Planning for MWR facilities should involve consideration of the individual facility in relationship to a comprehensive recreational program and facilities plan for the installation and the region. Consider the following factors, in addition to those relationships specifically indicated in the criteria for each facility:

- If other MWR facilities serving the same user population provide the same program activities, reduce the allowed capacity of the proposed facility by the capacity provided elsewhere at the installation or other nearby regional installations.
- Consider collocating the facility with other recreational facilities providing complementary programs, to provide the users with the increased convenience and attractiveness of clustered activities, and to take advantage of potential savings in support space requirements and operating costs.
- Size and locate an individual facility appropriately to the target population and geographical area its particular function is designed to serve. Convenient access for users should be considered in balance with the need for efficient facility operation and avoidance of duplicate facilities. Consider the DoD INST 1015.15 (Enclosure 3, Attachment 1) requirement for the use of appropriated funds (APF) for site development costs, archeological and ammunition clearances, water purification, demolition, excessive utility connections, and road service when selecting sites.
- Consider local community facilities. If the local community has a robust program and facilities for outdoor recreational activities consider partnerships with the local community for services, and/or other Public Private Venture initiatives.

750 10 OUTDOOR PLAYING COURTS (EA)

Design Criteria: Military Handbook (MIL-HDBK-1037/3) -- Outdoor Sports and Recreation Facilities

75010-1 **GENERAL**. See introduction to 750 series category codes for General Instructions regarding facility allowance planning procedures.

75010-2 **DEFINITION**. Outdoor Playing Courts provide facilities and support services to meet the individual physical fitness and recreation needs of military personnel. The facilities may also serve dependents, retirees and authorized civilians. Activities that may be accommodated in Outdoor Playing Courts include: basketball, tennis, volleyball, skate/skateboard parks, and outdoor skating/roller hockey rink

75010-3 **RELATED FACILITIES**. Consideration should be given to collocating the Outdoor Playing Courts with the following recreational facilities in order to (i) take advantage of potential savings in space requirements and operating costs, and (ii) provide users with the increased convenience of clustered facilities:

- 740 44 Indoor Physical Fitness Center (Gym)
- 740 45 Fitness Room
- 740 84 Indoor Playing Courts
- 750 20 Playing Fields
- 740 55 Youth Center

75010-4 **DEMAND AND ALLOWANCES**. Demand, market analysis and survey information, as well as the number of existing leagues/teams if applicable determine the number of Outdoor Playing Courts provided at each installation. Provision of lighted courts is recommended where there is a high demand and/or climate warrants later usage by patrons. Youth Outdoor Playing Courts will be provided as needed. They should be sized and located for the youth population, i.e. near the youth center if there is one. The Courts will be sized in accordance with industry standards for the youth age group or adult age group as appropriate.

750 20 PLAYING FIELDS (EA)

Design Criteria: Military Handbook (MIL-HDBK-1037/3) -- Outdoor Sports and Recreation Facilities

75020-1 **GENERAL**. See introduction to 750 series category codes for General Instructions regarding facility allowance planning procedures.

75020-2 **DEFINITION**. Playing Fields provide facilities and support services to meet the individual physical fitness, coordination, skills development, training and recreation needs of military personnel. The facilities may also serve dependents, retirees and authorized civilians. Activities which may be accommodated in Playing Fields include: baseball, football, soccer, softball, track and field, etc.

75020-3 **RELATED FACILITIES**. Consideration should be given to collocating the Playing Fields with the following recreational facilities in order to (i) take advantage of potential savings in space requirements and operating costs, and (ii) provide users with the increased convenience of clustered facilities:

- 740 44 Indoor Physical Fitness Center (Gym)
- 740 45 Fitness Room
- 740 53 Indoor Swimming Pool
- 750 10 Outdoor Playing Courts.
- 740 55 Youth Center

75020-4 **DEMAND AND ALLOWANCES**. Demand, market analysis and survey information, as well as the number of existing leagues/teams if applicable determine the number of Outdoor Playing Fields provided at each installation. Provision of lighted fields is recommended for expanded usage. Provision of lighted fields and use of artificial turf or installed sprinkler systems may serve to reduce the total requirement for filds by allowing extended playing hours, extended play without the need for field maintenance/recovery. Youth Outdoor Playing Fields will be provided as needed. They should be sized and located for the youth population, i.e. near the youth center if there is one. The Fields will be sized in accordance with industry standards for the youth age group or adult age group as appropriate.

750 21 BATTING CAGE (EA)

75021-1 Batting cages may be provided at Installations where there is a demand, where a MWR survey supports the requirement, and there is no convenient local alternative. Size according to industry standards.

750 22 JOGGING TRACK (KM/MI)

75022-1 Jogging tracks are provided and sized as required.

750 23 GO-CART TRACK (KM/MI)

75023-1 Go-Cart Tracks may be provided as a Category C facility where they are determined to be profitable enterprises. Market analysis for this facility must be provided by MWR. Size according to demand and industry standards.

750 30 OUTDOOR SWIMMING POOL - INSTALLATION (SQ.M./SF)

75030-1 (Use CC 740 53 SWIMMING POOL - INDOOR for sizing standards). With appropriate demand analysis, outdoor pools may include water park features and spray parks.

750 33 POOL PUMP/FILTER/TREATMENT FACILITY - REMOTE (EA)

75033-1 This code is for inventory purposes and only in those cases where such facilities are located in a structure remotely situated from the swimming pool proper.

750 34 WADING POOL/SPLASH POOL (EA)

75034-1 Wading pools normally are planned as adjuncts to main pools (see CC 740 53 Swimming Pool—Indoor). This code is for inventory purposes and only in those cases where wading pools are detached from the main facility.

750 35 ACTIVITY TV RECEIVER ANTENNA (EA)

75035-1 This Category Code Number is provided for inventory purposes only.

750 36 TV DISTRIBUTION SYSTEM (EA)

75036-1 Category Codes 750 35 and 750 36 are for inventory purposes only. Such facilities are provided only at remote installations where central TV reception and local distribution systems can be individually justified.

750 37 OUTDOOR ADVENTURE AREA (EA)

75037-1 Includes Ropes Courses, Natural Recreation Features (rock climbing, hiking trails, mountain bike trails, paintball ranges, motocross/BMX areas). Requirement is based on local availability (geography) and local demand. Size according to industry standards.

750 38 OUTDOOR MWR EQUIPMENT RENTAL STORAGE (SQ.M./SF)

75038-1 Outdoor fenced area with lighting for storage of MWR rental equipment (not enclosed). Facility should be co-located with the Outdoor Recreation Center CCN 740-37, if there is one.

750 39 MWR VEHICLE/RV/BOAT STORAGE COMPOUND (SQ.M./SF)

75039-1 Vehicle/RV/Boat Storage Compounds may be provided as Category C facilities where they are determined to be profitable enterprises. Markey analysis for this facility must be provided by MWR. Size according to demand and industry standards. Covered spaces may be included where justified by demand.

750 40 GOLF COURSE (EA)

Design Criteria: Military Handbook (MIL-HDBK-1037/3) -- Outdoor Sports and Recreation Facilities

75040-1 **GENERAL**. See introduction to 750 series category codes for General Instructions regarding facility allowance planning procedures.

75040-2 **DEFINITION**. Golf Courses are recreational facilities which may accommodate: recreational golfing, practice, instruction, tournaments, exhibitions, special events, and winter recreational activities such as cross-country skiing, ice skating, sledding and tobogganing. In addition to the Golf Course, space permitting, the facility may include a driving range, practice hole, chipping green with sand trap, and putting green(s). A Golf Course is a Category C MWR facility.

75040-3 **RELATED FACILITIES**. The Golf Course must be collocated with the following recreational facilities in order to (i) take advantage of potential savings in space requirements and operating costs, and (ii) provide users with the increased convenience of clustered facilities:

- 740 80 Golf Club House (including golf maintenance building/storage compound, chemical/fertilizer/pesticide storage and mixing building, and cart storage facilities).

- 750 56 Golf Driving Range.

75040-4 **DEMAND**. The Golf Course will be sized in accordance with a market survey approach. As a Category C facility the Golf Course must be profitable and a financial analysis or pro forma will be provided as well as the NPC Internal Needs Validation Study (INVS), and finally the Project Validation Assessment. The Planner will accomplish the initial demand investigation and review along with local MWR personnel. If project is financially sound it will be forwarded via the region to NPC (after 1 October 2004, CNI Field Support Activity) for INVS scoring and possible Project Validation Assessment.

75040-5 **FACILITY ALLOWANCE.** The Golf Course will be sized in accordance with industry standards. One resource for sizing criteria is the National Golf Foundation (NGF). Siting, water availability, and existing land area available will be the key considerations when planning a new Golf Course.

750 50 OUTDOOR THEATER (EA)

75050-1 No planning factors are available. If an outdoor theater (either seat- type or drive-in) is provided, the requirements for theaters (Code 740 56) must be reduced accordingly.

750 52 SKEET AND/OR TRAP RANGE (EA)

75052-1 Skeet and/or Trap Ranges may be provided as Category C facilities where they are determined to be profitable enterprises. Market analysis for this facility must be provided by MWR. Size according to demand and industry standards. In addition, suitable land must be available, and the activity must have a military population over 100. If a range building is authorized, see Category Code 740 52 for criteria. Table 75052-1 gives the corresponding land requirements. This facility must be self-sustaining.

Table 75052-1 Land Requirements for Skeet and Trap Ranges Land Area

Military Population (1)	Skeet Range	Trap Range
Up to 100	None	None
101 to 10,000	335m x 732m /1100' x 2400'	335m x 549m / 1100' x 1800'
10,001 to 15,000	335m x 732m /1100' x 2400'	335m x 576m / 1100' x 1890'
15,001 to 20,000	335m x 732m /1100' x 2400'	335m x 604m / 1100' x 1980'
20,001 to 25,000	335m x 732m /1100' x 2400'	335m x 631m / 1100' x 2070'
25,001 to 30,000	335m x 732m /1100' x 2400'	335m x 658m / 1100' x 2160'
30,001 to 40,000	335m x 777m /1100' x 2550'	335m x 686m / 1100' x 2250'
Over 40,000	335m x 823m / 1100' x 2700'	335m x 713m / 1100' x 2340'

(1) Military population consists of active duty military supported by the installation.

750 54 BAND STAND (EA)

75054-1 No planning factors are available. Requests for this facility will require individual justification.

750 56 GOLF DRIVING RANGE (EA)

75056-1 Installations, where the necessary land is already available, and the facility will be profitable as a Category C facility, are authorized a golf driving range. See Category Code 750-40

750 57 MWR OPERATED RECREATION GROUNDS (EA)

75057-1 No specific guidance is available. Local conditions usually will govern the development of any parks, playgrounds, or picnic areas. Recreation Pavilions (Code 740 78) are authorized in conjunction with these facilities.

750 58 RECREATIONAL CAMPGROUND-TENT (SQ.M./SF)

75058-1 Please see CCN 750-59 for general description of campground. This CCN will be used for tent camping vs. RV's. No vehicle pads are required. See Table 75059-1 for sanitary facilities requirements for tent campgrounds.

750 59 RECREATION CAMPGROUND - RV (SQ.M./SF)

Project Review: Base MWR representatives, EFD, NAVFAC HQ, BUPERS (Pers-656D)
Design Criteria: *(Military Handbook is not currently available)*

75059-1 **GENERAL**. See General Notes to 750 series category codes for General Instructions regarding facility allowance planning procedures.

75059-2 **DEFINITION**. Recreational Campgrounds provide the military community with outdoor recreation opportunities at locations with attractive natural resources. To complement the camping experience, and depending on location, Recreational Campgrounds may offer activities such as boating, canoeing, fishing, hiking, hunting, skiing and swimming. Facilities should be designed to take advantage of the natural features of the site, from vegetation to good views to unusual topography. At the same time, development should be environmentally appropriate, and not threaten the preservation of the natural heritage and scenic resources.

The planning criteria in this Category Code addresses only the camping sites and patron support facilities such as showers, toilets and laundromats. Other campground support facilities (particularly in relatively remote locations) such as an on-site manager's office, community room, kitchen, and convenience stores are not included in this Category Code. See CCN 740-92. Recreational campgrounds are encouraged to make use of the Camp Host concept to assist in the management of the campground. Space allowances for MWR Rental Cabins are addressed under Category Code 740 81.

Dump stations should generally be provided at campgrounds that accommodate RV's.. (CCN 750 59). The sizing and design of dump stations will vary according to local conditions (such as topography, soil conditions, proximity to water sources, etc.). All dump station facilities must comply fully with all applicable environmental regulations.

75059-3 **RELATED FACILITIES**. Where such locations are adjacent to the sea or other body of water, support facilities such as marinas, boat ramps and RV/vehicle/boat storage compounds maybe sited in close proximity to Recreational Campgrounds.

75059-4 **SPACE ALLOWANCE**. The total number of camping and/or RV sites provided at a location is primarily determined by two considerations:

- The Recreational Campground will be sized in accordance with a market survey approach. As a Category C facility the Campground must be profitable and a financial analysis or pro forma will be provided as well as the NPC Internal Needs Validation Study (INVS), and finally the Project Validation Assessment. The Planner will accomplish the initial demand investigation and review along with local MWR personnel. If the project is financially sound it will be forwarded via the region to NPC (after 1 October 2004, CNI Field Support Activity) for INVS Scoring and possible Project Validation Assessment.

- Capacity of the location to accommodate the proposed facilities at a recommended level of use density, and other site planning requirements for access and provision of utilities.

75059-4.1 The number of campsites which may be accommodated per acre will vary depending on the natural features (topography, geology, vegetation, etc.) of the proposed location and the desired degree of privacy between individual sites. Development of as few as 2.4 sites per hectare (6 sites per acre) to a maximum of 5.7 sites per hectare (14 sites per acre) is recommended as a planning guideline. However, this guideline may be modified by the financial analysis, which may, for example, indicate that 2.4 sites per hectare (6 sites per acre) may be too low to justify the investment required to provide the necessary infrastructure (paths, roads, patron support facilities, utilities, etc.). Furthermore, the financial analysis may also indicate a total minimum number of sites required to justify the investment in this recreational resource and the corresponding support building (CCN 740-92). RV Campsites should be planned with a vehicle pad 20 feet by 40 feet. Minimum separation between campsites should be 37 feet. It is recommended that, where financially feasible, the RV Campground include a mix of back-in and pull-through sites.

75059-4.2 Once the total number of campsites at a location has been determined, the required patron support facilities may be selected from the criteria in Table 75059-1.

Table 75059-1 Sanitary Facilities Requirements for Recreational Campgrounds

#Tent/Trailer	#Water Closets (M/F)	#Lavatories (M/F)	#Showers (M/F)	#Urinals
1-15	1/1	1/1	1/1	1
16-30	1/2	2/2	1/1	1
31-45	2/2	3/3	1/1	1
46-60	2/3	3/3	2/2	2
61-80	3/4	4/4	2/2	2
81-100	3/4	4/4	3/3	2

Notes for Table 75059-1:

(1) For recreational areas having more than 100 tent/trailer/camper/RV sites, provide one additional water closet and lavatory per each additional 30 sites, and one additional urinal per each additional 60 sites.

(2) For laundry facilities, provide one washer and one dryer for every increment of 12 sites or portion thereof.

75059-4.3 All facilities, which have the potential for causing environmental contamination—for example, dumpsters and dump stations—, must comply fully with all applicable local, state and federal regulations. The planning of Recreational Campgrounds located in areas under the jurisdiction of other agencies such as State

Parks and Forests Divisions, the U.S. Forest Service and the National Park Service, must adhere to all applicable development guidelines and review procedures.

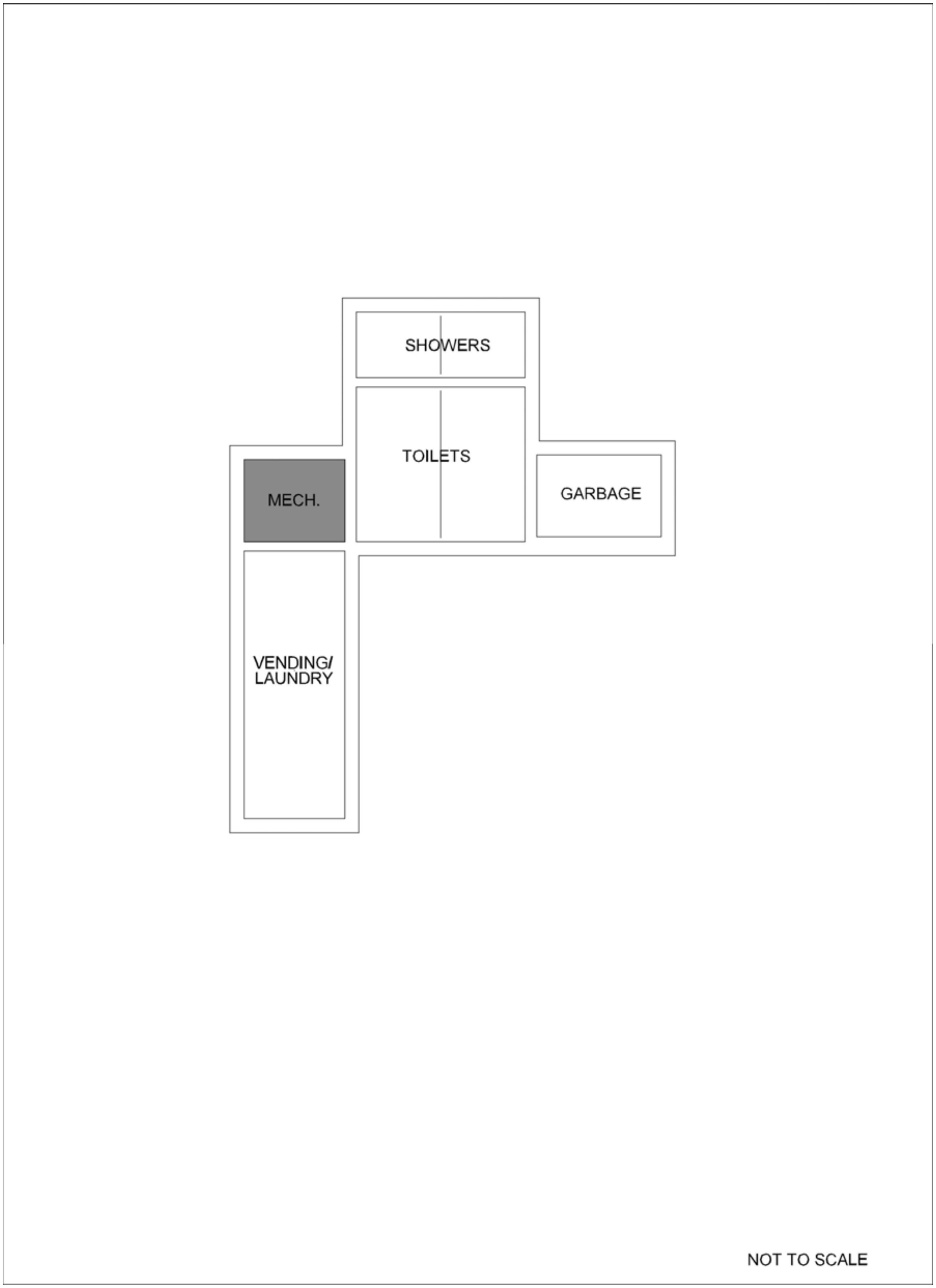


Figure 75059-1   Recreational Campground – Medium Size Support Facility

750 60 MARINA (EA)

75060-1 This facility requires special considerations and must be developed based on local conditions and supported by a detailed analysis. As a Category C facility, the Marina must be profitable and a financial analysis or pro forma will be provided as well as the NPC Internal Needs Validation Study (INVS), and finally the Project Validation Assessment. The Planner will accomplish the initial demand investigation and review along with local MWR personnel. If the project is financially sound it will be forwarded via the Region to NPC (after 1 October 2004, CNI Field Support Activity) for INVS Scoring and possible Project Validation Assessment. For a Category B sailing program marina, it is necessary to document the demand and to ensure that APF will be available to support operation of the sailing program. A marina support building or boathouse is authorized in conjunction with a marina and should be programmed as a part of the project nomination and validation process.. See Code 740 87 for marina support building criteria. There are two categories of Marina: Category B is the MWR sailing program and Category C is the rental slips operation.

750 61 RECREATIONAL PIER (EA)

75061-1 This CCN is used for stand-alone recreational pier facilities (e.g. fishing piers) where there is no existing Marina.

FAC 7542 Miscellaneous Outdoor Recreation Facility

FY25 SUC:	$3,472.52 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	New estimate for V13, FAC Composite

FAC 7542 Miscellaneous Outdoor Recreation Facility

UM = EA
Multiple catcodes shown on document included below

FAC cost based upon grandstand/bleacher required inspections (ICC and NFPA 102) and Skeet/Trap field; jogging trails disregarded as maintenance is FOM-based

Requirements		Unit	Qty	Reference FAC	Unit Cost	Frequency (years)	Extended Cost
	Grandstands & bleachers		1		1650	1	$ 1,650.00
	Jogging and bike trails				0		$ -
	Skeet or Trap Fields						$ -
	Skeet included: high/low house	SF	200	4422	0.87		$ 348.00
	Skeet included: shooting station	EA	7	8526	1.43		$ 20.02
							$ -
							$ -
TOTAL							$ 2,018.02
PER UNIT (EA)							$ 2,018.02

FAC 7601 Museum

FY25 SUC:	$4.33 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 7601 Museum

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $4.33
UM: SF
Expected Service Life: 55
Model Size: 15631

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair concrete stairs	30	60.00 S.F.	$1,912.64	$2,213.64	1.8333	1	1	$2,213.64	$2,213.64
Point clay brick wall, 1st floor	25	67.00 C.S.F.	$58,619.53	$72,475.67	2.2000	2	2	$144,951.34	$144,951.34
Waterproof clay brick wall, 1st floor	10	67.00 C.S.F.	$13,000.88	$15,666.33	5.5000	5	5	$78,331.67	$78,331.67
Repair painted clay brick wall, 1st floor	25	670.00 S.F.	$32,690.02	$40,072.32	2.2000	2	2	$80,144.63	$80,144.63
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	0.40 S.F.	$5.46	$6.41	55.0000	55	55	$352.64	$352.64
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	42.00 Ea.	$6,782.92	$8,083.15	2.7500	2	2	$16,166.30	$16,166.30
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	42.00 Ea.	$34,514.07	$40,324.76	1.1000	1	1	$40,324.76	$40,324.76
Replace glass - 2nd floor (1% of glass) - alum. window fixed	1	0.40 S.F.	$46.37	$57.29	55.0000	55	55	$3,151.20	$3,151.20
Repair aluminum storefront door	12	2.00 Ea.	$1,099.17	$1,310.67	4.5833	4	4	$5,242.68	$5,242.68
Replace 3'-0" x 7'-0" aluminum storefront doors	50	2.00 Ea.	$5,728.92	$6,718.40	1.1000	1	1	$6,718.40	$6,718.40
Replace insulating glass - (3% of glass) aluminum storefront door	1	1.30 S.F.	$87.88	$102.34	55.0000	55	55	$5,628.89	$5,628.89
Repair steel, painted, door	14	3.00 Ea.	$2,332.68	$2,762.30	3.9286	3	3	$8,286.91	$8,286.91
Refinish 3'-0" x 7'-0" steel, painted, door	4	3.00 Ea.	$143.98	$176.26	13.7500	13	13	$2,291.35	$2,291.35
Replace 3'-0" x 7'-0" steel, painted, door	45	3.00 Ea.	$2,207.58	$2,569.71	1.2222	1	1	$2,569.71	$2,569.71
Replace tempered glass - (3% of glass) steel painted door	1	1.90 S.F.	$62.60	$73.90	55.0000	55	55	$4,064.41	$4,064.41
Repair 12' x 12' steel roll-up door	10	1.00 Ea.	$902.17	$1,063.12	5.5000	5	5	$5,315.61	$5,315.61
Replace 12' x 12' steel roll-up door	35	1.00 Ea.	$3,608.67	$4,252.49	1.5714	1	1	$4,252.49	$4,252.49
Minor metal roof finish repairs, 2% of roof area, metal panel roofing	5	312.00 S.F.	$1,512.65	$1,795.12	11.0000	11	11	$19,746.28	$19,746.28
Metal roof flashing replacement, 2 SF/sq repaired, metal panel roofing	1	6.00 S.F.	$169.55	$201.77	55.0000	55	55	$11,097.34	$11,097.34
Minor metal roof panel replacement, 2.5% of roof area	20	390.00 S.F.	$5,393.99	$6,380.43	2.7500	2	2	$12,760.85	$12,760.85
Total metal roof panel replacement	30	156.00 Sq.	$149,949.56	$177,319.45	1.8333	1	1	$177,319.45	$177,319.45
Repair solid core wood door, interior	11	12.00 Ea.	$3,562.20	$4,155.86	5.0000	5	5	$20,779.31	$20,779.31
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	12.00 Ea.	$656.18	$798.26	13.7500	13	12	$10,377.44	$9,579.18
Replace 3'-0" x 7'-0" solid core wood door, interior	40	12.00 Ea.	$7,725.33	$8,907.61	1.3750	1	1	$8,907.61	$8,907.61
Replace 3'-0" x 7'-0" solid core, w/ safety glass, door, interior	40	11.00 Ea.	$9,403.13	$10,803.46	1.3750	1	1	$10,803.46	$10,803.46
Repair fabric wall finish fabric interior	9	155.00 S.Y.	$5,967.22	$7,113.09	6.1111	6	6	$42,678.51	$42,678.51
Repair 5/8" drywall - (2% of walls)	20	324.80 S.F.	$606.73	$737.99	2.7500	2	2	$1,475.98	$1,475.98
Refinish drywall	4	8,000.00 S.F.	$5,776.46	$7,083.23	13.7500	13	13	$92,082.02	$92,082.02
Refinish concrete floor finished	25	28.00 C.S.F.	$12,838.35	$15,424.47	2.2000	2	2	$30,848.94	$30,848.94
Replace vinyl sheet flooring	18	260.00 S.Y.	$20,741.03	$25,151.50	3.0556	3	3	$75,454.50	$75,454.50
Quarry tile floor repairs - (2% of floors)	15	47.30 S.F.	$329.51	$410.82	3.6667	3	3	$1,232.45	$1,232.45
Replace quarry tile floor	50	200.00 S.F.	$3,268.28	$3,903.91	1.1000	1	1	$3,903.91	$3,903.91
Replace carpet	8	720.00 S.Y.	$40,102.93	$46,375.79	6.8750	6	6	$278,254.72	$278,254.72
Replace flush valve diaphragm tankless water closet	10	9.00 Ea.	$248.31	$308.49	5.5000	5	5	$1,542.43	$1,542.43
Rebuild flush valve tankless water closet	20	9.00 Ea.	$1,739.44	$2,096.59	2.7500	2	2	$4,193.17	$4,193.17
Unplug clogged line tankless water closet	5	9.00 Ea.	$2,068.03	$2,590.09	11.0000	11	11	$28,491.00	$28,491.00
Replace tankless flush valve	25	9.00 Ea.	$2,453.90	$2,880.25	2.2000	2	2	$5,760.50	$5,760.50
Replace wax ring gasket for tankless water closet	5	9.00 Ea.	$1,347.79	$1,686.44	11.0000	11	11	$18,550.82	$18,550.82
Replace flush valve diaphragm for a urinal	7	4.00 Ea.	$110.36	$137.10	7.8571	7	7	$959.73	$959.73
Rebuild flush valve for a urinal	20	4.00 Ea.	$773.08	$931.82	2.7500	2	2	$1,863.63	$1,863.63
Unplug line urinal	5	4.00 Ea.	$611.61	$766.01	11.0000	11	11	$8,426.13	$8,426.13
Replace washer in spud connection lavatory, vitreous china	7	4.00 Ea.	$69.57	$84.93	7.8571	7	7	$594.54	$594.54
Replace washer in faucet lavatory, vitreous china	2	9.00 Ea.	$122.38	$152.67	27.5000	27	27	$4,121.97	$4,121.97
Replace faucets lavatory, vitreous china	10	9.00 Ea.	$1,787.60	$2,149.05	5.5000	5	5	$10,745.26	$10,745.26
Clean out strainer and P trap lavatory, vitreous china	2	9.00 Ea.	$333.79	$418.06	27.5000	27	27	$11,287.59	$11,287.59
Replace faucet washer sink, service/utility	2	1.00 Ea.	$13.50	$16.85	27.5000	27	27	$454.84	$454.84
Clean trap	3	1.00 Ea.	$9.02	$11.29	18.3333	18	18	$203.29	$203.29
Replace faucets sink, service/utility	10	1.00 Ea.	$198.62	$238.78	5.5000	5	5	$1,193.92	$1,193.92
Unstop sink	2	1.00 Ea.	$44.15	$55.30	27.5000	27	27	$1,493.07	$1,493.07
Replace sink, P.E.C.I. service/utility	35	1.00 Ea.	$1,659.02	$1,940.60	1.5714	1	1	$1,940.60	$1,940.60
Check / minor repairs drinking fountain	1	3.00 Ea.	$155.83	$195.17	55.0000	55	55	$10,734.47	$10,734.47
Repair internal leaks drinking fountain	4	3.00 Ea.	$143.37	$179.56	13.7500	13	13	$2,334.26	$2,334.26
Replace refrigerant drinking fountain	2	3.00 Ea.	$110.31	$128.99	27.5000	27	27	$3,482.77	$3,482.77
Repair drain leak drinking fountain	4	3.00 Ea.	$91.53	$110.43	13.7500	13	11	$1,435.53	$1,214.68
Replace fountain drinking fountain	10	3.00 Ea.	$4,570.18	$5,383.32	5.5000	5	5	$26,916.60	$26,916.60
Unclog floor drain, PVC	20	1.00 Ea.	$50.39	$63.11	2.7500	2	2	$126.21	$126.21
Unclog 4" - 12" diameter PVC main drain per L.F.	10	0.20 L.F.	$0.80	$1.00	5.5000	5	5	$5.01	$5.01
General maintenance & repair drain: roof, scupper, area	1	2.00 Ea.	$78.44	$98.24	55.0000	55	55	$5,403.02	$5,403.02
Replace drain: roof, scupper, area	40	2.00 Ea.	$2,192.71	$2,530.43	1.3750	1	1	$2,530.43	$2,530.43
Repair boiler, gas, 250 MBH	7	2.00 Ea.	$5,105.25	$5,979.12	7.8571	7	6	$41,853.83	$35,874.71
Replace boiler, gas, 250 MBH	30	2.00 Ea.	$3,272.50	$4,098.62	1.8333	1	1	$4,098.62	$4,098.62
Repair fan coil unit, 3 ton	10	6.00 Ea.	$3,467.97	$4,107.65	5.5000	5	5	$20,538.25	$20,538.25
Replace fan coil, DX 2 ton, with heat	15	4.00 Ea.	$7,417.03	$8,727.04	3.6667	3	3	$26,181.11	$26,181.11
Repair fan, induced draft, 2000 CFM	10	3.00 Ea.	$960.63	$1,173.57	5.5000	5	5	$5,867.83	$5,867.83
Replace fan, induced draft, 2000 CFM	20	3.00 Ea.	$15,885.95	$18,271.31	2.7500	2	2	$36,542.62	$36,542.62
Repair circulator pump, 1/12 - 3/4 H.P.	5	2.00 Ea.	$209.65	$247.29	11.0000	11	8	$2,720.23	$1,978.35
Replace circulator pump, 1/12 - 3/4 H.P.	15	2.00 Ea.	$7,375.75	$8,507.92	3.6667	3	3	$25,523.75	$25,523.75
Maintenance and repair infrared heater suspended, commercial	1	2.00 Ea.	$90.98	$114.13	55.0000	55	55	$6,277.08	$6,277.08
Repair terminal reheat, 12" x 24" coil	10	8.00 Ea.	$752.15	$942.03	5.5000	5	4	$4,710.16	$3,768.12
Replace terminal reheat, 12" x 24" coil	15	8.00 Ea.	$16,074.52	$18,435.81	3.6667	3	3	$55,307.44	$55,307.44
Repair single zone rooftop unit, 15 ton	10	2.00 Ea.	$73,865.44	$85,254.52	5.5000	5	5	$426,272.58	$426,272.58
Replace single zone rooftop unit, 15 ton	15	2.00 Ea.	$42,450.82	$50,048.47	3.6667	3	3	$150,145.41	$150,145.41
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	55.0000	55	55	$2,497.55	$2,497.55
Replace sprinkler head	20	46.00 Ea.	$4,217.77	$5,197.87	2.7500	2	2	$10,395.75	$10,395.75
Rebuild double check 3" backflow preventer sprinkler system	1	1.00 Ea.	$753.40	$903.05	55.0000	55	55	$49,667.91	$49,667.91
Maintenance and inspection lighting panel, indoor	3	6.00 Ea.	$262.90	$329.80	18.3333	18	18	$5,936.46	$5,936.46
Replace load center, 100 A	20	6.00 Ea.	$6,790.19	$8,331.55	2.7500	2	2	$16,663.10	$16,663.10
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	21.00 Ea.	$1,623.02	$2,036.08	2.7500	2	2	$4,072.16	$4,072.16
Maintenance and repair breaker, molded case, 480 V, 2 pole	20	5.00 Ea.	$386.43	$484.78	2.7500	2	2	$969.56	$969.56
Replace circuit breaker molded case, 480 V, 2 pole circuit breaker	50	5.00 Ea.	$6,015.05	$6,952.55	1.1000	1	1	$6,952.55	$6,952.55
Replace fluorescent light fixture ballast, 80 W	10	38.00 Ea.	$4,139.42	$5,104.44	5.5000	5	5	$25,522.19	$25,522.19
Replace lamps (2 lamps), 4', 34 W energy saver	10	38.00 Ea.	$1,031.76	$1,293.75	5.5000	5	5	$6,468.77	$6,468.77
Replace metal halide ballast, 175 W	10	12.00 Ea.	$2,058.74	$2,465.97	5.5000	5	5	$12,329.83	$12,329.83
Replace metal halide fixture lamp, 175 W	5	12.00 Ea.	$730.07	$887.08	11.0000	11	11	$9,757.90	$9,757.90
Repair smoke detector	10	24.00 Ea.	$1,458.36	$1,804.92	5.5000	5	4	$9,024.62	$7,219.70
Check operation smoke detector	1	24.00 Ea.	$419.17	$525.85	55.0000	55	55	$28,921.93	$28,921.93
Replace smoke detector	15	24.00 Ea.	$8,098.11	$9,636.18	3.6667	3	3	$28,908.53	$28,908.53
Repair heat detector	10	24.00 Ea.	$1,590.10	$1,954.62	5.5000	5	5	$9,773.12	$9,773.12
Replace heat detector	15	24.00 Ea.	$4,555.28	$5,563.64	3.6667	3	3	$16,690.92	$16,690.92
Check and repair manual pull station	10	6.00 Ea.	$569.93	$701.44	5.5000	5	4	$3,507.20	$2,805.76
Replace manual pull station	15	6.00 Ea.	$1,380.46	$1,659.03	3.6667	3	3	$4,977.08	$4,977.08
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Replace fire alarm control panel	15	1.00 Ea.	$2,335.26	$2,841.40	3.6667	3	3	$8,524.19	$8,524.19
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Replace annunciation panel	15	1.00 Ea.	$1,250.41	$1,502.49	3.6667	3	3	$4,507.48	$4,507.48
Replace fire alarm bell, 6"	20	5.00 Ea.	$1,002.18	$1,214.11	2.7500	2	2	$2,428.22	$2,428.22
Maintenance and repair building structure ground	7	2.20 M.L.F.	$210.01	$262.53	7.8571	7	7	$1,837.73	$1,837.73
Maintenance and repair of general wiring lightning protection system	1	2.20 M.L.F.	$244.91	$302.19	55.0000	55	55	$16,620.47	$16,620.47
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	55.0000	55	55	$26,253.24	$26,253.24
Replace lamp emergency lighting fixture	2	15.00 Ea.	$859.73	$1,037.68	27.5000	27	27	$28,017.43	$28,017.43
Replace emergency lighting fixture	20	15.00 Ea.	$9,356.73	$11,047.42	2.7500	2	2	$22,094.83	$22,094.83
Maintenance and repair exit light	20	15.00 Ea.	$598.73	$741.09	2.7500	2	2	$1,482.18	$1,482.18
Replace lamp exit light	5	15.00 Ea.	$274.47	$325.36	11.0000	11	11	$3,578.98	$3,578.98
Replace lighting fixture exit light	20	15.00 Ea.	$2,796.62	$3,386.77	2.7500	2	2	$6,773.55	$6,773.55
Maintenance and repair voice/data outlet	10	6.00 Ea.	$334.16	$417.69	5.5000	5	5	$2,088.44	$2,088.44
Replace voice/data outlet	20	6.00 Ea.	$169.90	$206.92	2.7500	2	2	$413.83	$413.83
Maintenance and inspection patch panel	0.5	2.00 Ea.	$185.00	$232.08	110.0000	110	110	$25,529.23	$25,529.23
Replace patch panel	15	2.00 Ea.	$1,894.36	$2,276.61	3.6667	3	3	$6,829.84	$6,829.84
			$698,038.55	$828,152.13				MR Subtotal:	$2,578,069.03
								MR Per Year:	$46,873.98
								PM Total:	$20,761.43
								Subtotal:	$67,635.41
								Total Per Unit:	$4.33

FAC 7601 Museum

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $4.33
UM: SF
Expected Service Life: 55
Model Size: 15631

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	4	1.04	$63.29	$46.94	$0.0000	110.22	130.63	154.21
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	1	4.07	$82.62	$184.02	$0.0000	266.64	330.10	397.70
Urinals, annualized	4	0.91	$27.36	$49.07	$0.0000	76.42	93.88	112.70
Toilet (vacuum breaker type), annualized	9	1.59	$82.65	$86.04	$0.0000	168.69	202.77	240.98
Lavatories, annualized	9	3.13	$69.46	$197.96	$0.0000	267.43	333.76	403.57
Drink fountain, annualized	3	1.86	$108.45	$100.25	$0.0000	208.70	249.62	295.96
Boiler, hot water, oil, gas, or comb. fired, 120 - 500 MBH, annualized	2	31.76	$180.74	$2,030.40	$0.0000	2,211.14	2,838.34	3,474.57
Air handling unit, 3 thru 24 tons, annualized	2	4.12	$326.32	$221.65	$0.0000	547.97	647.10	762.54
Fan coil unit, annualized	10	33.38	$859.76	$1,793.52	$0.0000	2,653.28	3,277.31	3,944.33
VAV Boxes, annualized	13	12.14	$123.83	$775.36	$0.0000	899.19	1,144.18	1,395.37
Fan, axial, up to 5,000 CFM, annualized	3	3.73	$41.33	$200.50	$0.0000	241.83	306.11	372.46
Package unit, air cooled, 3 thru 24 ton, annualized	2	4.79	$330.23	$307.94	$0.0000	638.17	763.58	905.49
Controls, central system, electro/pneumatic, annually	1	1.92	$179.77	$122.67	$0.0000	302.44	357.22	420.98
Steam humidification system, annually	2	2.54	$56.67	$162.43	$0.0000	219.10	273.49	330.72
Backflow prevention device, up to 4", annualized	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Fire pump, electric motor driven, annualized	1	47.75	$61.55	$3,003.30	$0.0000	3,064.85	3,972.00	4,882.22
Extinguishing system, dry pipe, annualized	1	13.02	$114.31	$820.62	$0.0000	934.93	1,192.55	1,455.88
Security, intrusion alarm system, annualized	1	3.83	$178.64	$242.03	$0.0000	420.67	511.14	610.55
Light, emergency, hardwired system, annualized	15	3.75	$136.23	$236.80	$0.0000	373.03	457.69	549.16
						$13,640.41	$17,124.98	$20,761.43

FAC 7602 Monument and Memorial

FY25 SUC:	$313.80 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Commercial Sources, 2010

FAC 7602 MONUMENTS AND MEMORIALS

There are 2729 monuments and memorials in the inventory. This FAC is based on Army, Navy, Air Force CAC Codes which are titled 'monument and memorial' or 'outdoor monument and memorial'. This group includes "Items such as commemorative plaques, military equipment displays, statues, and the like." Assumption that all are free-standing outdoor facilities. (Note that this does not include facilities covered under FAC 7603 Cemeteries).

Size, material, age, components and level of required care vary widely within this category. Areas for cost research included specific maintenance costs for these items:

A. Commemorative plaque horizontal on ground or on a base ((Note that plaque and base may or may not be of the same material)

- Bronze/other metal
- Marble
- Composite
- Granite/other stone
- Glass/other material

B. Commemorative plaque vertical freestanding

- Bronze/other metal
- Marble
- Composite
- Granite/other stone
- Glass/other material

C. Statue/sculpture and base (Note that statue/sculpture and base may or may not be of the same material)

- Bronze/other metal
- Marble
- Composite
- Granite/other stone
- Masonry

D. Equipment display or other assembly of equipment which may be firefighters equipment, military equipment (planes, tanks, jeeps, etc.) or special equipment like Pentagon memorial benches and area, commemorative benches, shelter, etc. This usually includes informative plaques attached to equipment or free-standing.

ANNUAL MAINTENANCE PROGRAMS AND COST

For category A and B Commemorative/informative plaques flat and upright, small memorials or monuments (grave marker & tombstone as examples)

For most accessible information, researched maintenance, cleaning and minor repair costs and schedule for gravestones, tombstones, plaques, etc. as the closest match to items in this category A/B. (EG. Arlington cemetery in 2007 had funding to clean memorials every other year, versus the desired practice of cleaning annually.)

Maintenance includes cleaning with material-appropriate products, removal of encroaching vegetation, inspection and documentation of changes in surface, all as described for statue/sculpture below.

Maintenance may include repainting or touch-up of lettering as needed. Maintenance may include photography, videography or other documentation for record-keeping on item condition.

Maintenance may require realigning, straightening, or even resetting due to subsidence or other ground disturbance caused by water, frost, vandals, animals, etc. A full resetting involves removal, new concrete base, curing and resetting, plus cleanup of work area – time up to 8 man-hours plus materials. The Connecticut Gravestone Network (2009) estimated average of $1000 per tombstone to reset. (UK price (2010) to refix was estimated at 235 -423 pounds ($369-$664)– new dowels, ground anchor, bearer and drilling/preparing ground). This could be a restoration cost rather than maintenance, depending on circumstances and extent of work.

Depending on geographic area, item requirements and available funding, maintenance cleaning and minor repair may occur at 6, 12, 24 or 36 month intervals. (eg. Arlington cemetery in 2007 stated the cleaning of each memorial took place every 2 years)

Other Cost Sources:

In general, memorial cleaners quote between $60-$200, depending on size and material (internet search of multiple sources)

UK surface clean lawn memorial = 82 pounds ($128), for traditional memorial (upright) $152 pounds ($237).

Stone and bronze marker $60; Taller than 6"monument/memorial $75-$90 per visit; will provide estimates for bronze plaques, etc. (www.memorialcleaners.com)

Bronze markers refinished so the lettering is bright and the background is restored to its original brown color, by shipping them back to the manufacturer, or contracting with monument companies. Cost will run $150 to $200 for a single 2x1 foot marker.

In most cemeteries – the annual fee or maintenance fee covers site, and does NOT include maintenance of the tombstone (cleaning, minor repairs, etc) unless contracted as a separate charge thru memorial caretakers or cemetery. Assume maintenance for any monument or memorial in FAC 7602 is funded separately from site maintenance.

For Category C: Statues and Sculptures
For statues and sculptures, recommended maintenance includes **annual** regular washing with dilute solution of detergent, water rinse, soft brushes or sponges; inspection and documentation of changes in surface patina, pitting, streaking, corrosion, blanching, structural problems or damage; removal of encroaching vegetation to discourage bird, animal, insect or vandal damage; clearing of weep holes for drainage; repointing or minor repair structural repair; and application of protective coating as appropriate (wax, resin, paint, sealer, etc).

For bronze/metal statues – recommend professional cleaning and relaquering on a five to ten-year cycle, which may require removal and reinstallation of parts. Geographic location, materials, condition, and prior maintenance will determine the schedule.

Maintenance of the memorial may include covering or enclosure, fencing, seating or sidewalks, landscaped area, fountain, etc. which are intrinsic part of memorial. (Williamstown Art Conservation Center Technical Bulletin, Woodlawn Cemetery Maintenance Plan, Minnesota Mall Maintenance Report). Reported cost range which agrees with other sources:

1. Savannah - **$1500** annually quoted by city official for cleaning of monument
2. Charlotte Dept of Transportation Queens Table Monuments and Four Sites (connected):Annual costs projected by city for maintenance of monument **$1200** per year
3. City of NY Parks and Recreation: Typical annual maintenance for figural bronze **$1000 to $2000**

For Category D. Equipment Grouping

Complexity of maintenance within this group varies depending on components involved. Examples:

- Plaque plus several antique fire vehicles (DOD Firefighters Memorial, Goodfellow AFB)
- Plaque plus one or more tanks, planes, etc: Most military installations
- Individual benches and setting: pentagon memorial

NOTE ON OUTSIDE ASSISTANCE. Maintenance funding or actual maintenance MAY come from private sources, groups, individuals, or volunteers to supplement or even replace DOD O&M funding.

In private and local government practice, donors of a memorial **must guarantee** payment of future maintenance costs from endowment, trust fund, pre-payment, before the government agencies will accept donation of new or transferred existing property as memorials. This approach allows agencies to consider the overall public benefit for taking the donation versus the long-term cost and budging capability to maintain the memorial/monument. This protects agencies from incurring unexpected and unjustifiable expenses over the expected life of the donation.

For new memorials proposals, expected maintenance costs are built into the overall project cost estimate, so that the full, rather than initial, cost to taxpayers is considers.

For existing or new DOD memorials, volunteers or interest groups with a strong vested interest in a monument/memorial have provided in-kind or financial support where DOD funding cannot offer the best level of care for the facility. Donations from these private sources, groups or individuals are NOT considered in determining the FAC 7602 SUC, but their participation can result in lower spending levels than DOD might otherwise incur.

Ten Years of Sculpture and Monument Conservation on the Minnesota State Capitol Mall, Paul Storch, Minnesota Historical Society, 2001

Annual Maintenance Program for Outdoor Sculpture, Williamstown Art Conservation Center, Technical Bulletin, 2009

Caring for Outdoor Bronze Plaques, National Park Service, 2005

Cleaning Gravestones, Monuments and Stone Sculptures, New England Cemetery Services, 2010

Connecticut Gravestone Network Newsletter, January 2009

DOD Firefighters Memorial, www.firehouse.com News, 2008

Monument Maintenance, http://www.findstone.com/awmon.htm, 2010

Gurnee Mayor Vetoes Veterans Memorial Deal, Daily Herald, 2010

Memorial Cleaners List of Services, Missouri, 2010

Guidelines for Donating Works of Art to City of New York/Parks and Recreation, 2010

Queen's Table Monuments, Presentation to Charlotte NC City Council, 2009

Lodge Brothers List of Services, UK, 2010

Woodlawn Lot Owner's Services, NYC, 2010

Lodge Brothers
Funeral Directors & Memorial Masons

Renovation & Maintenance

When a memorial is to be renovated it is always necessary for one of our experienced staff to inspect the memorial before the work commences. We are then able to compile a report of all the work that will be needed in order to restore the memorial to its original condition.

The following prices are, therefore, a guide to the costs that may be involved. However, each enquiry will be dealt with individually and priced accordingly.

Our estimates are free of charge and our clients are under no obligation to accept them.

Cleaning

Surface clean Lawn Memorial (headstone & base) using chemicals	£82.25
Surface clean Traditional Memorial using chemicals	£152.75
Thoroughly clean Lawn Memorial using abrasive machines and chemicals	£152.75
Thoroughly clean Traditional Memorial using abrasive machines and chemicals	£305.50
Re-beat inscription	From £35.25

Please note, it is not always possible to use abrasive machines where there is existing lettering. Often the lettering would need to be re-cut or cleaned around using a sandblaster or scraper.

Re-fixing

NAMM Re-fix Lawn (including new dowels, ground anchor, bearer and drilling/preparing memorial)		£235.00
Re-fix Traditional Complete re-fix drilling and dowelling but joints (guide price only)	From	£423.00

Lettering (Price per letter up to 1” high. Letters over 1” priced plus 50% per ¼”)

Letter carver’s call out fee Sandblast technician call out fee		From From	£70.50 £164.50
MARBLE	Sandblasted and Enamel Painted Hand cut only Hand cut and Enamel Painted Hand cut and Lead Filled		£3.23 £3.23 £3.84 £4.16
GRANITE	Sandblasted and Enamel Painted Sandblasted and Gilded		£3.35 £3.82

	Hand cut and Enamel Painted	£4.16
	Hand cut and Gilded	£4.77
	Raised Lead Enamel Painted	£8.04
	Raised Lead Gilded	£8.65
MARBLE & GRANITE	Re-Enamel Incised	£1.29
	Re-Gilded	£1.82

The methods used to create a cut, drilled and lead filled letter mean it is often not possible to replace just one or two letters. The process involved may lead to the loosening or misshaping of letters already present.

Memorial Interiors
The centre of many kerbset memorials are often filled with soil for planting. Families may move away and it can become difficult for them to maintain this area of the memorial. Our memorial staff are able to excavate the existing centre and lay any of the following in place of the soil:

Grey Granite Chippings on concrete chipping bed	£176.25
White Marble Chippings on concrete chipping bed	£193.88
Green, Cobalt Blue, Turquoise or White fossite chippings	£211.50

Maintenance
Where families have moved away or the upkeep of a grave is physically too difficult, we offer maintenance agreements on a 5 year contract basis. The memorial is visited twice a year, chemically cleaned, tidied around, levelled, joints re-pointed, photographed and a report made out on the condition of the memorial.

Please contact us if interested in taking out a maintenance agreement.

ALL PRICES ARE EXCLUSIVE OF V.A.T.

Lodge
BROTHERS 1780
4 Clarendon Road, Ashford, Middlesex, TW15 2QE
Tel: 01784 252227 begin_of_the_skype_highlighting 01784 252227 end_of_the_skype_highlighting email:
info@lodgebrothers.co.uk

Memorial Cleaners List of Services

Below is a listing of services offered. Gravesite beautification treatments and cleaning methods used on your monuments may vary depending on age, condition, type of stone, surface finish, and cemetery rules. This step is taken to preserve your memorials and cemetery surroundings.

Cleaning Price Chart Estimates and Descriptions

- **All prices below are estimations and could vary depending on the job and the location.**
- **Please call or email us today for a fast, more accurate quote!**
- **These are cleaning prices only and do not include restoration services.**

Services Offered		Pay Per Visit				Memorial Premium Service Plans click here for more info					
		Initial Visit*		Follow-Up Visit**		One Year		Two Year		Three Year	
		Single	Double	Single	Double	Single	Double	Single	Double	Single	Double
Stone & Bronze Markers		$60	$75	$40	$45	$140	$165	$220	$255	$300	$345
Small to Medium Headstones	**less than 4' tall**	$75	$100	$50	$60	$175	$220	$275	$340	$375	$460
	4'-6' tall	$90	$125	$60	$75	$210	$275	$330	$425	$450	$575
Large Headstones (taller than 6') Monuments & Memorials		Large headstones and monuments vary greatly in size and difficulty cleaning. It is impossible to make an estimated quote for every large headstone and monument. Please call us today for an accurate quote.								**Call or email for an Estimate!**	

Bronze Plaques	We take great care when cleaning your bronze plaque. We thoroughly examine the condition of the plaque, clean, wax and polish the surface ensuring a longer lifetime. We do offer full restorations for bronze plaques if needed, for more information visit our restoration page or give us a call.	**Call or email for an Estimate!**
Above Ground Tombs, Vaults and Sepulchers	Our above ground vault cleaning service is the same as our stone cleaning services but the prices will vary depending on location, stone age, condition and the size of the vault. Please call us for a more accurate vault cleaning quote.	**Call or email for an Estimate!**
Mausoleums & Columbariums	Our columbarium and mausoleum cleaning services carry the same excellence and dedication to preservation as our stone cleaning services but the prices will vary depending on location, stone age, condition and the size of the structure. Please call us for a more accurate mausoleum care quote.	**Call or email for an Estimate!**
Private or Family Cemeteries	Our services include mowing, trimming, clearing brush, minor landscaping, stone setting and leveling, memorial gravestone care and routine maintenance for private or family owned cemeteries.	**Call or email for an Estimate!**
Repair, Restoration & Deep Stain Removal	Our gravestone and monument restoration and repair services include mending, leveling and stone setting, along with surface restoration and deep stain removal. We can restore bronze plaques, place markers and bronze vases or urns. After our restoration service we highly recommend you schedule regular follow-ups to prevent your memorial from future deterioration.	**Call or email for an Estimate!**

Initial Visit

- All initial visits should be scheduled at least five days in advance unless specially requested.
- Express service may be available depending upon availability for an additional charge.
- Your initial visit will consist of the following, depending on the job. Vandalism and condition inspection, full thorough cleaning, polishing, surface stain removal, biocide treatment, grass trimming & edging, insecticide application, fresh flowers and digital before and after photos.
- If vacancies are available major holiday visits can be scheduled for "Pay Per Visit" first time customers on a first come basis.

**Follow-Up Visit

- All follow up visits **must be scheduled within one year of the initial visit** to qualify for follow-up pricing.
- All follow-up visits should be scheduled at least five days in advance.
- Biocide treatments are performed with annual follow-up visits.
- A follow-up visit consists of the following, depending on the job. vandalism and condition inspection, light general cleaning, grass trimming, insecticide application, fresh flowers and digital before and after photos.
- If vacancies are available major holiday visits can be scheduled for "Pay Per Visit" follow-up customers on a first come basis.

Holiday Visit

- Holiday visits should be scheduled at least five days in advance.
- Holiday visits may be used for any special occasion like birthdays or major holidays such as Memorial Day or Mothers Day.
- Holiday visits will be given the normal follow-up visit care along with any special holiday requests or placements of flowers, candles, etc.
- Due to popular demand holiday visits are reserved for our Premium Service Plan customers exclusively unless specially requested.
- If vacancies are available major holiday visits can be scheduled for "Pay Per Visit" customers on a first come basis.

Memorial Premium Service Plans

click here for pricing

One Year Plan	Two Year Plan	Three Year Plan
○ One initial visit. ○ Two 6 month follow up visits. ○ One customer choice holiday visit, to be scheduled within the one year service agreement term.	○ One initial visit. ○ Four 6 month follow up visits. ○ Two customer choice holiday visits, to be scheduled within the two year service agreement term.	○ One initial visit. ○ Six 6 month follow up visits. ○ Three customer choice holiday visits, to be scheduled within the three year service agreement term

FAC 7603 Cemetery

FY25 SUC: $0.00 / EA

Source:

FAC 7604 Columbarium

FY25 SUC:	$0.00 / CF
Source:	

FAC 7605 Pentagon Memorial

FY25 SUC:	$462.93 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Calculation below based on National 9-11 Memorial Data

FAC	Description	PRV	National 911 Memorial NYC Maintenance Multiplier	Area Adjustment - NYC to Arlington	Ratio Based SUC	Unit
7605	Pentagon Memorial	$ 145,641.77	0.30%	0.666666667	291.28354	EA
7606	Air Force Memorial	$ 48,178,966.98	0.30%	0.666666667	96357.93396	EA

Source of National 9-11 Memorial, NYC, Maintenance Multiplier: Thomas Cancelliere, Director of Facilities, National 9-11 Memorial, 1 Dec 2011

FAC 8111 Electrical Power Source, Plant

FY25 SUC:	$132.26 / KW
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8112 Stand-By/Emergency Power

FY25 SUC:	\$27.51 / KW
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8112 Stand-By/Emergency Power

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $27.51
UM: KW
Expected Service Life: 45
Model Size: 306

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	4.5000	4	4	$6,215.64	$6,215.64
Replace safety switch, heavy duty 100 A	25	1.00 Ea.	$1,662.22	$1,950.38	1.8000	1	1	$1,950.38	$1,950.38
Maintenance and repair electrical service ground	25	0.65 M.L.F.	$62.05	$77.57	1.8000	1	1	$77.57	$77.57
Maintenance and inspection generator, gasoline, 175 KW	0.08	1.00 Ea.	$69.98	$87.79	562.5000	562	562	$49,340.74	$49,340.74
Replace generator component gasoline, 175 KW	25	1.00 Ea.	$97,685.01	$112,040.95	1.8000	1	1	$112,040.95	$112,040.95
Maintenance and inspection transfer switch	0.5	1.00 Ea.	$43.82	$54.97	90.0000	90	90	$4,947.05	$4,947.05
Replace battery charger	20	1.00 Ea.	$1,263.88	$1,459.08	2.2500	2	2	$2,918.17	$2,918.17
			$102,108.85	$117,224.65				MR Subtotal:	$177,490.50
								MR Per Year:	$3,944.23
								PM Total:	$4,474.86
								Subtotal:	$8,419.09
								Total Per Unit:	$27.51

FAC 8112 Stand-By/Emergency Power

Release:	2024 Qtr 3	FY25 SUC:	$27.51
Zip Code Prefix:	222	UM:	KW
Type:	PM	Expected Service Life:	45
		Model Size:	306

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Circuit breaker, high voltage air, annualized	1	0.47	$16.52	$33.37	$0.0000	49.88	61.54	74.03
Emergency diesel or gas generator, over 15 KVA, annualized	2	32.30	$177.64	$2,041.80	$0.0000	2,219.44	2,849.75	3,488.94
Battery system and charger, annualized	1	8.73	$21.96	$552.78	$0.0000	574.74	742.77	911.89
						$2,844.06	$3,654.06	$4,474.86

FAC 8113 Electrical Power Source, Hydroelectric Plant

FY25 SUC:	$27,510.00 / MW
Source:	Set to FAC 8112: CostWorks Model; UM conversion factor = 1000 KW

FAC 8114 Electrical Power Source, Wind Generated

FY25 SUC:	$27.51 / KW
Source:	Set to FAC 8112; Cost Works Model

FAC 8115 Electrical Power Source, PhotoVoltaic

FY25 SUC:	$28.50 / KW
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8115 Electrical Power Source, PhotoVoltaic

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $28.50
UM: KW
Expected Service Life: 33
Model Size: 556

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Replace solar panel 3' x 8'	15	14.00 Ea.	$19,910.17	$23,268.44	2.2000	2	2	$46,536.87	$46,536.87
Repair 500 kva transformer, primary, liquid filled	10	1.00 Ea.	$3,062.11	$3,520.43	3.3000	3	3	$10,561.29	$10,561.29
Maintenance and inspection primary transformer, dry	0.5	1.00 Ea.	$43.82	$54.97	66.0000	66	66	$3,627.84	$3,627.84
Repair switchgear 1200 A mainframe	5	2.00 Ea.	$4,137.36	$4,840.15	6.6000	6	5	$29,040.90	$24,200.75
Maintenance and inspection switchgear, mainframe	1	2.00 Ea.	$139.97	$175.59	33.0000	33	33	$5,794.46	$5,794.46
Replace switchgear 1200 A mainframe	20	2.00 Ea.	$9,016.12	$10,863.30	1.6500	1	1	$10,863.30	$10,863.30
Repair switchboard meter	10	4.00 Ea.	$5,287.56	$6,215.64	3.3000	3	3	$18,646.92	$18,646.92
Replace switchboard meter	20	4.00 Ea.	$18,409.72	$21,006.98	1.6500	1	1	$21,006.98	$21,006.98
Maintenance and repair rectifier, up to 600 V	2	1.00 Ea.	$744.52	$887.31	16.5000	16	15	$14,196.98	$13,309.67
Maintenance and inspection rectifier, up to 600 V	0.33	1.00 Ea.	$139.97	$175.59	100.0000	100	100	$17,558.98	$17,558.98
Replace rectifier, up to 600 V	20	1.00 Ea.	$1,391.36	$1,602.81	1.6500	1	1	$1,602.81	$1,602.81
Maintenance and repair of general wiring lightning protection system	1	0.35 M.L.F.	$38.96	$48.08	33.0000	33	33	$1,586.50	$1,586.50
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	33.0000	33	33	$15,751.94	$15,751.94
Maintenance and repair transfer switch	5	2.00 Ea.	$774.52	$935.06	6.6000	6	6	$5,610.35	$5,610.35
Replace voice/data outlet	20	4.00 Ea.	$113.27	$137.94	1.6500	1	1	$137.94	$137.94
Maintenance and inspection patch panel	0.5	1.00 Ea.	$92.50	$116.04	66.0000	66	66	$7,658.77	$7,658.77
Replace patch panel	15	4.00 Ea.	$3,788.72	$4,553.23	2.2000	2	2	$9,106.45	$9,106.45
Repair cable splice overhead service	12	1.20 M.L.F.	$710.18	$887.65	2.7500	2	2	$1,775.29	$1,775.29
Cable inspection overhead service, splice	5	1.20 M.L.F.	$60.11	$75.41	6.6000	6	6	$452.45	$452.45
			$68,242.78	$79,841.95				MR Subtotal:	$215,789.56
								MR Per Year:	$6,539.08
								PM Total:	$9,306.07
								Subtotal:	$15,845.15
								Total Per Unit:	$28.50

FAC 8115 Electrical Power Source, PhotoVoltaic

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $28.50
UM: KW
Expected Service Life: 33
Model Size: 556

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Controls, central system, electro/pneumatic, annualized	4	7.68	$719.07	$490.68	$0.0000	1,209.75	1,428.86	1,683.93
Switchboard, with air circuit breaker, annualized	4	53.27	$76.45	$3,804.72	$0.0000	3,881.17	5,030.23	6,183.11
Circuit breaker, high voltage air, annualized	4	1.88	$66.07	$133.46	$0.0000	199.53	246.18	296.13
Circuit breaker, high voltage oil, annualized	2	1.71	$38.02	$122.51	$0.0000	160.53	201.09	243.54
Switch, interrupt, high voltage, fused air, annualized	8	2.91	$132.14	$207.17	$0.0000	339.30	414.67	496.64
Transformer, oil pad mounted, annually	2	2.16	$1.90	$154.38	$0.0000	156.28	202.78	249.38
Power stablizer, annualized	2	1.25	$21.96	$78.68	$0.0000	100.64	126.44	153.34
						$6,047.20	$7,650.25	$9,306.07

FAC 8116 Battery Energy Storage System

FY25 SUC:	$46,386.92 / MW
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8116 Battery Energy Storage System

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $46,386.92
UM: MW
Expected Service Life: 20
Model Size: 1

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Repair 500 kva transformer, primary, liquid filled	10	2.00 Ea.	$6,124.21	$7,040.86	2.0000	2	2	$14,081.72	$14,081.72
Maintenance and inspection primary transformer, dry	0.5	2.00 Ea.	$87.63	$109.93	40.0000	40	40	$4,397.38	$4,397.38
Repair switchgear 1200 A mainframe	5	2.00 Ea.	$4,137.36	$4,840.15	4.0000	4	3	$19,360.60	$14,520.45
Maintenance and inspection switchgear, mainframe	1	2.00 Ea.	$139.97	$175.59	20.0000	20	20	$3,511.80	$3,511.80
Replace switchgear 1200 A mainframe	20	2.00 Ea.	$9,016.12	$10,863.30	1.0000	1	1	$10,863.30	$10,863.30
Repair switchgear, - (5% of total C.B.), indoor, less than 600 V	10	4.00 Ea.	$3,567.89	$4,117.98	2.0000	2	2	$8,235.95	$8,235.95
Maintenance and inspection switchgear, indoor, less than 600 V	3	4.00 Ea.	$175.26	$219.87	6.6667	6	6	$1,319.21	$1,319.21
Repair switchboard meter	10	8.00 Ea.	$10,575.11	$12,431.28	2.0000	2	2	$24,862.56	$24,862.56
Replace switchboard meter	20	8.00 Ea.	$36,819.43	$42,013.96	1.0000	1	1	$42,013.96	$42,013.96
Maintenance and repair rectifier, up to 600 V	2	8.00 Ea.	$5,956.15	$7,098.49	10.0000	10	9	$70,984.89	$63,886.40
Maintenance and inspection rectifier, up to 600 V	0.33	8.00 Ea.	$1,119.74	$1,404.72	60.6061	60	60	$84,283.11	$84,283.11
Replace rectifier, up to 600 V	20	8.00 Ea.	$11,130.91	$12,822.46	1.0000	1	1	$12,822.46	$12,822.46
Maintenance and repair secondary transformer, dry	10	8.00 Ea.	$2,364.08	$2,810.11	2.0000	2	2	$5,620.21	$5,620.21
Maintenance and inspection secondary transformer, dry	0.5	8.00 Ea.	$696.19	$873.37	40.0000	40	40	$34,934.74	$34,934.74
Maintenance and repair of general wiring lightning protection system	1	0.35 M.L.F.	$38.96	$48.08	20.0000	20	20	$961.51	$961.51
Maintenance and repair lightning ground rod	1	4.00 Ea.	$381.84	$477.33	20.0000	20	20	$9,546.63	$9,546.63
Maintenance and repair transfer switch	5	2.00 Ea.	$774.52	$935.06	4.0000	4	4	$3,740.23	$3,740.23
Maintenance and inspection transfer switch	0.5	2.00 Ea.	$87.63	$109.93	40.0000	40	40	$4,397.38	$4,397.38
Replace transfer switch	18	2.00 Ea.	$61,467.95	$70,341.72	1.1111	1	1	$70,341.72	$70,341.72
Maintenance and inspection battery, dry	0.08	8.00 Ea.	$350.53	$439.74	250.0000	250	250	$109,934.50	$109,934.50
Replace battery, dry	5	8.00 Ea.	$1,758.32	$2,030.47	4.0000	4	4	$8,121.88	$8,121.88
Maintenance and inspection UPS battery	0.17	8.00 Ea.	$559.87	$702.36	117.6471	117	117	$82,176.04	$82,176.04
Replace motor generator UPS battery	15	8.00 Ea.	$9,564.66	$11,308.92	1.3333	1	1	$11,308.92	$11,308.92
Replace voice/data outlet	20	4.00 Ea.	$113.27	$137.94	1.0000	1	1	$137.94	$137.94
Maintenance and inspection patch panel	0.5	4.00 Ea.	$370.00	$464.17	40.0000	40	40	$18,566.71	$18,566.71
Replace patch panel	15	4.00 Ea.	$3,788.72	$4,553.23	1.3333	1	1	$4,553.23	$4,553.23
Repair cable splice overhead service	12	1.20 M.L.F.	$710.18	$887.65	1.6667	1	1	$887.65	$887.65
Cable inspection overhead service, splice	5	1.20 M.L.F.	$60.11	$75.41	4.0000	4	4	$301.64	$301.64
			$171,936.61	$199,334.08				MR Subtotal:	$650,329.24
								MR Per Year:	$32,516.46
								PM Total:	$13,870.46
								Subtotal:	$46,386.92
								Total Per Unit:	$46,386.92

FAC 8116 Battery Energy Storage System

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $46,386.92
UM: MW
Expected Service Life: 20
Model Size: 1

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Controls, central system, electro/pneumatic, annualized	4	7.68	$719.07	$490.68	$0.0000	1,209.75	1,428.86	1,683.93
Switchboard, with air circuit breaker, annualized	4	53.27	$76.45	$3,804.72	$0.0000	3,881.17	5,030.23	6,183.11
Circuit breaker, high voltage air, annualized	32	15.04	$528.54	$1,067.71	$0.0000	1,596.25	1,969.42	2,369.02
Circuit breaker, high voltage oil, annualized	2	1.71	$38.02	$122.51	$0.0000	160.53	201.09	243.54
Switch, interrupt, high voltage, fused air, annualized	8	2.91	$132.14	$207.17	$0.0000	339.30	414.67	496.64
Transformer, oil pad mounted, annually	2	2.16	$1.90	$154.38	$0.0000	156.28	202.78	249.38
Power stablizer, annualized	32	20.00	$351.30	$1,258.94	$0.0000	1,610.24	2,023.05	2,453.43
Cathodic protection system, annualized	1	1.46	$38.36	$89.67	$0.0000	128.03	158.77	191.42
						$9,081.55	$11,428.87	$13,870.46

FAC 8121 Electrical Power Distribution Line, Overhead

FY25 SUC:	$0.43 / LF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8122 Exterior Lighting, Pole

FY25 SUC:	$80.62 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8123 Electrical Power Distribution Line, Underground

FY25 SUC:	$0.93 / LF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8123 Electrical Power Distribution Line, Underground

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $0.93
UM: LF
Expected Service Life: 55
Model Size: 1

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	0.02 S.F.	$0.81	$0.99	3.6667	3	3	$2.97	$2.97
Clean floor drain w/o bucket	4	0.01 Ea.	$0.62	$0.77	13.7500	13	13	$10.06	$10.06
Replace service cable	50	0.00 M.L.F.	$11.72	$14.22	1.1000	1	1	$14.22	$14.22
Replace branch wiring with junction box	50	0.00 M.L.F.	$1.70	$2.10	1.1000	1	1	$2.10	$2.10
Replace circuit breaker enclosed, 600 V, 3 pole circuit breaker 800 A	50	0.00 Ea.	$11.46	$13.25	1.1000	1	1	$13.25	$13.25
Maintenance and repair special ground system	4	0.02 Ea.	$0.46	$0.58	13.7500	13	13	$7.58	$7.58
Cable inspection overhead service, splice	5	0.00 M.L.F.	$0.05	$0.06	11.0000	11	11	$0.69	$0.69
			$26.82	$31.97				MR Subtotal:	$50.89
								MR Per Year:	$0.93
								PM Total:	$0.00
								Subtotal:	$0.93
								Total Per Unit:	$0.93

FAC 8123 Electrical Power Distribution Line, Underground

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM

FY25 SUC: $0.93
UM: LF
Expected Service Life: 55
Model Size: 1

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
						$0.00	$0.00	$0.00

FAC 8124 Electric Vehicle Charge Facility

FY25 SUC:	$137.40 / KW
Source:	Multiple Industry Studies

FAC	8124	Electric Vehicle Charge Facility		UM = KW	Source	Industry Study, 2019		
Level	**Type of Charger**	**Chargers per Pedestal**	**KW/ Charger**	**Per Charger Cost for Maintenance**	**$/KW**	**Inflation Adjustment by ENR Index**	**Adjusted Cost**	
Level 1	Non-networked	One	1.4	$ 364.90	$ 260.64	1.4397	Level I Average	
Level 1	Non-networked	Two	1.4	$ 361.60	$ 258.29	1.4397	$ 373.55	KW
Level 2	Non-networked	One	6.6	$ 427.20	$ 64.73	1.4397		
Level 2	Non-networked	Two	6.6	$ 402.80	$ 61.03	1.4397		
Level 2	Networked	One	6.6	$ 621.70	$ 94.20	1.4397	Level II Average	
Level 2	Networked	Two	6.6	$ 588.30	$ 89.14	1.4397	$ 111.25	KW
DC fast	Networked 50 kW	One	50	$ 5,536.50	$ 110.73	1.4397		
DC fast	Networked 150 kW	One	150	$ 10,331.20	$ 68.87	1.4397	Level III Average	
DC fast	Networked 350 kW	One	350	$ 17,909.70	$ 51.17	1.4397	$ 110.75	KW
						Weighted Average	$ 137.40	KW

Notes: Based on Industry data, population weighting is 10% Level I, 75% Level II, 15% Level III

Primary Source: Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas by Michael Nicholas

Alternate Source: Financial Viability Of Non-Residential Electric Vehicle Charging Stations; UCLA

Alternate Source: Plug-In Electric Vehicle and Infrastructure Analysis; Idaho National Laboratory

Alternate Source: Pulling Back the Veil on EV Charging Station Costs; Rocky Mountain Institute

FAC 8131 Electrical Power Substation

FY25 SUC:	$22.43 / KV
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8132 Electrical Power Switching Station

FY25 SUC:	$0.87 / KV
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8133 Electrical Power Transformers

FY25 SUC:	$8.76 / KV
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8134 Lightning Protection System, Standalone

FY25 SUC:	$1,344.26 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8211 Heat Source, Plant

FY25 SUC:	$0.003 / BH
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8221 Heat Distribution Line

FY25 SUC:	$4.20 / LF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8221 Heat Distribution Line

Release:	2024 Qtr 3	FY25 SUC:	$4.20
Zip Code Prefix:	222	UM:	LF
Type:	MR	Expected Service Life:	34
		Model Size:	12687

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Replace threaded steel pipe and fittings, 4"	75	960.00 L.F.	$127,368.92	$151,498.36	0.4533	0	0	$0.00	$0.00
Repair deaerator	10	4.00 Ea.	$313.74	$392.95	3.4000	3	3	$1,178.84	$1,178.84
Replace deaerator	20	4.00 Ea.	$212,185.11	$247,935.38	1.7000	1	1	$247,935.38	$247,935.38
Repair flash tank 24 gallon	5	2.00 Ea.	$935.00	$1,171.03	6.8000	6	6	$7,026.20	$7,026.20
Replace steam regulator valve 3" diameter	6	4.00 Ea.	$67,435.50	$76,724.59	5.6667	5	5	$383,622.94	$383,622.94
Repair condensate meter	15	4.00 Ea.	$6,231.98	$7,230.85	2.2667	2	2	$14,461.71	$14,461.71
Replace condensate meter 1500 lb./hr.	30	4.00 Ea.	$25,738.64	$29,329.50	1.1333	1	1	$29,329.50	$29,329.50
Replace steam trap, 15 PSIG, 2" threaded	7	4.00 Ea.	$5,007.90	$5,785.58	4.8571	4	4	$23,142.31	$23,142.31
Replace radiator valve 1-1/4" angle union	50	4.00 Ea.	$1,207.46	$1,409.99	0.6800	0	0	$0.00	$0.00
Install new gasket, 4" pipe size, steel/iron, flanged	25	175.00 Ea.	$38,514.50	$47,860.62	1.3600	1	1	$47,860.62	$47,860.62
Repack drain valve gland, 3/4" valves	3	4.00 Ea.	$118.24	$141.53	11.3333	11	11	$1,556.79	$1,556.79
Replace drain valve stem assembly, 3/4" valves	8	4.00 Ea.	$281.16	$339.41	4.2500	4	4	$1,357.65	$1,357.65
Repair circulator pump, 1 H.P.	5	4.00 Ea.	$420.22	$495.73	6.8000	6	4	$2,974.39	$1,982.93
Replace circulator. pump, 1 H.P.	15	4.00 Ea.	$21,844.52	$25,076.08	2.2667	2	2	$50,152.16	$50,152.16
Repair damaged pipe insulation, fiberglass 4"	5	15.00 Ea.	$571.87	$693.86	6.8000	6	6	$4,163.17	$4,163.17
Replace pipe insulation, fiberglass 4"	5	6.00 M.L.F.	$95,573.98	$115,362.66	6.8000	6	6	$692,175.98	$692,175.98
Replace pipe insulation, fiberglass 6"	5	0.60 M.L.F.	$11,812.97	$14,267.79	6.8000	6	6	$85,606.74	$85,606.74
Maintenance and repair voice/data outlet	10	28.00 Ea.	$1,559.42	$1,949.21	3.4000	3	3	$5,847.64	$5,847.64
Replace voice/data outlet	20	28.00 Ea.	$792.88	$965.61	1.7000	1	1	$965.61	$965.61
			$617,914.01	$728,630.73				MR Subtotal:	$1,598,366.17
								MR Per Year:	$47,010.77
								PM Total:	$6,252.71
								Subtotal:	$53,263.48
								Total Per Unit:	$4.20

FAC 8221 Heat Distribution Line

Release:	2024 Qtr 3	FY25 SUC:	$4.20
Zip Code Prefix:	222	UM:	LF
Type:	PM	Expected Service Life:	34
		Model Size:	12687

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Valve, check, above 4", annualized	8	2.06	$55.10	$110.32	$0.0000	165.42	204.03	245.39
Valve, OS&Y, above 4", annualized	12	1.91	$82.65	$102.54	$0.0000	185.19	224.22	267.37
Valve, pressure relief, above 4", annualized	12	1.78	$73.28	$95.43	$0.0000	168.70	204.66	244.28
Valve, pressure regular, above 4", annualized	15	5.39	$91.59	$291.87	$0.0000	383.46	480.18	581.48
Valve, sediment strainer, above 4", annualized	14	4.38	$85.49	$235.70	$0.0000	321.18	400.44	483.97
Pump, condensate return unit, 2 pumps, annually	4	2.29	$279.42	$145.51	$0.0000	424.93	496.53	582.10
Heat exchanger, steam, annualized	1	0.92	$24.91	$49.49	$0.0000	74.40	91.74	110.33
Heat pump, water cooled, over 5 ton, annualized	4	12.91	$586.20	$825.70	$0.0000	1,411.90	1,718.22	2,053.86
Controls, central system, electro/pneumatic, annualized	4	7.68	$719.07	$490.68	$0.0000	1,209.75	1,428.86	1,683.93
						$4,344.93	$5,248.88	$6,252.71

FAC 8231 Heat Gas Production Plant

FY25 SUC:	$0.00008 / BH
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8232 Heat Gas Storage

FY25 SUC:	$570.43 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8241 Heat Gas Distribution Line

FY25 SUC:	$0.52 / LF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8261 Refrigeration and Air Conditioning Source, Plant

FY25 SUC:	$79.28 / TR
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8271 Chilled Water and Refrigerant Distribution Line

FY25 SUC:	$3.65 / LF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8311 Sewage Treatment

FY25 SUC:	$190.94 / KG
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8312 Industrial Waste Treatment

FY25 SUC:	$188.65 / KG
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8313 Water Separation Facility

FY25 SUC:	$4.07 / KG
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8314 Septic Tank and Drain Field

FY25 SUC:	$0.13 / GA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8315 Septic Lagoon and Settlement Ponds

FY25 SUC:	$0.0042 / GA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8316 Sewage Lift Stations

FY25 SUC:	$12.84 / KG
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8316 Sewage Lift Stations

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $12.84
UM: KG
Expected Service Life: 25
Model Size: 731

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Unclog main drain pipe & fittings, cast iron	10	2.00 Ea.	$97.66	$122.31	2.5000	2	2	$244.62	$244.62
Unclog 4" - 12" diameter main drain per L.F.	10	4.00 L.F.	$16.00	$20.04	2.5000	2	2	$40.08	$40.08
Insp/chk pump/mtr oper, lub, chk align, rainwater sump pump	1	2.00 Ea.	$25.20	$31.57	25.0000	25	25	$789.15	$789.15
Replace rainwater sump pump / motor assembly	20	2.00 Ea.	$1,265.14	$1,498.44	1.2500	1	1	$1,498.44	$1,498.44
Repack gate valve gland, 2" - 3" valves	10	4.00 Ea.	$157.26	$188.23	2.5000	2	2	$376.46	$376.46
Replace gate valve, partial, 2" - 3" valves	20	4.00 Ea.	$8,647.35	$9,894.68	1.2500	1	1	$9,894.68	$9,894.68
Repack gate valve gland, 8" - 12" valves	5	4.00 Ea.	$720.20	$875.81	5.0000	5	5	$4,379.04	$4,379.04
Repair failed breaker, molded case, 600 V, 3 pole	10	4.00 Ea.	$1,617.77	$1,925.22	2.5000	2	2	$3,850.44	$3,850.44
Maintenance and inspection circuit breaker, molded case, 600 V, 3 pole	0.33	4.00 Ea.	$138.75	$174.06	75.7576	75	75	$13,054.72	$13,054.72
Maintenance and repair safety switch, 3 pole safety switch, heavy duty	8	4.00 Ea.	$175.26	$219.87	3.1250	3	3	$659.61	$659.61
Maintenance and repair voice/data outlet	10	1.00 Ea.	$55.69	$69.61	2.5000	2	2	$139.23	$139.23
Remove and replace 50 HP pump motor	25	8.00 Ea.	$83,395.20	$95,248.06	1.0000	1	1	$95,248.06	$95,248.06
Remove and replace steel guard rail	7	14.00 L.F.	$1,002.27	$1,164.28	3.5714	3	3	$3,492.85	$3,492.85
Raise MH or catch basin frame and cover	10	1.00 Ea.	$430.13	$524.23	2.5000	2	2	$1,048.47	$1,048.47
			$97,743.88	$111,956.41				MR Subtotal:	$134,715.85
								MR Per Year:	$5,388.63
								PM Total:	$3,998.26
								Subtotal:	$9,386.89
								Total Per Unit:	$12.84

FAC 8316 Sewage Lift Stations

Release:	2024 Qtr 3	FY25 SUC:	$12.84
Zip Code Prefix:	222	UM:	KG
Type:	PM	Expected Service Life:	25
		Model Size:	731

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Switchboard, annualized	2	1.40	$9.50	$100.60	$0.0000	110.10	141.23	172.83
Motor control center, over 400 A, annualized	4	1.56	$103.79	$111.55	$0.0000	215.34	259.19	308.22
Manual slide gate, annualized	1	1.52	$11.51	$82.41	$0.0000	93.92	119.79	146.24
Vertical lift, over 1 H.P., annualized	8	11.65	$454.84	$631.96	$0.0000	1,086.80	1,321.87	1,579.69
Sewage lift, over 1 H.P., annualized	8	11.65	$317.84	$631.96	$0.0000	949.80	1,171.17	1,408.44
Cathodic protection system, annualized	2	2.92	$76.72	$179.34	$0.0000	256.06	317.53	382.84
						$2,712.02	$3,330.78	$3,998.26

FAC 8321 Sewer and Industrial Waste Line

FY25 SUC:	$1.15 / LF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8331 Refuse Collection and Recycling Structure

FY25 SUC:	$2.70 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8332 Incinerator

FY25 SUC:	$1,484.88 / TH
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8333 Sanitary Landfill

FY25 SUC:	$6,690.61 / AC
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Cornerstone Environmental Annual Engineer’s Report for multiple sites

Source: Cornerstone Environmental Annual Engineer's Report
Montgomery-Otsego-Schoharie Solid Waste Management Authority
27-May-14

Combined Cost Summary

	Eastern Landfill	Central Landfill	C&D Landfill
Personnel Costs	$ 26,991.00	80963	1624
Leachate Disposal	$ 103,746.00	78926	
Leachate System Cleaning	$ 9,900.00	7623	
Fuel	$ 6,960.00	4732	287
Equipment Repairs & Maintenance	$ 4,635.00	2266	
Landfill Repairs & Miantenance	$ 7,112.00	27495	1373
Engineering	$ 4,218.00	2867	174
Monitoring	$ 15,380.00	25149	
Waste Transporter Permits	$ 678.00	460	28
Uniforms	$ 516.00	351	21
Utilities	$ 1,750.00	1189	72
Insurance	$ 6,202.00	4216	256
Total	188088	236237	3835
Site Acreage (AC)	85	92	5
Size of Waste Footprint (AC)	47	32	1.8
Cost per AC	$ 4,001.87	$ 7,382.41	$ 2,130.56
Average Cost per Acre			$ 4,504.94

FAC 8334 Hazardous Waste Landfill

FY25 SUC:	$6,690.61 / AC
Source:	Set to FAC 8333

FAC 8412 Water Treatment Facility

FY25 SUC:	$44.47 / KG
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8413 Water Storage, Potable

FY25 SUC:	$0.0041 / GA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8414 Water Well, Water Source

FY25 SUC:	$6.99 / KG
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	EPA data on pump replacement

FAC 8414 Potable Water Well

KG = 500 based upon (1) production well size in inventory and (2) base population of 5,000 consuming 150 GPCD

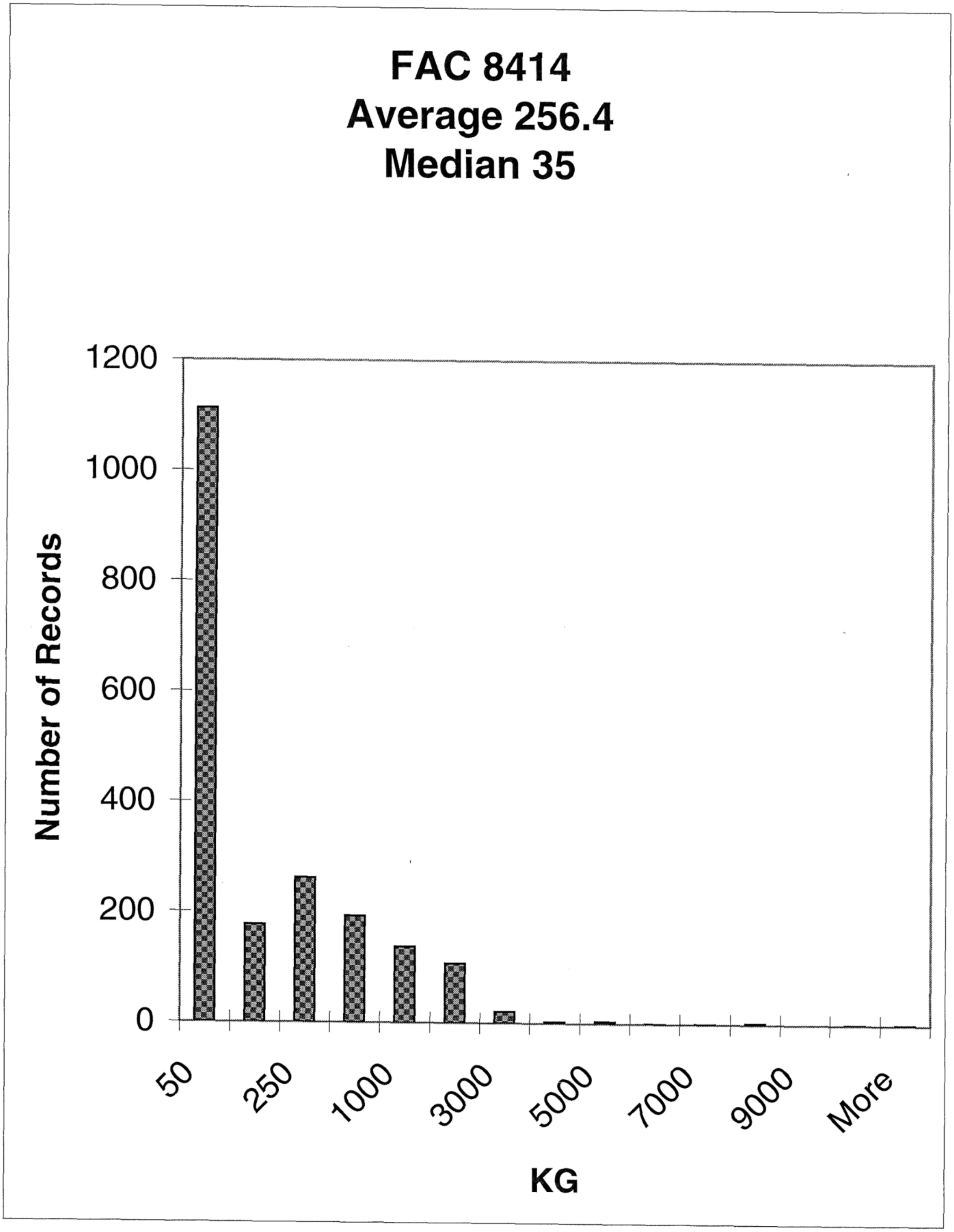
CCF

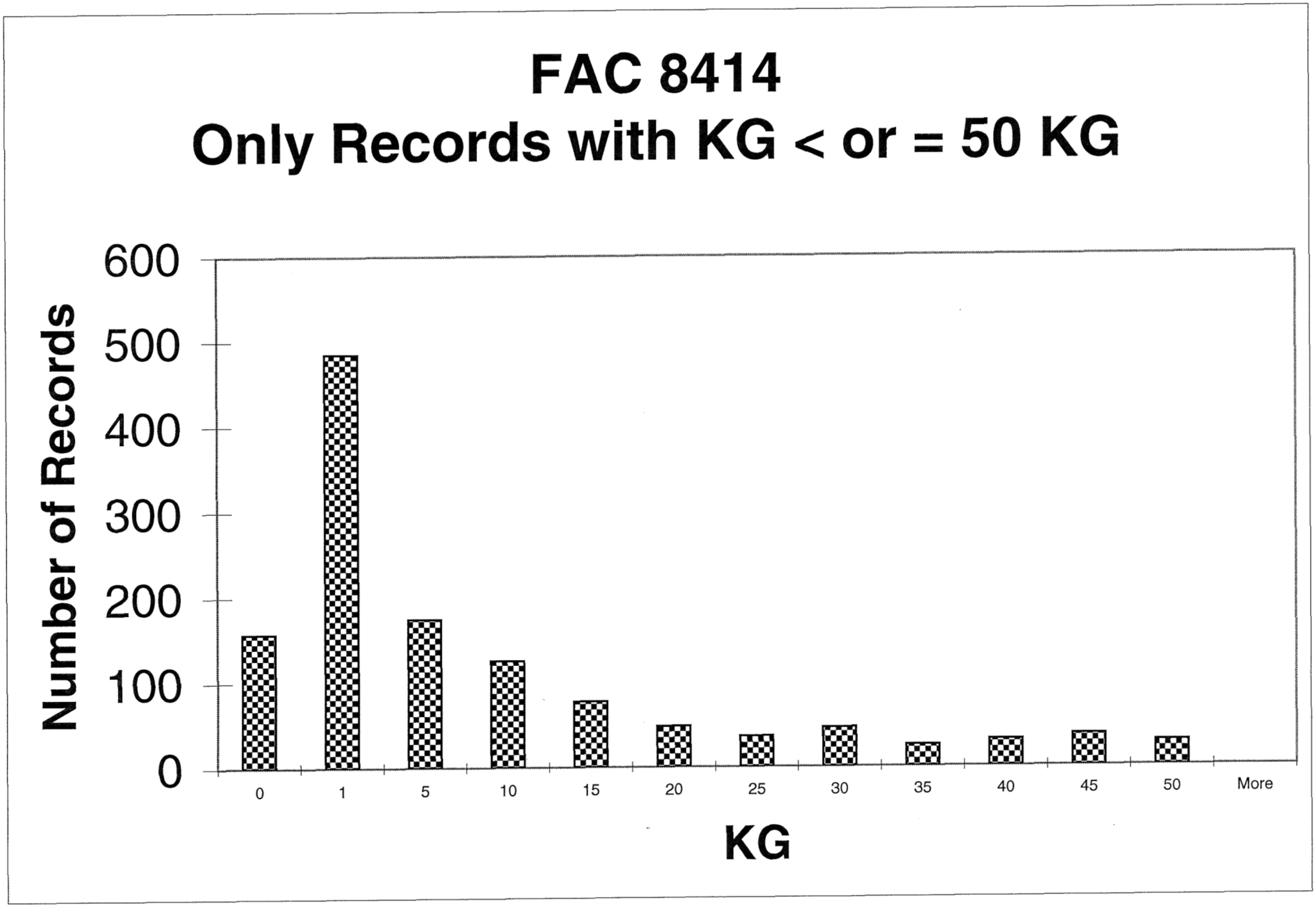
Borehole depth	500 ft	assumed
Well depth	480	
Borehole diameter	22 inches	
Casing diameter	12 inches	
Screen length	50 ft	

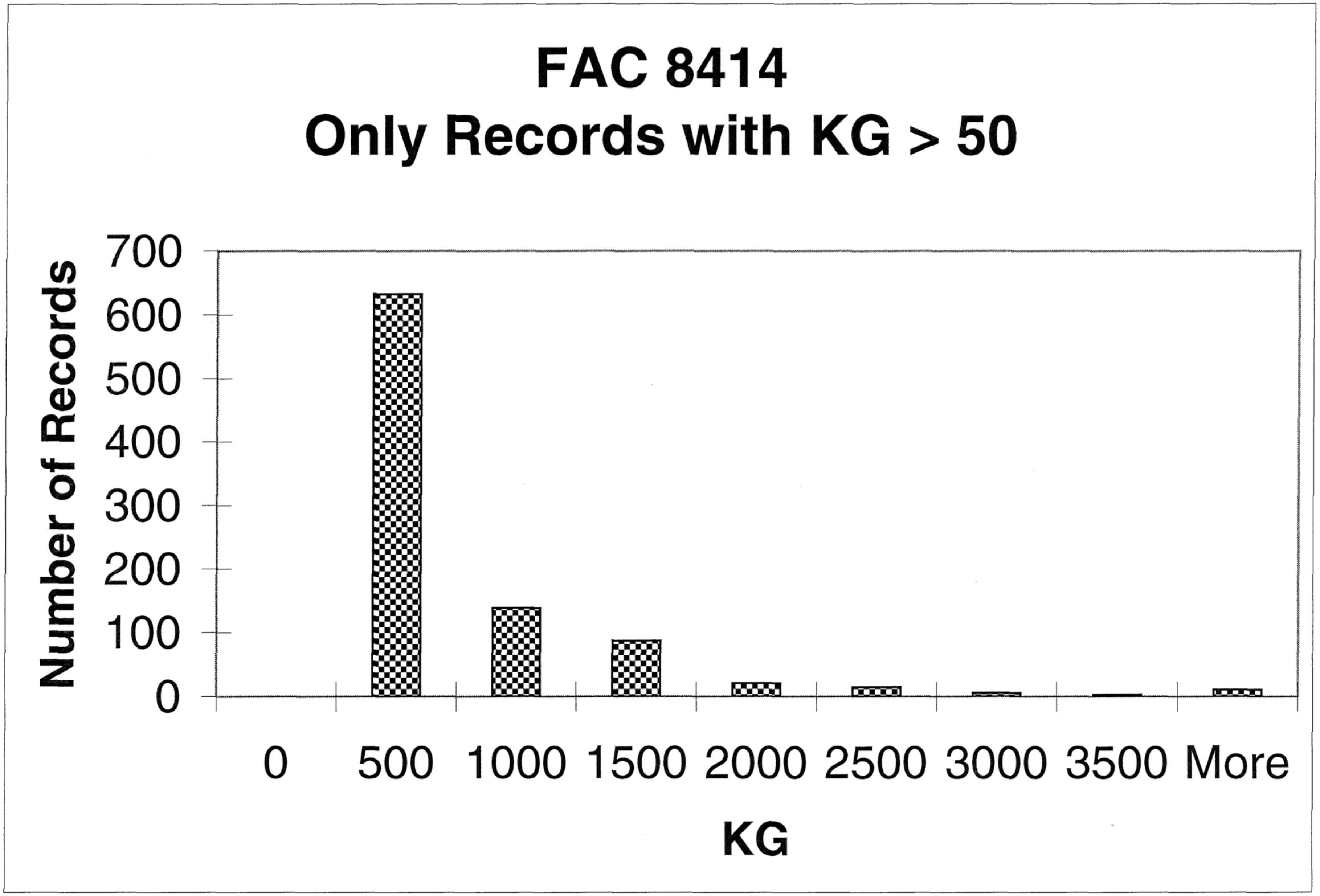
Cost Estimate	Qty	Units	Unit Cost	Total Cost
Install 22 inch conductor casing	50	ft	$125	$6,250
Drill pilot hole	500	ft	$40	$20,000
E-log	1	ea	$4,000	$4,000
Ream pilot hole to 26 inches	500	ft	$50	$25,000
Caliper log	1	ea	$2,000	$2,000
Install blank casing	480	ft	$55	$26,400
Install screen	50	ft	$75	$3,750
Install gravel pack	75	ft	$25	$1,875
Gravel tube	80	ft	$6	$480
Grout seal	425	ft	$45	$19,125
Plumb and alignment test	1	ea	$2,500	$2,500
Surge/airfit development	24	hr	$275	$6,600
Pumping Development	24	hr	$150	$3,600
Step test	10	hr	$150	$1,500
Constant Q test	40	hr	$150	$6,000
Pump Cost	1	ea	$20,000	$20,000
Install pump	1	ea	$6,500	$6,500
Electric & Wellhead finish	1	ea	$20,000	$20,000
				$175,580
Cost per KG				$351

SCF

Replace pump, 10 year life cycle	1	ea	$20,000	$20,000
Annualized cost				$2,000
Cost per KG (500 KG)				$4.00


FAC 8414
Average 256.4
Median 35
Number of Records
1200
1000
800
600
400
200
0
50
250
1000
3000
5000
7000
9000
More
KG


FAC 8414
Only Records with KG < or = 50 KG
Number of Records
600
500
400
300
200
100
0
0
1
5
10
15
20
25
30
35
40
45
50
More
KG


FAC 8414
Only Records with KG > 50
Number of Records
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
3000
3500
More
KG

FAC 8415 Desalinization Plant

FY25 SUC:	$91.55 / KG
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Multiple Commercial Sources

An Investigation of the Marginal Cost of Seawater Desalination in California

by James Fryer,
Environmental Scientist

March 18, 2010

Sponsored by

Residents for Responsible Desalination

"Organized for coastal protection advocacy and education purposes about seawater desalination."

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Table of Contents

Abbreviations, Acronyms & Definitions

ADC: Affordable Desalination Coalition

Ann: Annual

Avg: Average or statistical mean

AF: An acre-foot of water or 325,851 gallons, which is enough water to flood one acre of land one foot deep and supply about four single-family households with enough water for one year AFY: Acre-feet per year kWh: Kilowatt-hour, or 1,000 watts of energy used for a duration of 1 hour

Marginal Cost: The cost of producing one more unit of a good, or in this report the cost of producing or saving and acre-foot of water. The marginal cost provides a mechanism to compare the cost of different water supply and conservation options on a realistic cost comparison basis.

MG: Million gallons

MGD: Million gallons per day, a 1 MGD facility is theoretically equivalent to 1,120 AFY at 100% capacity for 365 days a year

MMWD: Marin Municipal Water District

NPV: Net present value, a term used to account for the discounted future value of dollars

O&M: Operations and maintenance, this will exclude project design, capital costs and financing

PPM: Parts per million

Executive Summary

There is much interest, but little clarity on the cost of desalinated seawater in California and how it compares to other urban water management options. To address this issue, this investigation collected general information along with costs and production records and cost projections for many prominent seawater desalination facilities and proposed projects in North America and California. Along with many others, this included Tampa Bay, Carlsbad, Santa Barbara, and Marin. These four projects are described and evaluated as case studies in this paper.

The marginal cost of water produced by any specific seawater desalination project will depend on many variables including:

Site characteristics
Size of the facility
Financing cost
Energy cost
Water quality conditions for intake seawater
Environmental mitigation and monitoring costs
Actual water production
Connection and pumping costs to existing infrastructure
Taxes (privately own facilities)
Profit (privately owned facilities)

Seawater desalination for \$800 to \$1,000 per acre-foot?

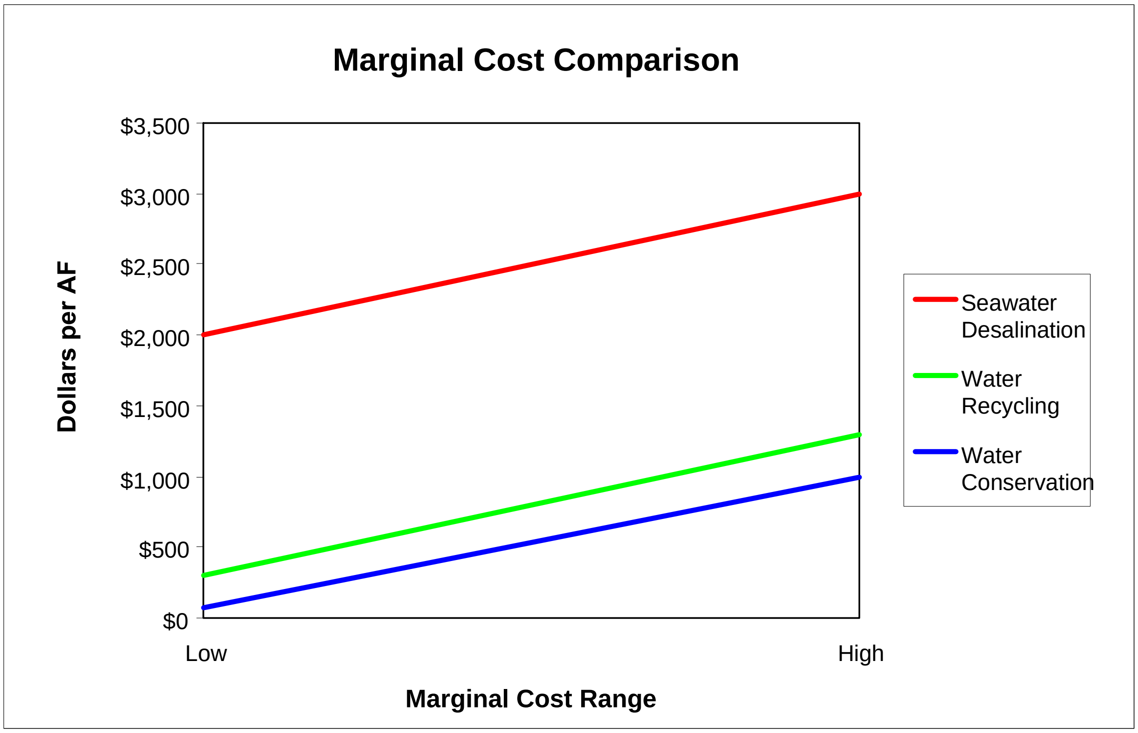
Some advocates of seawater desalination suggest marginal costs of $800 to $1,000 per acre-foot are now possible in California. However, despite a thorough investigation, **this study found no evidence of seawater desalination facilities in North America producing water in that cost range.** This study also found no credible evidence that new seawater desalination projects in California, given local conditions, could produce water in that cost range.

Given the best presently available technology, this investigation found **realistic estimates of the marginal costs for seawater desalination in California will range from a minimum of about $2,000 to $3,000 or more per acre-foot of water produced.**

This compares to typically much lower marginal costs of well under $1,000 per acre-foot for most urban water conservation measures.[1] Water recycling for urban areas typically costs between $300 and $1,300 per acre-foot.[2] Both water conservation and recycling appear to be far from fully utilized in California's urban areas.[3]

For comparison, the relative marginal costs in California of seawater desalination, water recycling, and water conservation are shown in Figure 1 below.

Figure 1



While many agencies pursuing seawater desalination cite it as a drought proof supply, as evidenced by the demand reductions by urban consumers in California during a recent series of dry years, it appears many water managers may underestimate demand elasticity during shortages. Behavioral-based demand reductions during shortages can occur at very low cost to ratepayers and society.

Many areas in California are now seriously evaluating and pursuing a suite of promising new water conservation measures such as graywater use and local rainwater harvesting that may be less costly and environmentally beneficial compared to seawater desalination. Low-impact development and integrated watershed and floodplain management practices are also gaining favor that can increase groundwater recharge and locally available water supplies while improving environmental conditions.

A better understanding of the real costs of the various water management options is important to rational decision making and appropriately prioritizing limited funding for the best alternatives for individual water users and society. The realistic costs of seawater desalination need to be more transparent and understood by the public. Proponents of seawater desalination projects should clearly delineate the costs of the projects in the categories identified in this paper. Also the costs of emerging water management alternatives such as graywater use, and rainwater water capturing, low-impact development and integrated watershed and floodplain management practices should be better evaluated for identifying the most cost-effective options for improved water management in California.

Background

California is faced with increasing competition for water supplies. Concern over the possible impacts of climate change further alarms many water managers. As a result, there is increasing interest in seawater desalination, its potential benefits, costs, energy use, and environmental impacts.

Some advocates of seawater desalination suggest the cost has decreased in recent years and is now similar to the cost of other urban water supply options.[4] Private water industry interests view the production and sale of desalinated seawater water as a potentially lucrative business opportunity. Some environmental advocates hope increased use of seawater desalination will reduce present or future water diversions and their impacts on California's rivers, streams, and groundwater basins. Others express concern over the cost, the potential privatization of water supplies, energy use and the environmental impacts, and potential health risks.[5] This investigation focuses exclusively on the cost issue and leaves the other important issues to other analyses.

Numerous new desalination projects are proposed in California and in various stages of development. These include proposed projects in Carlsbad, Huntington Beach, Santa Cruz, Marin County, and Cambria. In the early 1990s, a seawater desalination facility was constructed in Santa Barbara but immediately mothballed without being operated for water production.

The Carlsbad project, at 50 MGD design capacity, is the largest presently proposed project in California and the most progressed within the permitting process. It is proposed by a private corporation, Poseidon Resources, and is subject to less cost transparency than public projects. Since Poseidon Resources is seeking publicly subsidized funding and financing, and indicates a willingness to match the cost of existing water supply options, much interest is presently focused on the realistic cost of water produced by the proposed Carlsbad facility. This analysis evaluates the realistic cost of desalinated water for the proposed Carlsbad and other desalination facilities from which adequate cost records and projections could be obtained.

What Will Large-Scale Seawater Desalination Realistically Cost in California?

With limited exceptions, water agencies and private interests involved in seawater desalination appear reluctant to release verifiable marginal costs analysis for their seawater desalination projects. This has troubled many observers since marginal costs analyses form the basis of integrated water resources planning and rational decision making for water management plans and infrastructure investments.

This project was undertaken to better identify realistic marginal costs of seawater desalination in California and the actual or realistic costs of various categories of costs. These categories are listed below and include facility design, capital, operating, maintenance, energy use, permitting and environmental mitigation and monitoring costs. Ideally, the sub categories of the costs listed below should have been tallied and compared. However, despite considerable effort, it was not possible to obtain detailed and credible enough cost figures for most of the various categories in order to provide a reliable comparison. However, data useful in identifying likely overall marginal costs were obtained and will be used in this analysis.

Cost Categories for Seawater Desalination Projects:

Capital Costs
Land/site acquisition and right-of-way for pipelines
Building construction
Electrical connections
Miscellaneous piping and plumbing
Intake pipes, screens
Prefiltering components
Pumps
Membranes and cartridges Discharge
pipes, diffusers
Facility controls and monitoring equipment
Treated water connection to water distribution system including pipes, pumps, tanks
Construction contingency
Contractor costs – overhead, profit, bonding, insurance, etc
Mitigation, including capital for sensitive area acquisition for protection/environmental mitigation
Taxes (privately owned facilities)

Operations and Maintenance Costs (O&M)
Electricity
Treatment chemicals
Membrane replacement
Pump maintenance/replacement
Plant operator labor
Plant maintenance labor

Solids disposal
Environmental monitoring and mitigation costs
Carbon offsets
Profit (for privately owned facilities)
Taxes (for privately owned facilities)

Miscellaneous Design and Approval Costs
Design fees
Permitting fees
EIR and public process costs

Financing Costs
Financing term and interest rate

In addition to the above noted costs categories, other factors would impact marginal costs, including actual production from the facility compared to design production, and uphill delivery of desalinated water to existing infrastructure for the service area. Since seawater desalination draws its source water at or below sea level, the distribution and delivery of the product water to its targeted service area will require uphill pumping. Service areas with high elevations will require more pumping, and incur the associated higher energy cost for delivering the water to end users.

The Affordable Desalination Collaboration
The Affordable Desalination Collaboration (ADC) is a group of desalination industry advocates and many California water agencies interested in seawater desalination. The organization is chaired and managed by industry advocates and leaders in promoting desalination. Their mission "is to demonstrate affordable, reliable and environmentally responsible reverse osmosis desalination technologies and to provide a platform by which cutting edge technologies can be tested and measured for their ability to reduce the overall cost of the SWRO treatment process." [6]

ADC indicates the cost seawater desalination ranges from around $800 to $1,000 per acre-foot of fresh water produced
The Affordable Desalination Collaboration's website has a test results page with links to numerous spreadsheets with analyses that indicate the cost seawater desalination ranges from around $800 to $1,000 per acre-foot of fresh water produced.[7] According to ADC's CEO and Managing Director, the engineering assumptions, such as optimum membrane feed pressures for the different membranes tested, were based on a pilot project with tests conducted in Port Hueneme, California in 2005 and 2006.[8] The remainder of the **cost figures in the ADC projections were not based on an actual operating facility but instead were estimates and projections**.[9] Given the membership and participants of this group,[10] it is very likely that these figures serve as a primary source of widely circulated suggestions that the cost of seawater desalination is now similar to the cost of other water supply sources. Many interested observers find the prospect of seawater desalination in California at a marginal cost near or below $1,000 per acre-foot highly appealing.

Problems with ADC costs projections
However, a review of ADC's website costs analysis for their theoretical 50 MGD facility found many fundamental flaws with the cost projections and associated assumptions. [11] These include:

Energy Costs is underestimated

An energy cost of $0.08/kWh was used for the ADC analysis. This compares with an energy cost of $0.116/kWh determined in two recent independent analyses for the proposed Carlsbad project[12] and $0.12 for the Marin project.[13] Energy is one of the largest components of O&M costs. This represents an underestimate of about 32% for this major cost.

Energy requirement is underestimated

The range for the specific energy use assumption in the ADC analyses, which represent the overall energy efficiency of the desalination process, appear unrealistically low. It ranges from a low of 10 kWh/1000 gallons to a high of 14 kWh/1000 gallons of water produced. The ADC tests were a series of short-run tests with new membranes, generally less than a full day run for each test, and the membranes were tested for less than a full year of run time.[14] This does not replicate operating a facility at 100% of design capacity 95% of the time for 365 days per year, which is the assumption of ADC's marginal costs calculations. It also does not reflect performance decline from membrane scaling and clogging during an assumed 6-year membrane life.

By comparison, the O&M records from the Tampa Bay facility, which operates with warmer temperature and lower salinity feed water than seawater facilities in California can expect, indicate that in 2007, with new membranes, the energy requirement was 9kWh/1000 gallons produced. The energy requirement increased to 15.9kWh/1000 gallons in 2009 with membranes that were less than three years old.[15] The Santa Barbara facility, located near the site of the ADC tests, projects an energy requirement of 17.1kWh/1000 gallons produced with a refurbished and modernized facility.[16] The proposed Marin facility projects an energy requirement of 15kWh/1000 gallons to 16kWh/1000 gallons per water produced during drought periods with a new state-of-the-art facility using feed water with generally lower salinity and warmer temperatures than typical California seawater.[17] Table 1 provides an energy use comparison.

Table 1
Energy Requirement Comparison

Facility	ADC	Tampa Bay	Santa Barbara	Marin
Water Temp (°F)	53.6 to 64.4	86	56 - 65	62.7 (avg)
Salinity (ppm)	31,668	29,000	34,000	21,700 (avg)
kWh/1000 gal	10 to 14	15.9	17.1	15 to 16

Capital costs are underestimated

The capital costs in the ADC projections per MGD of capacity are much lower than other completed or proposed projects. Table 2 below provides a comparison of capital cost per MGD of design capacity for various facilities discussed in this paper. The ADC high estimate is 17% lower than the actual capital cost of the Tampa Bay facility. As noted, the Tampa Bay location has advantages for feed water quality compared to California facilities. These advantages, subsequently discussed in this paper, would increase capital costs for a comparable facility in California. The capital cost for the proposed Carlsbad facility in California is presently 41% higher than the ADC high estimate.

Table 2
Capital Cost per MGD Design Capacity (2009 Dollars)

Project	ADC (Low Estimate)[18]	ADC (High Estimate)[19]	Tampa Bay[20]	Santa Barbara[21]	Carlsbad	Marin[22]	Marin[23]
Design Capacity	50 MGD	50 MGD	25 MGD	6.7 MGD	50 MGD	10 MGD	5 MGD
Capital Cost (Millions)	$239.3	$313.8	$190.3	$59.6	$534	$131.4	$88.6
$ (Millions)/MGD	$4.8	$6.3	$7.6	$8.9	$10.7	$13.1	$17.7

Intake water salinity lower than average seawater

Average intake water salinity of 31,688 parts per million (ppm) was reported for the ADC tests and cost projections.[24] This compares to 33,520 ppm for the proposed Carlsbad site[25] south of Port Hueneme and 34,000 ppm for the Santa Barbara site[26] just north of Port Hueneme. Given present membrane technology, the higher source water salinity for the Carlsbad and other California coastal sites will result in either higher product water salinity or the selection of membranes with lower water permeability, which correlates with lower salt permeability.[27] Membranes with lower water permeability require higher feed water pressure, which will result in higher energy use. [28]

Unrealistic water production assumptions

The ADC cost projections are based on unrealistic water production assumptions of operating at 100% of design capacity 95% of the time for 356 days per year. This is a production level that the best comparative example in North America, the Tampa Bay facility discussed below, has not come close to achieving on an annual basis. As noted above, the ADC tests were a series of short-run tests with new membranes, generally less than a day long run for each test, and the membranes were tested for less than a full year of run time.[29] This does not reflect operating a facility at 100% of design capacity for 95% of the time, 365 days per year. It also does not reflect performance decline from membrane scaling and clogging during an assumed 6-year membrane life. Even with the best known chemical and physical maintenance techniques, reverse osmosis membranes are known to experience a performance decline as they age and suffer increased clogging and scaling. Declining performance as membranes age will lower water production or require increased design capacity, either of which would increase marginal costs over the life of the project.

O&M costs underestimated

The ADC analyses have unrealistic overall O&M costs ranging from a low of $496 per acrefoot to a high of $616 per acre-foot. A 2009 report by Carollo Engineers determined the

O&M costs for a rehabilitated and modernized Santa Barbara facility would be $1470 per acre-foot.[30] This is more than double the ADC high cost projection. Costs based on a pilot project by Kennedy/Jenks Consultants for a proposed new, state-of-the–art 10 MGD facility in Marin projected O&M marginal costs of $1,107 per acre-foot for a facility being operated at 100% capacity.[31] The Marin facility is proposed to be sited along San Rafael Bay in the San Francisco Bay. As a result of bay water mixing with runoff from inland California, in most years the Marin facility would be operating with significantly lower feed water salinities and frequently warmer feed water temperatures than typical California seawater. This should result in lower O&M costs for the Marin facility compared to projects using typical California seawater, yet the O&M cost projections are nearly double the highest ADC projected cost.

Inaccurate discount rate for net present value calculations

The net present value calculations in the ADC spreadsheets do not accurately account for the discount rate as the difference between the rate of inflation and the interest rate for financing. Rather than subtracting the assumed inflation rate of 3% from the financing rate of 5% for a 2% discount rate, which is standard economics practice, the ADC calculations use a 5% discount rate. Using the proper discount rate actually lowers the long-term capital costs, but this issue is more than offset by underestimated initial capital cost assumptions and other underestimated cost assumptions.

Costs estimates do not include many necessary costs

The marginal costs do not include any land cost for citing a facility, costs for an intake water structure, brine discharge structure, or necessary improvements to deliver the desalinated water to a local distribution system for end users.[32] The marginal costs assumes that a facility will be co-located with a power generating plant and share the generating plant's cooling intake water facility, which will not always be possible.[33] In addition, the ADC assumptions do not account for high capacity electrical power lines that will often be necessary to provide adequate power supply to desalination facilities. Cost also do not include expenses for administrative, laboratory, legal, reporting or management.[34]

Costs figures do not include environmental mitigation and monitoring

The ADC marginal costs figures do not account for environmental permitting costs, or substantial environmental mitigation and monitoring costs that can be expected for new facilities as a condition of environmental permits.

A more thorough analysis of all the ADC assumptions and calculations may reveal additional problems with the projections, but this is sufficient to illustrate that these figures are not a reliable indication of realistic seawater desalination costs in California. ADC's CEO/Managing Director appears aware that these projections are based on many "best case" assumptions, some of which may no longer be valid.[35] However, the figures remain on ADC's website at the time of this writing as valid projections for seawater desalination cost. The figures appear to provide a reference point as valid cost estimates for desalinated seawater for many interested parties, including agencies considering or planning seawater desalination facilities. Therefore, it is important to note the limitations of the ADC cost projections.

Case Studies

To better assess the realistic costs of seawater desalination in California, this investigation collected actual and projected cost and water production data on a broad range of constructed and proposed desalination projects in California and North America. Despite considerable effort, in many cases, very limited data were available. However, sufficient data were collected to provide the following four case studies and to develop a realistic marginal cost estimate range for seawater desalination in California.

Marin Project

The Marin Municipal Water District (MMWD) in the San Francisco Bay Area recently approved an EIR and issued a Notice of Determination to build a 5 MGD desalination facility expandable to 15 MGD. MMWD is now moving forward with detailed design work and permitting for the facility.

The Marin facility is proposed to be located on land already owned by MMWD along San Rafael Bay in the northern part of San Francisco Bay. The San Francisco Bay experiences water temperatures and salinities that range from typical seawater near the Golden Gate to less saline, and often warmer estuarine conditions further upstream in the estuary. The water quality conditions in San Rafael Bay vary widely based on tide cycles, wind conditions, season and runoff conditions for the very large watershed that includes most of California's Central Valley and the Sierra Nevada mountains. As a result of bay water mixing with freshwater from inland California, in most years the facility would operate with feed water with significantly lower salinity compared to California seawater. There would also be periods when water temperatures would be warmer than California seawater.

MMWD conducted a desalination pilot project to better understand conditions for the proposed site and optimum facility design parameters. A water quality sampling program at the proposed site was conducted between March 2005 and April 2006.[36] This was during a period of very wet winters with serious flooding in California. As a result, freshwater outflow through San Francisco Bay was heavier than occurs in many years, and particularly during drought years. Salinity readings recorded during the pilot study ranged from a high of 29,000 ppm to a low of 2,500 ppm, with an average of 21,700 ppm.[37] The area is documented to have salinities of up to 32,000 ppm.[38] Water temperatures recorded during the pilot study ranged from a high of 69.8 degrees F to a low of 50 degrees F with and average of 62.7 degrees F. [39] The maximum temperature documented is 71.1 degrees F. [40]

Pilot program data were used to develop capital and operating costs projections for a 5 MGD and 10 MGD facility that could be expanded to 15 MGD. MMWD did not release an actual marginal cost analysis for the 5 MWD or 10 MGD facility. Furthermore, MMWD did not publicly release any capital or O&M cost projections for a 15 MGD facility, despite board approval of the facility in 2009.

A recent independent analysis based on MMWD's publicly released cost figures determined the marginal costs of the 5 MGD facility to be $3,600 per acre-foot of product water and the 10 MGD facility to be $2,903 per acre-foot.[41] These marginal costs figures were in nominal dollars to provide a better comparison to water conservation program costs publicly released by MMWD.

These marginal costs did not include a 15% construction contingency fee identified in MMWD reports.

For this analysis, the marginal costs are updated to include the 15% construction contingency fee and the financing costs are discounted back to net present value terms in 2009 dollars. The result is a marginal cost of $3,009 per acre-foot for the 5 MGD facility and $2,430 for the 10 MGD facility. Table 3 below provides costs for various categories that are the basis of these marginal costs figures.

Table 3
Marginal Cost for Marin's Proposed Desalination Facility

Facility Capacity	Capital Cost (Millions)	Annual Cap Cost (Millions)	Ann Op Cost at 100% (Millions)	Projected Avg Annual Op Cost[42] (Millions)	Total Avg Ann Cost (Millions)	Avg Ann Production[43] (AF)	Marginal Cost per AF
5 MGD	$111.2	$5.0	$6.5	$4.1	$9.1	3,024	$3,009
10 MGD	$173.4	$7.4	$12.4	$6.8	$14.7	6,048	$2,430

The capital cost figures include the costs of connection to MMWD's water distribution system. The capital cost figures reflect shared use of an existing pier with the nearby Marin Rod and Gun Club for part of the feed water intake structure to reduce the cost of this facility. The rejected brine would be discharged with wastewater from the nearby Central Marin Sanitation Agency, reducing the cost of a discharge structure.

Unlike the ADC energy costs projection of $0.08/kWh noted above, MMWD assumes a $0.12/kWh average energy cost in their O&M projections.[44]
It should also be noted that these marginal cost figures are based on water production with the management scheme indicated in MMWD's EIR for the facility.[45] Under the proposed management scheme, the facility would be operated at 50% of capacity during wet years, and 100% of capacity during drought years to reduce costs, energy use, and environmental impacts. This analysis assumed 23 wet years of production for every 2 years of drought production. The operating costs were reduced to reflect the reduced production in most years. Operating the facility at 100% capacity in all years would result in a marginal cost several hundred dollars lower, since the capital costs would be spread over higher water production and the facility would produce more water during conditions of more favorable intake water quality on San Francisco Bay during wet years. However, it would also result in higher overall costs to ratepayers for water produced unnecessarily in wet years when adequate supply already exists for the service area.

Tampa Bay Project
The largest facility now functioning in North America is the 25 MGD Tampa Bay project, which began operation in 2003. The project has a troubled history. Shortly after beginning operations, serious problems developed which required closing the facility and undergoing a major rehabilitation to correct design and construction flaws. Rehabilitation was completed and water production resumed in 2007. Since the Tampa Bay project is an actual operating facility, it provides information useful for assessing the cost of seawater desalination. Using Tampa Bay as a

base case, operating conditions can be adjusted to reflect local conditions in California to provide a more accurate projection of realistic costs for seawater desalination facilities in California.

A recent independent analysis determined the marginal costs of water actually produced at the Tampa facility since 2003 is $1,826 per acre-foot.[46] The results of the analysis are summarized in the following tables. Tampa Bay Case 1 in Table 4 below was based on a total capital cost of $158 million financed 30 years at 5.2%, and an average of 7-year O&M costs and water production from all seven operating years from 2003 through 2009.

Table 4
Tampa Bay Case 1

Total Capital Cost	Ann Cap Cost	Avg Ann O&M	Avg AF/Yr Produced	Marginal Cost/AF
$158 Million	$7,250,167	$9,620,560	9,240	**$1,826**

Tampa Bay Case 2 in Table 5 below was based on a total capital cost of $158 million financed 30 years at 5.2%, and an average of 2-year O&M costs since completion of rehabilitation and water production for 2008 and 2009.

Table 5
Tampa Bay Case 2

Total Capital Cost	Ann Cap Cost	Avg Ann O&M	Avg AF/Yr Produced	Marginal Cost/AF
$158 Million	$7,250,167	$16,953,837	20,173	**$1,200**

Table 6 below shows that if the Tampa Bay facility was constructed with 2009 dollars and experienced for the 30-year life of the project the same operating costs and production the facility actually experienced during its first sever years, the marginal costs of water produced will be $1,961.

Table 6
Tampa Bay w/2009 Cap Cost and Case 1 assumptions

Total Capital Cost	Ann Cap Cost	Avg Ann O&M	Avg AF/Yr Produced	Marginal Cost/AF
$190.3 Million	$8,495,447	$9,620,560	9,240	**$1,961**

Table 7 below shows that if the Tampa Bay facility was constructed with 2009 dollars and experienced the same operating costs and production levels for the 30-year life of the project as the facility actually experienced in the two years since completion of the major rehabilitation, the marginal costs of water produced would be $1,262.

Table 7
Tampa Bay with 2009 Cap Cost and Case 2 Assumptions

Total Capital Cost	Ann Cap Cost	Avg Ann O&M	Avg AF/Yr Produced	Marginal Cost/AF
$190.3 Million	$8,495,447	$16,953,837	20,173	**$1,262**

The marginal costs figure of $1,262 per acre-foot is based on the actual costs and performance of an actual, full-scale facility and is only about 30% higher than the high marginal cost estimate by ADC. However, **it is important to note numerous costs differences between this facility and California facilities.** The Tampa Bay energy cost thus far is lower then expected energy costs in California, feed water is much warmer than in California, the feed water salinity is lower, and the geography of the service area is much flatter so less energy will be required to pump the water produced uphill to end users. It is also important to note that the two years of operations would not reflect potentially declining membrane performance as they age and reach the end of their operating life, which is generally assumed to be six years. These important factors that add significantly to the cost of a project in California will subsequently be discussed in more detail in this paper.

Table 8 below is based on operating records provided by Tampa Bay Water and show water production and energy use since the Tampa facility was initially completed in 2003.

Energy at $0.04/kWh?
Original cost projections for the Tampa Bay project assumed a very low electrical cost of $0.04/kWh.[47] However, as indicated in Table 8, **recent records obtained from Tampa Bay Water document actual energy cost of $0.069/kWh in 2004 rising to $0.096/kWh in 2009.**[48] Also note that the kWh's of energy consumption per 1,000 gallons of water produced rapidly increases after the installation of new membranes. This occurred after completion of the facility in 2003 and was exacerbated by inadequate pretreatment systems. However it occurs again, but to a lesser extent, after upgrading the pretreatment systems and replacement of the membranes in 2006. This appears indicative of a decline in membrane performance that can be expected as the membranes age, even with the best pretreatment, chemical, and physical flushing maintenance processes in place. It demonstrates that projections of desalination energy consumption and production levels based on short-term trials, as in the ADC projections previously discussed, are not realistic for long-term operation performance.

Table 8
Tampa Bay Desalination Energy Use Analysis[49]

Fiscal Year	Energy Use kWh/MG	Total Energy use kWh	Water Production (MG)	Energy Cost	Avg Energy Cost per MG Produced	Avg Energy Cost $/kWh	Energy Consumption kWh/1000 gal
2003		NA	2,680.53	$1,398,349.08	$521.67	NA	NA
2004	23,010	39,792,325	1,729.34	$2,772,641.73	$1,603.29	$0.069678	23.01
2005	34,680	9,156,107	264.02	$826,440.86	$3,130.22	$0.090261	34.68
2006	NA	1,234,519	0.00	$99,110.21	NA	$0.080282	NA
2007	8,995	29,279,472	3,255.04	$2,623,705.29	$806.04	$0.089609	9.00
2008	13,407	98,695,350	7,361.40	$8,282,058.69	$1,125.07	$0.083915	13.41
2009	15,923	92,122,660	5,785.61	$8,843,750.00	$1,528.58	$0.096000	15.92

Use of preheated feed water from power plant discharge

The Tampa facility is co-located with a power generation project and uses the power plant's cooling water discharge as warm feed water for the desalination facility. This reduced the capital cost of the facility and provides heated feed water that reduces operating costs. Records obtained from Tampa Bay Water indicate an average feed water temperature of 86 degrees F. Seawater water temperatures in Southern California average around 55 to 60 degrees F.[50] Cooler feed water temperatures have a substantial impact on energy use for seawater desalination. According to membrane manufacturers, the general rule is a 3% increase in energy use for each 1.8 degree F drop in feed water temperatures.[51] New regulations for once-through cooling water in California will have the effect of prohibiting the shared use of warmed water discharged from the cooling systems of power plants after 2017.[52]

Feed water salinity is lower than average seawater

The Tampa facility is located where it experiences lower feed water salinity due to mixing with land-based freshwater inflows. The Tampa Bay facility has feed water with an average salinity of 29,000 ppm.[53] This compares to typical seawater salinity of 32,000 ppm to 35,000 ppm. Intake water salinity at the proposed Carlsbad site in California averages 33,520 ppm.[54] Given present membrane technology, the higher source water salinity for most California sites will result in either higher product water salinity or the selection of membranes with lower water permeability, which correlates with lower salt permeability.[55] Membranes with lower water permeability require higher feed water pressure, which will result in higher energy use.[56] Membranes used in higher feed water salinities may also experience a more rapid performance decline compared to membranes used in areas with lower salinities.

Since the Tampa facility operates with lower salinity and warmer seawater intake temperatures than experienced on California, the costs should be expected to be significantly higher in California.

Santa Barbara Project

In 1992, a 6.7 MGD facility was completed in Santa Barbara at a capital cost of $34 million[57] ($59.6 million in 2009 dollars). The facility was mothballed four months after completion and since that time has not been operated for water supply production. After several original partners withdrew from further participation in the project, some of the components were removed and sold. The remaining facility has been maintained by the City of Santa Barbara in a mothballed state for a cost of about $100,000 per year.[58] A recent detailed engineering analysis of the facility by Carollo Engineers determined it could be rehabilitated with more up-to-date technology and reactivated for $20.2 million. The result would be a facility with a 2.8 MGD capacity.[59]

The 2009 Carollo report for Santa Barbara determined the O&M cost of a rehabilitated facility, excluding past and rehabilitation capital cost, would be $1,470 per acre-foot of water produced.[60] Energy costs were based on September 2008 pricing for the city of $0.086/kWh.[61] This may not be realistic for future energy costs as evidenced by the actual 2009 energy cost for the Tampa Bay project of $0.096/kWh[62] and projected energy costs for the proposed project in Marin of $0.12/kWh and Carlsbad of $0.116/kWh.

It is important to note that even with the potentially low energy cost assumption, the O&M cost alone for a rehabilitated and modernized facility in Santa Barbara is projected to be $1,470 per acre-foot of water produced. As is evidenced by past capital costs for the Santa Barbara facility and the figures for the Marin facility in Table 3, the capital cost will result in a total marginal cost well above $2,000 per acre-foot of water produced if the facility is brought back into operation.

Carlsbad Proposed Project

Poseidon Resources is a private corporation working to develop a 50 MGD seawater desalination facility in Carlsbad, California. Poseidon projects a $534 million capital cost for the proposed 50 MGD facility.[63] O&M costs and a marginal cost analysis were not publicly released. There has been considerable interest in the realistic marginal cost of water for this proposed facility. But since the proposed project is privately managed, there is no requirement for cost transparency.

A recent independent study examined costs figures from the Tampa Bay facility and adjusted the costs for local conditions at the proposed Carlsbad site.[64] In order to reflect a reasonable range of uncertainty with assumptions and cost variables, four cases of marginal costs with a range of assumptions were developed for the proposed Carlsbad project. Average energy cost for the Carlsbad facility was assumed to be $0.116/kWh,[65] which is consistent with two independent analyses[66] and differs from Poseidon Resources' estimate of $0.075/kWh figure.[67] All four cases are expressed in net present value terms in 2009 dollars. The four cases along with a summary of the assumptions in each case are listed below. Interested readers are referred to the report "Marginal Cost Analysis for the Proposed Carlsbad Project" for a full description of the analytical techniques and assumptions in the four Carlsbad cases. [68]

As shown in Table 9, **if the proposed Carlsbad desalination project performed at the same level as the Tampa Bay facility has performed over its seven year operational life, the marginal cost of water produced by the Carlsbad facility would be $3,507 per acre-foot.**

Assumptions for Carlsbad Case 1 in Table 9:

- Based on Tampa Bay Case 1 with capital cost overruns, 7-year average production and O&M costs
- Financing was assumed to be 30 Years at 5.2%
- The energy cost was adjusted to $0.116 per kWh, which is the likely minimum energy cost as determined by two independent studies[69]

- A modest 5% profit on O&M, but not capital costs was assumed to begin in year eight
- Warm intake water from the nearby Encina Power Station once-through cooling water discharge was assumed to continue through 2017
- A cost of $15 per metric ton of carbon dioxide emitted for power consumption was added as a carbon mitigation cost
- Federal. state, and local taxes for a private facility not included

Table 9
Carlsbad Case 1

Ann Cap Cost	Avg Ann O&M	Energy Cost Adj	Temp Impact Adj	Carbon Offset Adj	Avg AF/Yr Produced	Profit	Marginal Cost/AF
$35,196,267	$22,941,119	$2,714,217	$3,345,999	$619,046	18,480	$1,220,627	**$3,507**

As shown in Table 10, if the proposed Carlsbad project does not encounter the same operational problems experienced by the Tampa Bay facility, and functions and produces water at the rate of the post-rehabilitated Tampa Bay facility for its 30-year life, the marginal cost would be $2,175 per acre-foot.

Assumptions for Carlsbad Case 2:

- Based on Tampa Case 2 above with capital cost overruns, 2-year average production and O&M
- Financing was assumed for 30 Years at 5.2%
- The energy cost was adjusted to $0.116 per kWh
- A modest 5% profit on O&M, but not capital cost, was assumed to begin in year eight
- Warm intake water from the nearby Encina Power Station was assumed to continue through 2017
- A cost of $15 per metric ton of carbon dioxide emitted for power consumption was added as a carbon mitigation cost
- Federal, state, and local taxes for a private facility not included

Table 10
Carlsbad Case 2

Ann Cap Cost	Avg Ann O&M	Energy Cost Adj	Temp Impact Adj	Carbon Offset Adj	Avg AF/Yr Produced	Profit	Marginal Cost/AF
$35,196,267	$37,607,673	$6,547,964	$7,086,827	$1,311,139	40,347	$1,898,956	**$2,175**

Two additional cases provide marginal cost results if the proposed Carlsbad project does not incur capital cost overruns equivalent to the capital cost overruns experienced by the Tampa Bay project.

Assumptions for Carlsbad Case 3 in Table 11:

- Based on Tampa Bay Case 1 with 7-year average production and O&M
- $534 million capital cost with no cost overruns
- Financing was assumed for 30 years at 5.2%
- The energy cost was adjusted to $0.116 per kWh
- A modest 5% profit on O&M, but not capital cost, was assumed to begin in year eight
- Warm intake water from the nearby Encina Power Station was assumed to continue through 2017
- A cost of $15 per metric ton of carbon dioxide for power consumption emitted was added as a carbon mitigation cost
- Federal, state, and local taxes for a private facility not included

Table 11
Carlsbad Case 3

Ann Cap Cost	Avg Ann O&M	Energy Cost Adj	Temp Impact Adj	Carbon Offset Adj	Avg AF/Yr Produced	Profit	Marginal Cost/AF
$24,503,730	$22,941,119	$2,714,217	$3,345,999	$619,046	18,480	$1,220,627	**$2,929**

The Carlsbad Case 4 assumptions in Table 12 represent a suite of all best-case assumptions for the proposed facility. Under this scenario, the marginal cost is $1,910 per acre-foot. However, this does not include taxes on a private facility. It also assumes financing at low interest rate generally only available to public facilities.

Assumptions for Carlsbad Case 4 in Table 12:

- Based on Tampa Bay Case 2 with 2-year average production and O&M
- $534 million capital cost with no cost overruns
- Financing was assumed for 30 Years at 5.2%
- The energy cost was adjusted to $0.116 per kWh
- A modest 5% profit on O&M, but not capital cost, was assumed to begin in year eight
- Warm intake water from the nearby Encina Power Station was assumed to continue through 2017
- A cost of $15 per metric ton of carbon dioxide emitted for power consumption was added as a carbon mitigation cost
- Federal, state, and local taxes for a private facility not included

Table 12
Carlsbad Case 4

Ann Cap Cost	Avg Ann O&M	Energy Cost Adj	Temp Impact Adj	Carbon Offset Adj	Avg AF/Yr Produced	Profit	Marginal Cost/AF
$24,503,730	$36,607,673	$6,547,964	$7,086,827	$1,311,139	40,347	$1,898,956	**$1,910**

Another method of projecting marginal costs for the Carlsbad project is to combine the Carlsbad capital costs of $534 million with the recently released operating costs projections for a rehabilitated and modernized Santa Barbara seawater desalination facility discussed in the above section. The result is provided in Table 13 below, along with a range of financing costs and their impact on the marginal costs. A February 26, 2010, Research Update by Standards & Poor's assigned Poseidon Resources a BBB- credit rating.[70] A rating any lower would be considered junk bond status. Public agencies with tax power or rate assessment revenue streams generally obtain long-term financing for capital projects in the 5% range. Since Poseidon Resources is a private corporation with a BBB- credit rating, its ability to obtain financing at low public interest rates is in question. Therefore, a range of interest rates from 5% to 10% were included in the analysis.

Table 13
Carlsbad Marginal Costs Analysis Using Santa Barbara Operating Costs

Interest Rate	Annual Cap Cost[71]	Actual Production, % of Design Capacity	Actual Production, afy	Marginal Cost per af for Cap Cost Only	Santa Barbara O&M Costs/afy	Total Marginal Cost per af
5%	$23,887,708	100%	56,007	$427	$1,470	$1,897
5%	$23,887,708	90%	50,406	$474	$1,470	$1,944
5%	$23,887,708	80%	44,806	$533	$1,470	$2,003
7.5%	$32,844,475	100%	56,007	$586	$1,470	$2,056
7.5%	$32,844,475	90%	50,406	$652	$1,470	$2,122
7.5%	$32,844,475	80%	44,806	$733	$1,470	$2,203
10%	$43,113,726	100%	56,007	$770	$1,470	$2,240
10%	$43,113,726	90%	50,406	$855	$1,470	$2,325
10%	$43,113,726	80%	44,806	$962	$1,470	$2,432

This costs evaluation method does not provide for any capital cost overruns, profit or taxes on the capital or O&M costs, or for any ongoing carbon offset costs to provide a carbon neutral project as stated by Poseidon Resources on its website. Private facilities are subject to taxes that are generally not applicable to publicly owned and operated facilities. These can include property, sales, and income taxes. As evidence of the potential tax assessment on private facilities, Poseidon Resources has been negotiating with the City of Huntington Beach on tax assessment issues.[72] Taxes are costs that will be passed along to ratepayers and will increase the marginal costs of a project. These additional costs can be expected to increase the marginal cost by 5% to 10% or more.

All of the various analytical approaches suggest a marginal cost for the Carlsbad facility of at least around $2,000 per acre-foot in the best case scenarios. The marginal cost ranges as high as around $3,507, which is based on the actual costs of the Tampa Bay facility, adjusted for conditions at the Carlsbad site, after seven years of Tampa Bay's 30-year operating life.

The Comparative Marginal Costs for Water Conservation and Recycling

Although not the primary focus of this analysis, for a comparison basis, well-accepted marginal costs are provide for a range of water conservation measures and water recycling programs. These are important as a comparison point for seawater desalination costs and a primary reason for developing marginal costs. A recent comprehensive study of the marginal costs of well-accepted conservation measures was funded by the CALFED Bay-Delta Program. It found that water conservation savings from a broad range of measures can be obtained for a cost of well under $1,000 per acre-foot.[73] The 2009 California Water Plan published by the Department of Water Resources lists the recycled water marginal costs for most California urban areas ranging between $300 and $1,300 per acre-foot.[74]

While it remains uncertain if the often optimistic and unproven marginal costs for seawater desalination in the analysis above can be obtained, the marginal costs for water conservation and recycling programs are well-proven with a large number of functioning projects in California.

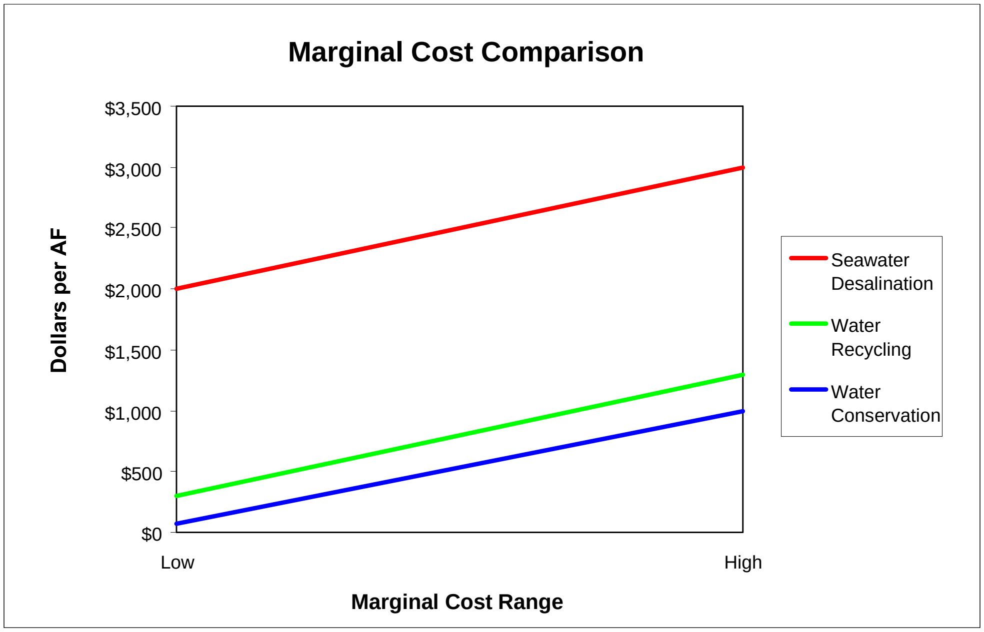
Conclusion

It appears that realistic estimates of seawater marginal costs in California given current technology will range from a low of about $2,000 to $3,000 or more per acre-foot depending on local variables such as the site characteristics and cost, size of the facility, financing cost, energy cost, local intake water quality conditions, environmental mitigation costs, actual water production, and the cost of a connection and pumping to existing infrastructure.

This compares to much lower marginal costs of generally well under $1,000 per acre-foot for water conservation measures[75] and generally $300 to $1,300 per acre-foot for water recycling.[76] Both of these options appear to be far from fully utilized in California's urban areas.[77]

The relative marginal costs in California of seawater desalination, water recycling, and water conservation are shown in Figure 1 below.

Figure 1



While many agencies pursuing seawater desalination cite it as a drought-proof supply, as evidenced by the demand reductions by urban consumers in California during a recent series of dry years, it appears many water managers may underestimate demand elasticity during shortages. Behavioral-based demand reductions during shortages can occur at very low cost to ratepayers and society.

Many areas in California are now seriously evaluating and pursuing a suite of promising new water conservation measures, such as graywater use and local rainwater harvesting, which may be less costly and environmentally beneficial compared to seawater desalination. Low-impact development and integrated watershed and floodplain management practices are also gaining favor that can increase groundwater recharge and locally available water supplies while improving environmental conditions.

A better understanding of the real costs of the various water management options is important to rational decision making and appropriately prioritizing limited funding for the best alternatives for individual water users and society. The realistic costs of seawater desalination need to be more transparent and understood by the public. Proponents of seawater desalination projects should clearly delineate the costs of the projects in the categories identified in this paper. Also the costs of emerging water management alternatives such as graywater use and rainwater water capturing, low-impact development and integrated watershed and floodplain management practices should be better evaluated for identifying the most cost-effective options for improved water management in California.

Acknowledgements

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Residents for Responsible Desalination can be contacted at: HBDesal@yahoo.com

About the Author:
James Fryer has over 20 years of experience working on freshwater, estuarine, and marine conservation policies, programs, and projects. He has produced numerous papers and reports on water management policies, practices, and economics. He was the head of Marin Municipal Water District's water conservation programs in the 1990s. In subsequent work with the NGO community in the Florida Keys, he directed coral reef and water quality monitoring programs. He helped establish the Tortugas Ecological Reserve, a 191 square nautical mile, and largest marine protected area in U.S. continental waters while serving on the Florida Keys National Marine Sanctuary Advisory Committee. He developed a conservation planning GIS analysis of the Indian River Lagoon watershed, a 156-mile stretch of coastal lagoons and surrounding watershed in Southeast Florida, considered the most biologically diverse estuary in North America, and served on the Indian River Lagoon National Estuary Program Advisory Committee. He also assisted the Florida Dept. of Environmental Protection in the development of statewide water conservation plans for Florida. In 1997, he served on the U.S./South Africa Bilateral Commission sent to South Africa to assist the Mandela government with watershed and water resources planning. In 1996 he served as an advisor to the British Columbia Water and Wastewater Association for development of a regional planning effort. He has a M.S. in Environmental Management from the University of San Francisco where his thesis project was developing an Integrated Floodplain Management model for the San Francisco Bay-Delta watershed. He is an experienced river runner, scuba diver and sailor and recently returned to California after spending the previous five years on a global sailing voyage.

He can be contacted at: jfryer.iwrca@gmail.com

Endnotes

1 "CALFED Water Use Efficiency Comprehensive Evaluation." CALFED Bay-Delta Program. 2006. p.144.

2 "California Water Plan Update 2009." DWR bulletin 160-09, Pre-final draft, Vol. 2, p.11-6.

3 More information on the potential for additional water conservation can be found at "CALFED Water Use Efficiency Comprehensive Evaluation." CALFED Bay-Delta Program, and "20X2020 Water Conservation Plan." February 2010. Available at: http://www.swrcb.ca.gov/water_issues/hot_topics/20x2020/docs/20x2020plan.pdf More information on the potential for increased recycled water use can be found in the "California Water Plan Update 2009." DWR bulletin 160-09, Pre-final draft, Vol. 2, p. 11-4, 11-5, 11-6.

4 See http://www.affordabledesal.com/home/test_data.html for analyses that indicates a seawater desalination cost range of about $800 to less than $1,000 per acre-foot of product water in 2006 dollars. The "California Water Plan Update 2009." DWR bulletin 160-09, Pre-final draft, Vol. 2, p.9-5 indicates a range of $1,000 to $2,500 per acre-foot for seawater desalination.

5 For more information on these issues see Residents for Responsible Desalination at: http://R4RD.org/
Also see: www.marinwatercoalition.org
www.desalresponsegroup.org
www.foodandwaterwatch.org www.environmentnow.org
http://www.surfrider.org/a-z/desal.php

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15 Figures provided by and derived from operational records supplied by Tampa Bay Water in response to a request for public records in the fall of 2009. Records received from Tampa Bay Water include: Annual Desalination Budget Reports for FY 2003 through 2009, Desalination Product Water Production Report for 2003 through 2009, kWh energy usage per MG product water, Desalination Construction Cost by Major category spreadsheet, intake water temperature and salinity tables and graphs. There is more information on this issue in Tampa Bay section of this report.

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18 The 2006 capital cost figures were adjusted to 2009 dollars to provide a more level comparison basis with the capital costs of other facilities.

19 The 2006 capital cost figures were adjusted to 2009 dollars to provide a more level comparison basis with the capital costs of other facilities.

20 The Tampa Bay capital cost figure of $158 million ($110 million in 2002 and $48 million in 2007) was adjusted to $190.3 million in 2009 dollars to provide a more level comparison basis with the capital costs of other facilities.

21 The 1991 capital cost figure of $34 million was adjusted to $59.6 in 2009 dollars to provide a more level comparison basis with the capital costs of other facilities. The original design capacity of 6.7 MGD was used to reflect the original capital cost per MGD design capacity.

22 The distribution system improvement cost of $42 million was deducted from the total capital cost capital costs of $173.4 for a 10 MGD facility. These figures are from MMWD staff Excel spreadsheet “Desalination Conceptual Cost Estimate” Updated October, 23, 2008 and based on costs in “Seawater Desalination Pilot Program.” Marin Municipal Water District Engineering Report, Kennedy/Jenks Consultants. January 26, 2007.

23 The distribution system improvement cost of $22.6 million was deducted from the total capital cost capital costs of $111.2 million for a 5 MGD facility. These figures are from MMWD staff Excel spreadsheet “Desalination Conceptual Cost Estimate” Updated October, 23, 2008 and based on costs in “Seawater Desalination Pilot Program.” Marin Municipal Water District Engineering Report, Kennedy/Jenks Consultants. January 26, 2007. Capital costs for the 5 MGD facility include some infrastructure and built in costs for future expansion up to 15 MGD capacity.

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[36] "Seawater Desalination Pilot Program." Marin Municipal Water District Engineering Report, Kennedy/Jenks Consultants. January 26, 2007. p.46. [37] "Seawater Desalination Pilot Program." Marin Municipal Water District Engineering Report, Kennedy/Jenks Consultants. January 26, 2007. p.46. [38] "Seawater Desalination Pilot Program." Marin Municipal Water District Engineering Report, Kennedy/Jenks Consultants. January 26, 2007. p.46. [39] "Seawater Desalination Pilot Program." Marin Municipal Water District Engineering Report, Kennedy/Jenks Consultants. January 26, 2007. p.46. [40] "Seawater Desalination Pilot Program." Marin Municipal Water District Engineering Report, Kennedy/Jenks Consultants. January 26, 2007. p.46. [41] Fryer, James. "Sustaining Our Water Future, A Review of the Marin Municipal Water District's Alternative to Improve Water Supply Reliability." published by Food & Water Watch, June 2009. p.20. Available at: http://www.foodandwaterwatch.org/water/report/sustaining-our-water-future/

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[43] Reflects an average operating scheme of 23 years at 50% capacity and & 2 years at 100% capacity every 25 years.

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[49] Figures provided by and derived from operational records supplied by Tampa Bay Water in response to a request for public records in the fall of 2009. Records received from Tampa Bay Water include: Annual Desalination Budget Reports for FY 2003 through 2009, Desalination Product Water Production Report for 2003 through 2009, kWh energy usage per MG product water, Desalination Construction Cost by Major category spreadsheet, intake water temperature and salinity tables and graphs.

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60 "Desalination Rehabilitation Study" Prepared for City of Santa Barbara by Carollo Engineers, March 2009. p.ES-9.
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62 Figures derived from operational records supplied by Tampa Bay Water in response to a request for public records in the fall of 2009. Records received from Tampa Bay Water include: Annual Desalination Budget Reports for FY 2003 through 2009, Desalination Product Water Production Report for 2003 through 2009, kWh energy usage per MG product water, Desalination Construction Cost by Major category spreadsheet, intake water temperature and salinity tables and graphs.
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More information on the potential for increased recycled water use can be found in “California Water Plan Update 2009.” DWR bulletin 160-09, Pre-final draft, Vol. 2, p. 11-4, 11-5, 11-6.

FAC 8415 Desalination Plant FY-14 SUC Recalculation

Reported Size: 471.833 KG (Thousands of Gallons/Day) V15.1

Sustainment:

O&M Cost Range		$ 1.50	to	$ 4.00	per kgal produced	
Maintenance =		6%			of total O&M Cost	
Average total O&M * 6% =			$ 0.17		per thousand gallons	
Per day cost =		472	*	$ 0.17	$ 77.88	
Per year cost		365	*	$ 77.88	$ 28,426.20	
Per unit:		$ 28,426.20	divided by	471.833	$ 60.25	per KG
		$ 60.25	*		0	

Inflation from CY 2010

Sources: Seawater Desalination Costs, Water Reuse Association, Revision January 2012

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C:\FXM V16\FAC 8415 Desalination Plant

Texas Innovative Water 2010

A Seminar to Advance the Development and Management of Innovative Water Supplies in Texas

Water Globe Consulting

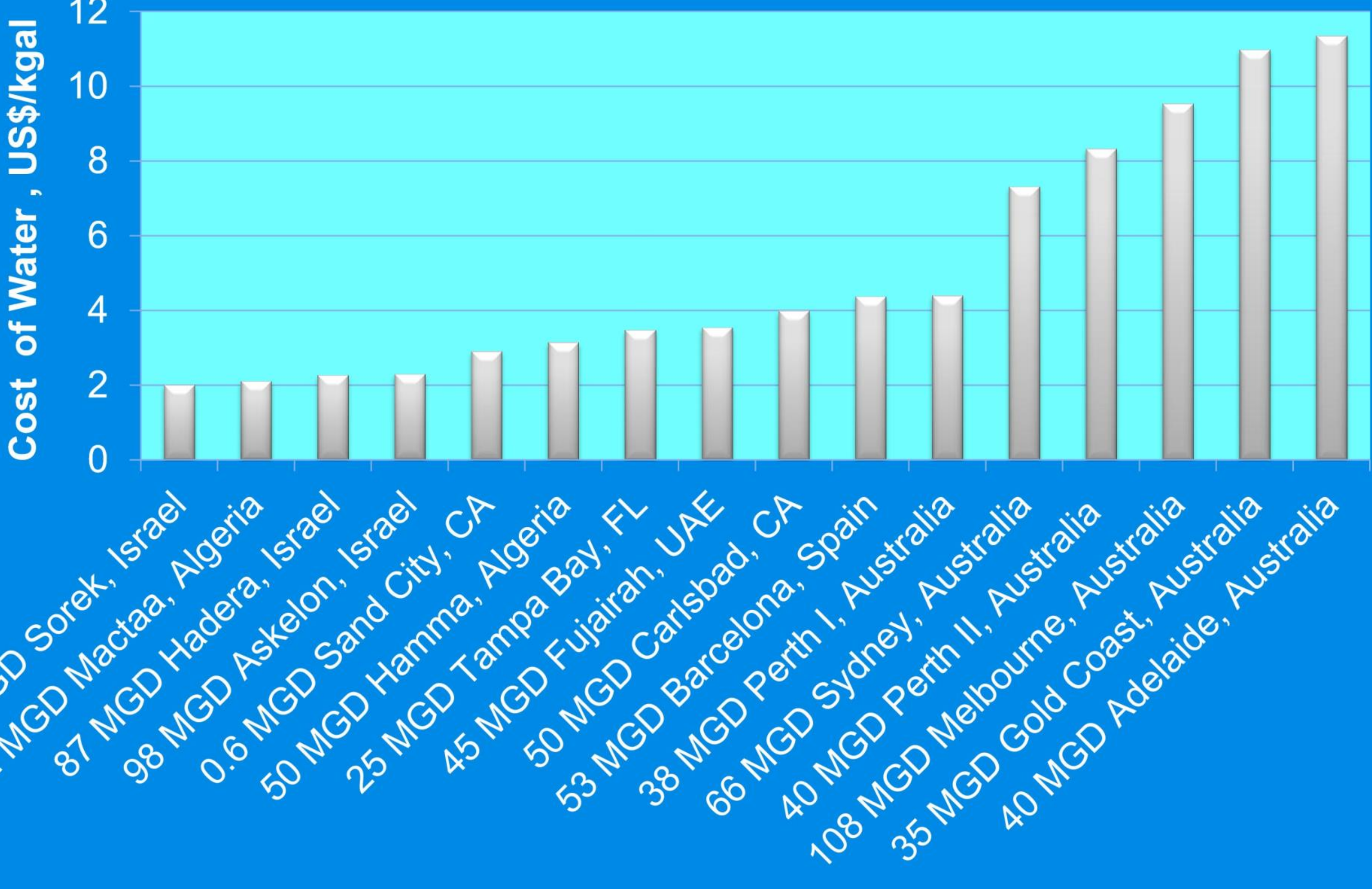
How Much Does Seawater Desalination Cost?

Nikolay Voutchkov, PE, BCEE

Presentation Outline

- Overview of Current Desalination Cost Trends
- Low-Cost Bracket Desalination Projects – Key Features
- High-Cost Bracket Desalination Projects – What Factors Drive the High Costs?
- Key Cost Components
- Main Factors Impacting Costs

Cost of Water of Recent Desalination Projects



Costs of Recent US SWRO Projects

Project	Status	Capital Cost (US$)	Annual O&M Cost (US$/kgal)	Cost of Water (US$/kgal)
0.6 MGD Sand City, CA since 2010	In Operation	[illegible]	[illegible]	[illegible]
25 MGD Tampa Bay, FL since 2008	In Operation	US$138 MM	US$1.54/kgal	US$3.48/kgal
50 MGD Carlsbad, CA	In Financing	US$350 MM	US$1.75/kgal	US$4.00/kgal
2.5 MGD Santa Cruz, CA	In Planning	US$59-64 MM	US$3.94/kgal	US$7.6-8.0/kgal
2.5 MGD Brownsville Demo Project, TX	In Planning	US$22.5 MM	US$2.80/kgal	US$4.38/kgal

25 MGD-80 MGD **Coquina Coast, FL**	**In Planning**	**US$180 MM - US$560 MM**	**US$1.99/kgal**	**US$4.47/kgal (US$5.35-US$6.10 w/ conveyance)**

Typical Cost and Energy Ranges
(Medium & Large SWRO Plants)

Classification	Cost of Water Production (US$/kgal)	SWRO System Energy Use (US$/kgal)
Low-End Bracket	2.0 - 3.0	9.5 – 10.5
Medium Range	**3.5 – 5.0**	**11.0 - 12.0**
High-End Bracket	6.5 - 11.5	12.5 – 14.0
Average	4.0	11.5

Common Features of Low-Cost Desalination Projects

- Point of Product Water Delivery within 5 Miles of Desalination Plant Site;
- RO System Design w/ Feed of Multiple Trains by Common High Pressure Pumps and Energy Recovery Systems;
by Common High Pressure Pumps and Energy Recovery Systems;
- Turnkey (BOOT, BOO) Method of Project Delivery
- Turnkey (BOOT, BOO) Method of Project Delivery.

Key Reasons for Cost Disparity Between High-End & Low-end Cost Projects

(US$2.0 – 3.0 vs. US$6.5-11.5/kgal)

- **Desalination Site Location** (NIMBI vs. Science Driven)
  - **Costly Plants Have Overly Long Product Water Delivery Pipelines**
  - **120 MGD Melbourne Plant – Cost of Plant/Delivery + Power Supply Systems =**

US$1.7 BB/1.1 BB (50 miles)

- 66 MGD Sydney SWRO Plant – Cost of Plant/Delivery System

  = US$560 MM/US$490 MM (10 miles of underground tunnel under Botany Bay).

➢ Environmental Considerations

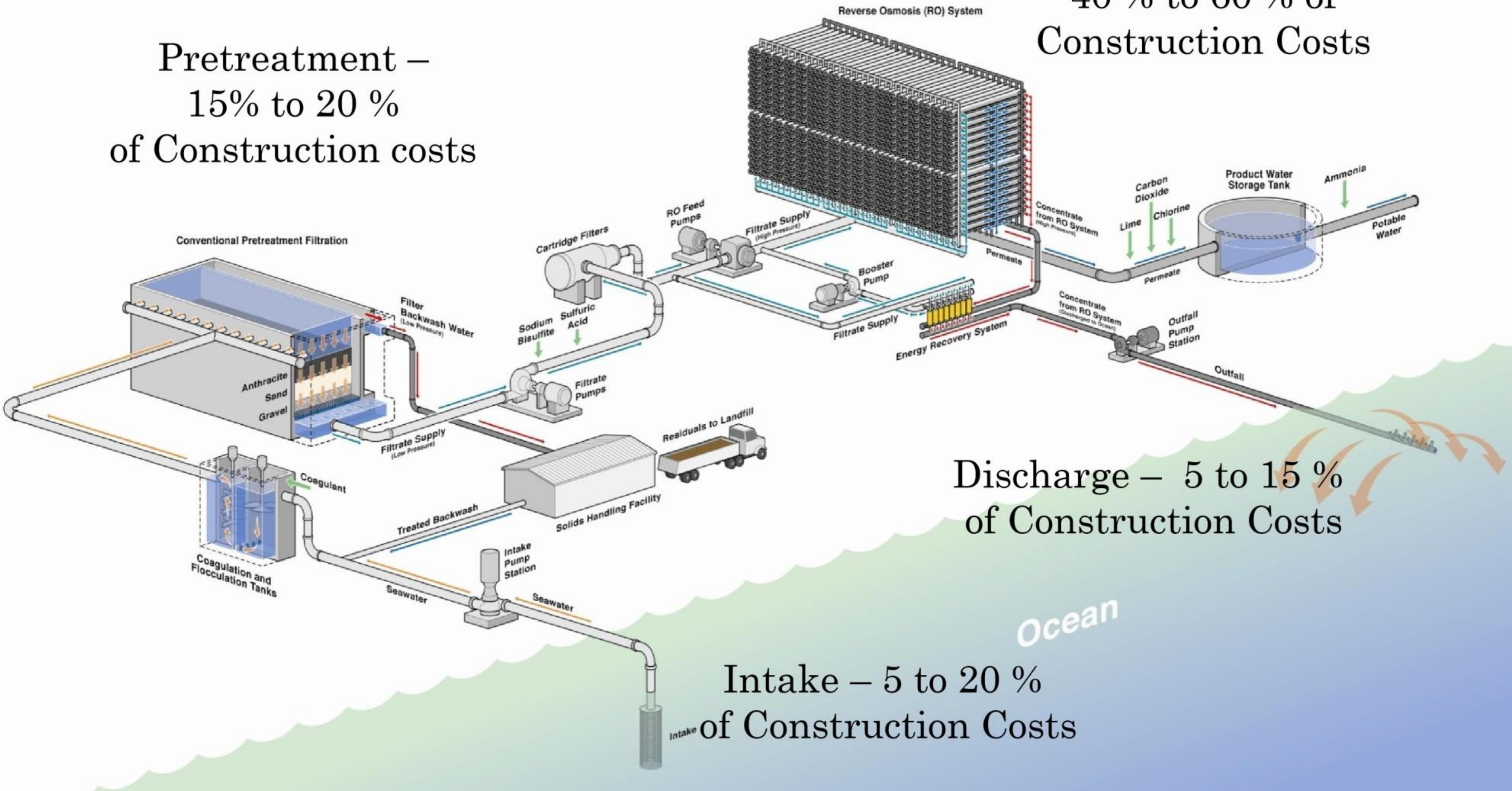
- Complex Intakes & Diffuser Systems

➢ Phasing Strategy

- Intake and Discharge System Capacity;
- Pretreatment & RO System Design;

➢ Labor Market Pressures ➢ Method of Project Delivery & Risk Allocation

Seawater Desalination Plant – Construction Costs



Pretreatment –
15% to 20 %
of Construction costs

RO System –
40 % to 60 % of
Construction Costs

Discharge – 5 to 15 %
of Construction Costs

Intake – 5 to 20 %
of Construction Costs

Intake Construction Costs Key Factors

- Very Dependent on Source Water Quality
- Usually US$0.5 – 1.5 MM/MGD (up to 3.0 MM/MGD for Complex Tunnel Intakes)
- Beach Well Intakes Are Usually Less Costly
- Horizontal and Slant Wells Comparable to Open Intakes
- Infiltration Galleries Often are More Expensive than Open Intakes

Pretreatment Construction Costs

- Very Dependent on Source Water Quality & Type of Treatment Technologies
- Usually US$0.5 – US$1.5 MM/MGD
- High Quality Well Water Sources Require Only Cartridge Filtration (Low Cost Pretreatment)

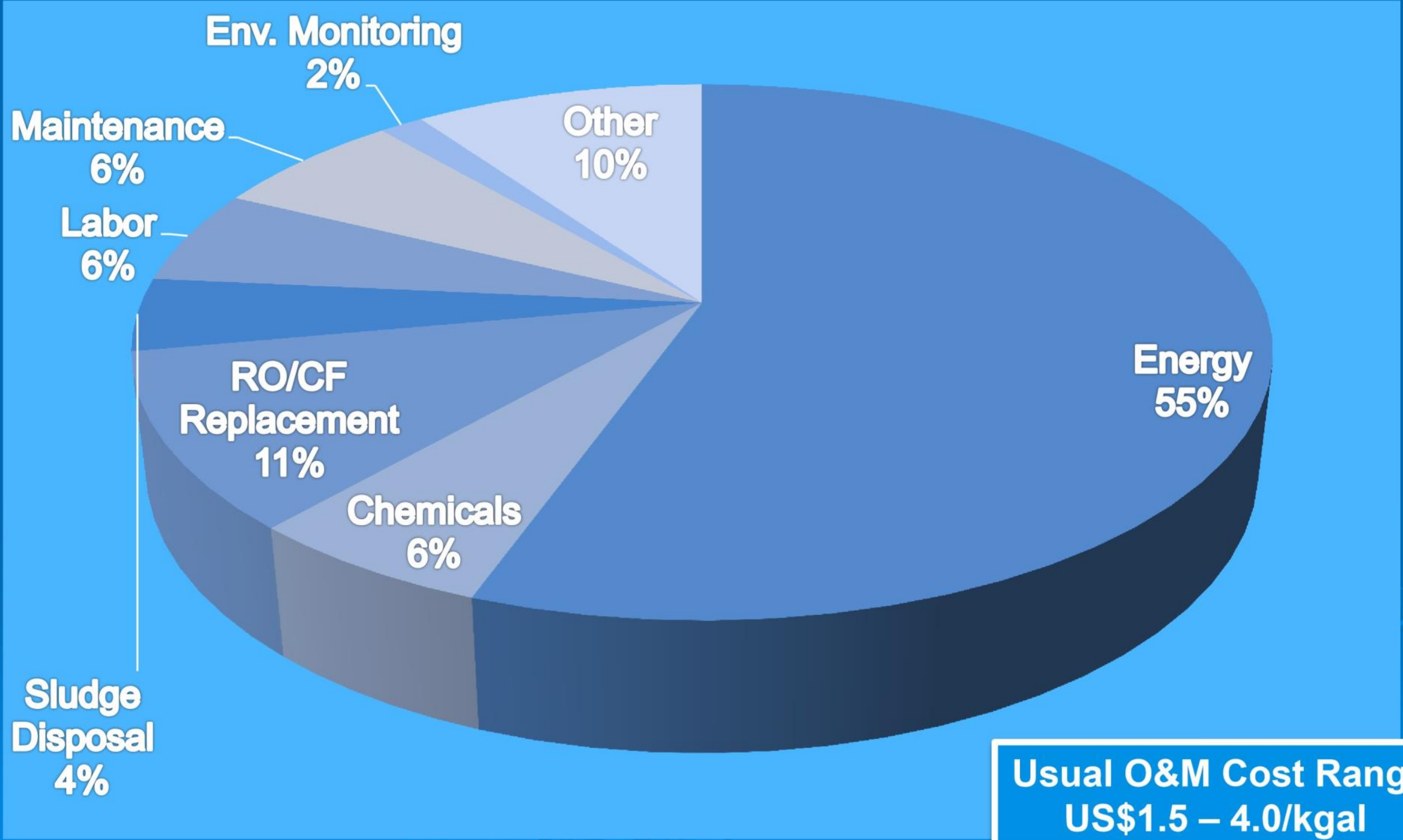
SWRO System Construction Costs

- Dependent on Source Water Quality & Target Product Water Quality
- Usually Between US$1.5-4.0 MM/MGD
- Single-stage/Single Pass SWRO System is Least Costly

Concentrate Disposal Construction Costs

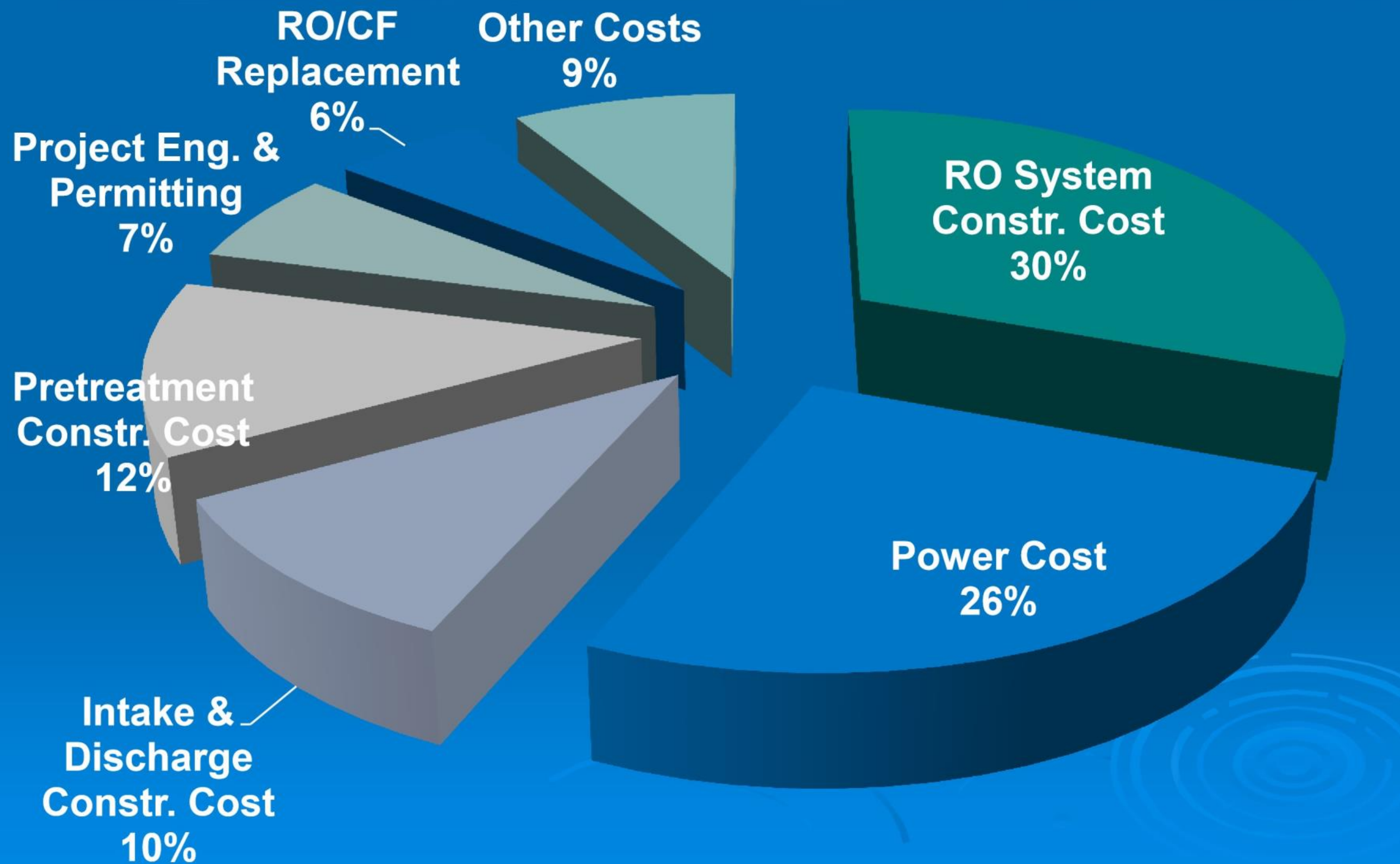
Disposal Method	Construction Cost (US$ Million/MGD)
New Outfall w/Diffusers	2.0 – 5.5
Power Plant Outfall	0.2 – 0.6
Sanitary Sewer	0.1 – 0.4
WWTP Outfall	0.3 – 2.0
Deep Well Injection	2.5 – 6.0
Evaporation Ponds	3.0 – 9.5
Zero-Liquid Discharge	5.5 – 15.0

Typical O&M Cost Breakdown



Usual O&M Cost Range
US$1.5 – 4.0/kgal

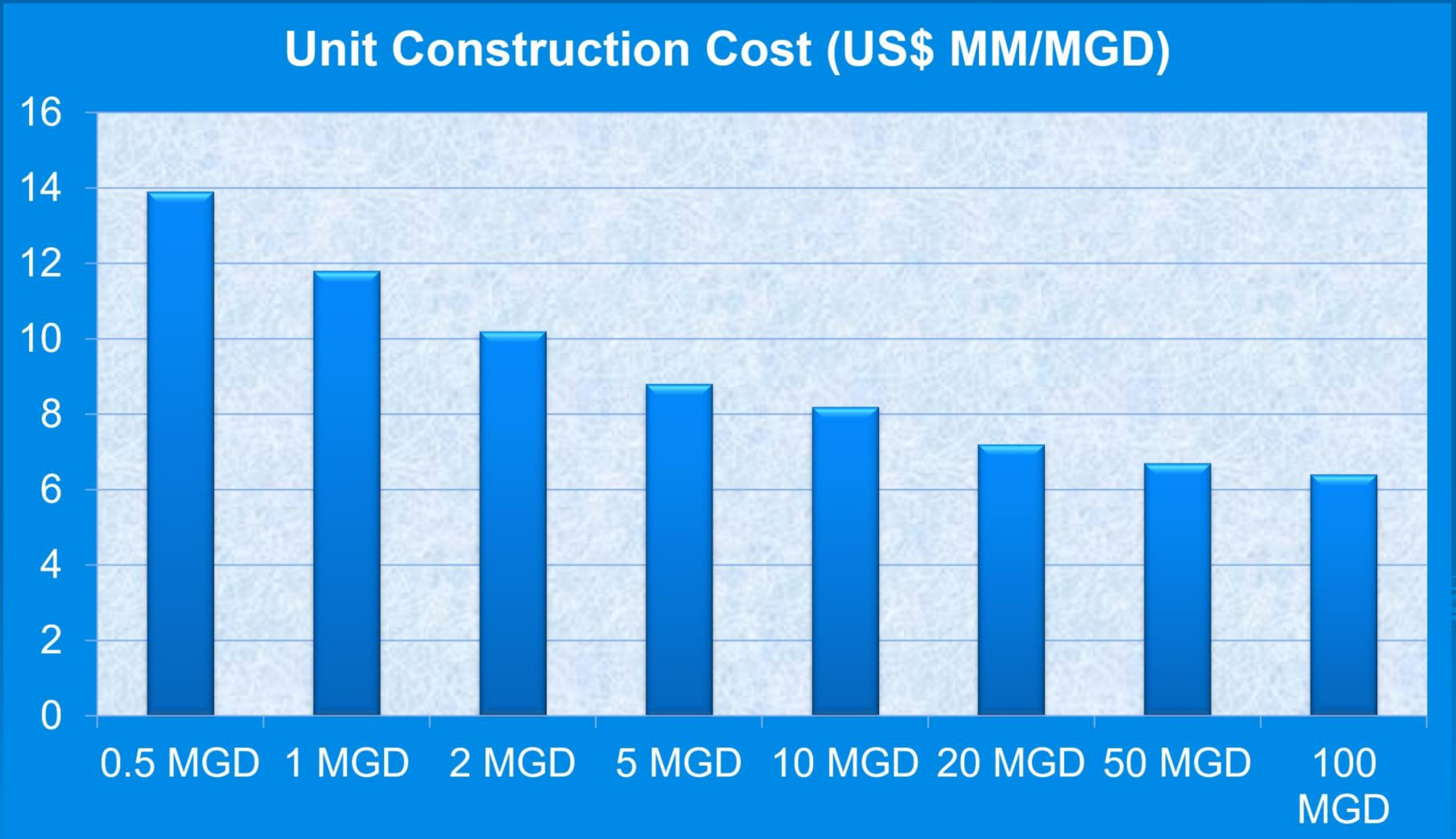
Cost of Water Breakdown



Key Factors Affecting Costs

- Plant Size – Bigger is Better
- Source Water Quality - TDS, Temperature, Solids, Silt and Organics Content.
- Product Water Quality – TDS, Boron, Bromides, Disinfection Compatibility.
- Concentrate Disposal Method;
- Power Supply & Unit Power Costs;
- Project Delivery Method & Financing;
- Other Factors:
  - Intake and Discharge System Type;
  - Pretreatment & RO System Design;
  - Plant Capacity Availability Target.

Desalination Plant Construction Cost as Function of Capacity



Product Water Quality & Costs

Target WQ	Constr. Costs	O&M Costs	Cost of Water
TDS/Cl = 500/250 mg/L; Boron = 1 mg/L.	1.0	1.0	1.0
TDS/Cl = 250/100 mg/L; Boron = 0.75 mg/L.	**1.15-1.25**	**1.05-1.10**	**1.10-1.18**
TDS/Cl = 100/50 mg/L; Boron = 0.5 mg/L.	1.27-1.38	1.18-1.25	1.23-1.32
TDS/Cl = 30/10 mg/L; Boron = 0.3 mg/L.	1.40-1.55	1.32-1.45	1.36-1.50

Where Future Cost Savings Would Come From?

"The Best" of Seawater Desalination Present Status & Future Forecasts

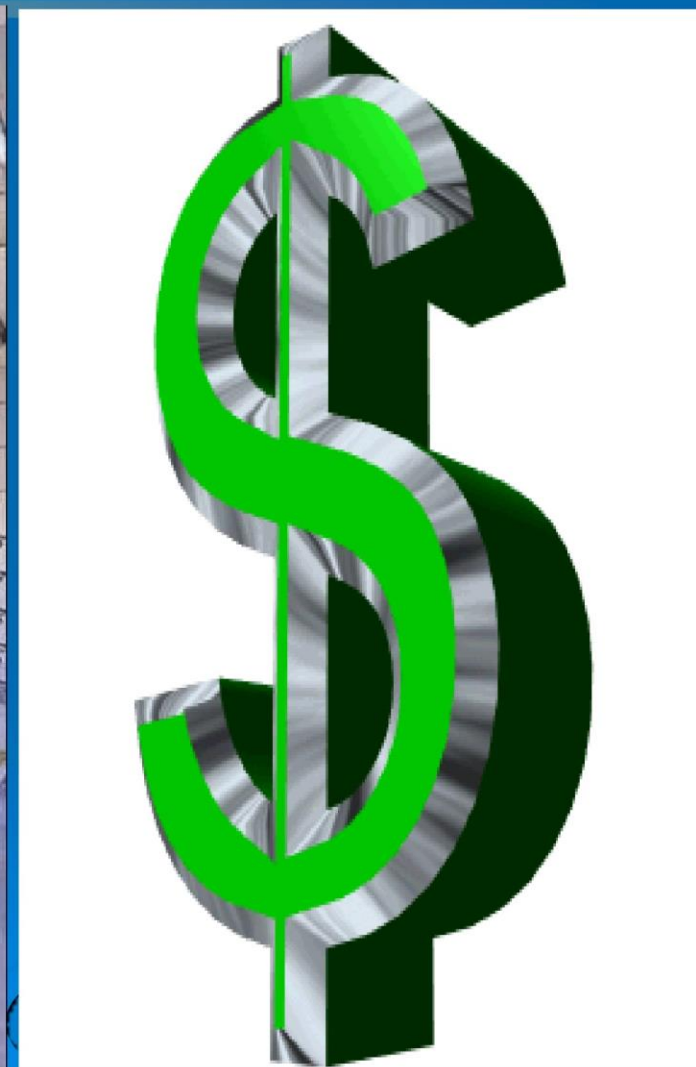
Parameter	Today	Within 5 Years	Within 20 Years
Cost of Water (2010 US$/kgal)	US$2.0-3.0	US$1.5-2.5	US$1.0-1.5
Construction Cost (Million US$/MGD)	4.5-8.0	4.0-6.5	2.0-3.5
Power Use of SWRO System (kWh/kgal)	9.5-10.5	8.0-10.0	5.0-6.5
Membrane Productivity (gallons/day/membrane)	6,500-12,500	9,000-15,000	25,000-40,000
Membrane Useful Life (years)	5-7	7-10	10-15
Plant Recovery Ratio (%)	45-50	50-55	55-65

Concluding Remarks

- Seawater Desalination is Economical Today and Will Become Even More Cost-Competitive in the Future;
- Typical Cost of Water is US$3.5 to US$5.0/kgal;
- The Future of Seawater Desalination Is Bright – 20% Cost of Water Reduction in the Next 5 Years;
- Long-term Investment In Research and Development Has the Potential to Reduce the Cost of Desalinated Water by 80 % In the Next 20 Years.

Seawater Desalination Costs

Questions?



Investment and production costs of desalination plants by semi-empirical method

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***Abstract* - Energy consumptions and costs of desalting systems are among the main parameters affecting the choice of certain desalting system and desalted water final cost. The paper describes a semi-empirical method for determining production and investment costs taking into account plant capacity, availability, energy price and consumption, plant capital cost, membrane service life and other process variables. This study concerns the different desalting processes of seawater, namely distillation multi-stage multiflash, distillation multi-effect, vapour compression and the reverse osmosis. Results show that this method can give a good estimation of the investment and production costs for the concerned processes. Surely, this method can be useful especially in the maturation and the feasibility of any project in the field of desalination. So that most decisions of realization of any project can be taken in a relatively short time and therefore, costs of engineering can be reduced considerably.**

***Keywords* -** Desalination, Process, Economical, Plant

1. Introduction

The need of pure water throughout the world is in constant increase, as well as its insufficiency due to limited stocks and pollution. With more than 70% of the earth's surface covered with water, our planet is a "Water Planet". It is the most common substance in our life and is fundamental to all things living. About 97.4% (1350 × 106 km^3) of the water on the earth's surface is salty water leaving less than 3% of water as freshwater. Two per cent of the freshwater is stored as snow, polar ice caps and glacier (27.5 × 106 km^3) while 0.6% is stored below ground, soil moisture and swamp water (8.3 × 106 km^3) [1]. The world has been a six fold increase in water usage since 1950 and the demand for freshwater is increasing twice as fast as population growth. The world population will increase from 6 billion in year 2000 to 8 billion in 25years [1]. The only conclusion that can be drawn from the above facts is that life to continue on earth will need to use the abundant salty water to produce freshwater supplies capable of meeting the increasing demand. Desalination in the last few decades has proven to be the method to

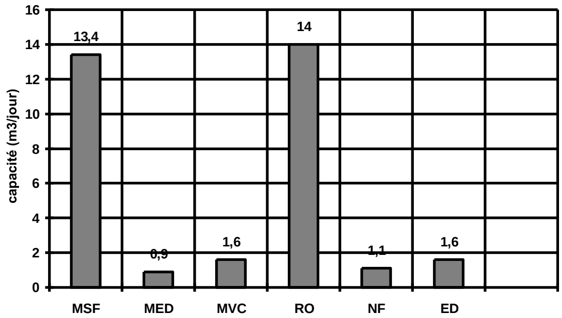

Figure 1. Plants of desalting brackish and seawater throughout the world, according process type [2].

Produce freshwater out of salty water with competitive cost compared to the cost of alternative sources. Because of that, different water desalting plants are used to generate large volumes of acceptable purity water, by processing brackish water, seawater and even waste water. The currently processes employed throughout the world are shown in figure 1.

The major task of desalination engineers is to choose the appropriate process with reduced energy consumption and specific investment cost, long service time and high availability with low amount of maintenance. The cost of producing a unit volume of product water has shown a continuous change over the last two decades. The method of estimation is applied to the plants of multi-stage flash (MSF-Once Through & Brine Recirculation), multi-effect distillation (MED-Horizontal Tubes & Vertical Tubes), vapor compression (VC-Mechanical & Thermal) and the reverse osmosis (RO).

2. Economical evaluation and study

This section develops and discusses a method that estimates investment and production costs for different type of processes. The cost of the produced water for each process is estimated including capital cost, energy cost, operation and maintenance cost, membrane replacement cost and filters replacement cost when used [3].

The data and the assumptions used in this section for the estimation of the capital investment and the production costs for each type of plant, are based on cost studies for specific site items for an approximate comparison plants concerning the costs *Cn* of item *n* and the units of the flow rates and energy rates, *Wn* and capital and erection costs for the main comparison of the year 1986 [4]. These assumptions can be resumed as follows:

- The major design parameters for various types of 1000 m^3/day desalting;
- For thermal desalting process plants, steam requirements are handled as a utility part of operating cost;
- Estimated cost of desalting seawater is based on plant life (about 30 years), production rates approximately 100%, capacity produced 2 × 1000 m^3/day, and stream factor (time that the plant is considered to be in service) nearly equals 85%.

2.1. Investment cost estimation

Total investment cost is defined as the sum of fixed capital cost and working capital cost; this includes the items listed below:

- Direct costs, Indirect costs, Contingencies, Contractor's fee, Start-up costs [(a)] → Total Depreciable Capital Cost
- Land costs, Site development
- Total Depreciable Capital Cost + Land costs + Site development → Fixed Capital Cost
- Start-up costs [(b)] → Working capital
- Fixed Capital Cost + Working capital → Total Capital Cost

(a) Depreciable portion of start-up costs.
(b) Non-depreciable portion of start-up costs.

Figure 2. Different items of investment cost.

Greig and Wearmouth [4] consider that the total capitalized cost of the plant is to be the sum of capital cost, erection cost and the capitalized operational running costs (steam, electrical power, seawater, compressed air, chemicals and replacements materials). Therefore, the capitalized operational running cost for each type of plant is estimated with the method used for the approximate comparison for other sites according to the following equation:

$$C_t = C_c + C_e + C_r \quad (1)$$

$$C_{rn} = C_{an} \cdot I \quad (2)$$

$$C_{an} = 8760 \cdot W_n \cdot C_n \cdot A \quad (3)$$

$$I = \left[\left(1+\frac{i}{100}\right)^{T} - 1\right] \Big/ \left[\frac{i}{100}\left(1+\frac{i}{100}\right)^{T}\right] \quad (4)$$

$$C_{an} = 8760 \cdot W_n \cdot C_n \cdot A \cdot I \quad (5)$$

Ct: plant total capitalized cost; *Cc*: plant capital cost; *Ce*: plant erection cost; *Cr*: plant capitalized operational running cost; *Crn:* plant capitalized operational running cost of item *n* (steam or electrical power or seawater or compressed air or an individual chemical); *Can*: annual operating cost of the item *n*; *I*: represents worth factor; *i*: percentage interest rate; *T:* plant life time; *Wn*: the flow rate of energy rate of the item *n*; *Cn*: unit price of the item *n* for no specific site; *A*: stream factor of the plant.

2.2. Production cost estimation

An important task is to estimate the costs for operating the plant and/or facility, and for selling the products. Total production costs consist of manufacturing and general expenses. The manufacturing are also termed operating costs and is generally divided into direct and indirect portions. The time period that is defined for the basis of production costs is usually a year, although it can also be based on unit-of-product and 24 hours operating or daily basis and can be represented as the sum of the items shown in figure 3.

2.3. Investment cost calculation

Capital running costs for each type of plant is estimated according to Greig and Wearmouth [4]. Building and transport costs are not taken into account due to differences of desalting process types. Results are summarized in table 1.

2.4. Production cost calculation

The total production cost is the sum of direct and indirect costs. A semi-empirical method is used to estimate the production cost. It is based on observed results in different industries such as chemistry and petrochemical where data base has been built over a long period of time (15 to 20 years). Details of different calculation equations, according to Reidy [3] are listed in figure 4.

Results for each plant expressed as capital cost, energy cost, chemical cost and different other costs in \$/m^3/year are listed in table 2.

2.5. Discussion

The economic results are mainly based on the investment and production costs for each type of plant calculated using the results obtained by the method

proposed by Greig and Wearmouth [4]. As it is known, we have used the results (data in our case) obtained from the approximate comparison for calculation the running costs, however, the values of the capital and erection costs proposed in the main comparison are taken as data for our case. Justifying this choice by the importance given in our opinion to the running costs which may vary considerably from one country to another, like for example the energy
and labour costs, which could represent a major and

- Raw materials
- Catalysts and solvents
- Utilities
- Maintenance supplies
- Maintenance labor & supervision *Direct*
- Operating supplies *Cost*
- Operating labor
- Quality control
- Royalties

- Depreciation
- Property taxes *Fixed*
- Insurance *Cost*
- Rent
- Indirect labour, supervision
- Fringe benefits
- Medical facilities - Fire, safety, security *Plant* *Prod.*
- Waste treatment facilities *Indirect* *C ost*
- Recreation facilities *Overhead* *Cost* - Salvage services, control *Cost* laboratories
- Shipping & receiving facilities - Storage & maintenances facilities

- Executive
- Clerical
- Engineering *Administration*
- Legal *Cost*
- Communications

General Cost

-Sales expenses
-Advertising *Marketing*
- Product distribution *cost*
- Sales service

- Financing interest
- Research and developments

Figure 3. Different items of total production cost.

important part of the plant's capital cost during its whole life. The cost structure keeps, in the case of production cost, almost the same pattern and the same share of capital, energy, chemicals and furniture and others costs, which are in the range of those found in literatures and publications having potentially an expected errors. This can be in part explained, in the case of the investment cost, that its composition in figure 2 is reduced to the method [4] where assumptions are made to neglect some extra expense involved in constructing service facilities, storage facilities, loading terminals (this is very true for desalting plant), transporting facilities, and an other necessary utilities at a completely undeveloped site. The fixed capital investment for a new plant located at an undeveloped site may be much greater than that for an equivalent plant constructed as an addition or expansion to an existing plant. On the

Table 1. Investment costs of different desalting seawater plants.

Plant	MSF-OT	MSF-BR	MED-VT	MED-HT	MVC	TVC	R O
$/m^3/ year	0.71	0.75	0.91	0.85	0.39	0.65	0.93

Table 2. Production costs of different desalting seawater plants.

Plant	Production cost (%)				Prod. Cost ($/m^3/)
	Capital	Energy	Chem. Fournît.	Other	
MSF (OT)	15	37	3	45	1.20
MSF (BR)	21	30	2	47	1.34
MED (HT)	18	29	13	40	1.38
MED (VT)	28	22	16	34	1.45
MVC	21	7	4	68	1.02
TVC	17	34	2	47	1.15
RO	12	3	34	51	1.81

other hand, and in the case of the production cost, the multiplying factor for each item in the composition of production cost (figure 4) are not determined in the field of the desalination that is why errors in the estimation can be expected to be important in some cases.

It is to be noted that we can apply the same data, as in the production cost, for estimating the investment cost using the composition of the different items shown in figure 2. But the problem is that for the periods start up costs (1 and 2) and the working capital cost in the field of desalination are unknown period for us. So for the rest, we can consider that this can be in a great similitude to any other plant in the field of chemistry.

Direct cost
Raw material=□(vol. incoming streams)□unit Price Catalyst-solvents=□(vol.income.streams)□unit Price Utilities: Electricity= Power consumed □ Rate Fuel= Fuel consumed □ Rate Stream = Stream consumed □ Rate Operating lab= Operat.labor [(a)] (hr/kg) □ (rate, $/hr) Operating supervision = 0.20 □ Operating labor cost Quality control = 0.20 □ Operating labor cost Maintenance labor = 0.027 □ fixed capital Cost Maintenance labor = 0.018 □ fixed capital Cost
Indirect costs *Fixed Cost* Depreciation=(1-fs)(c) □ deprec.capit.cost /plant life Property taxes = 0.02 □ fixed capital cost Insurance = 0.01 □ fixed capital cost *Plant overhead costs* Fringe Benefits=0.22□(direct labor & supervis.)(e) Overhead = 0.5 □ (direct labor & supervision)(e) *General costs* Administrative = 0.045 □ production cost Commercial = 0.135 □ production cost Financing= i □ (fixed capital cost + working capital) Research = 0.0575□ production cost
Production cost = ∑ items above

(a) expressed by modified Wessel equation; (b) fixed capital cost = depreciable capital cost + land development cost;
(c) salvage fraction of original cost (fs = 0.1);
(d) working capital cost = 0.20 × (fixed capital cost); (e) direct labor includes both operating and maintenance labor.

Figure 4. Direct and indirect calculation costs.

3. Conclusion and recommendations

We can say that the results found are interesting and encouraging mainly when some data of the plant are not available before the detailed engineering design stage. Such methods provide good order of magnitude estimates for early budgetary purposes. They can be taken as an introduction for the development of new techniques where the number of the many factors influencing the estimation of different costs may be reduced to a minimum number of variables. Consequently and in the case of the production cost, the different items are expressed in relationship with basically fixed capital cost, labour cost and production cost. For future purpose, it is suggested that a semi-empirical method for the estimation of the investment cost will be developed with an adequate number of items which will depend only for example on capital erection, and investment costs just like in the case of the production cost. And why not creating a data bank concerning the different items of the costs and through a sufficient and necessary period of time adjust the factors used in the production cost estimation to the field of desalination, and proposing an interesting model in the same way for the investment cost estimation.

At the end we hope that the developed methods will completely be empirical so when applying such methods in other countries will not require local rates and neither specific site parameters. Such model will meet at least the needs in the stage of the maturation and the feasibility of any project not more?

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America's Authority in Membrane Treatment

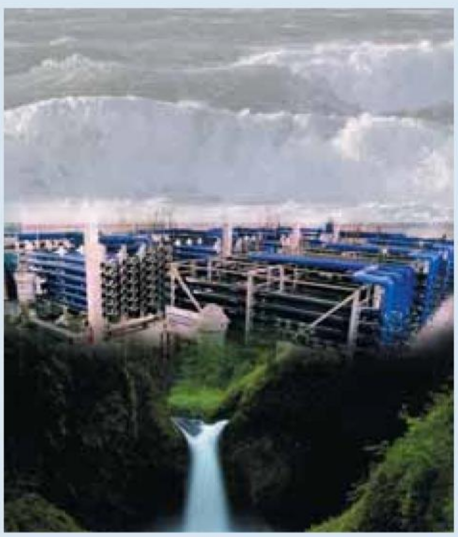
AMTA

American Membrane Technology Association

Improving America's Waters Through Membrane Treatment and Desalting

Membrane Desalination Costs

The growing demand for fresh water in many areas of the world, due to drought, water shortages, population increases and the desire for high quality drinking water, has spurred unprecedented interest in the process of desalting seawater or brackish water (less salty than seawater, but not fresh) to increase the reliability and quantity of water supplies. Long used on ships, island resorts and in water-short countries, the practice of employing desalting technology to produce large-scale domestic supplies is only a few decades old in the United States.



Currently, more than 1,300 desalting plants are operating in the United States, producing over 400 million gallons per day of high quality water, mostly for drinking, with an anticipated investment for the next 5 years of almost $3 billion. Worldwide membrane and thermal desalination capacity is over 11 billion gallons per day from over 12 thousand plants, worth $9.2 billion per year, growing at rate of 12% per year. Desalinated water has found many uses throughout the world. As shown in Figure 1, the largest of which is the production of acceptable quality drinking water. This water, in general, meets the US health and safety standards of the Environmental Protection Agency (EPA) and Food and Drug Administration (FDA) as well as standards established by other global Agencies, such as the World Health Organization (WHO).

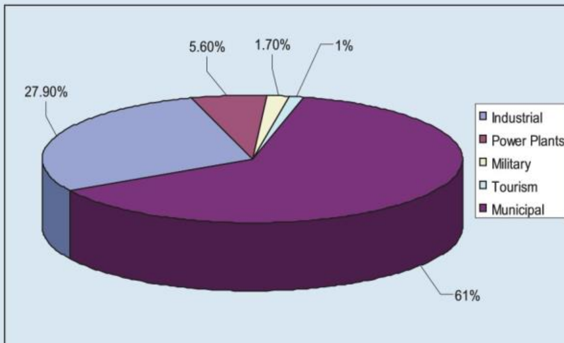


Figure 1: Worldwide Distribution of Desalination Market Users

Figure 2 shows the general cost reduction trend in the last few decades, in producing water using brackish and sea water sources.

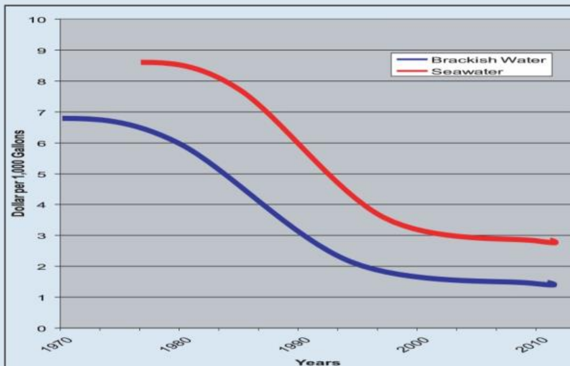


Figure 2: Cost Reduction in Membrane Desalination

Over the last 3 decades, pricing for desalting elements has been reduced substantially. As shown in Figure 3, due to technological improvements by suppliers, automation in the manufacturing process and competition, there have been significant reductions in seawater membrane costs. Similar trends have been present in brackish water modules.

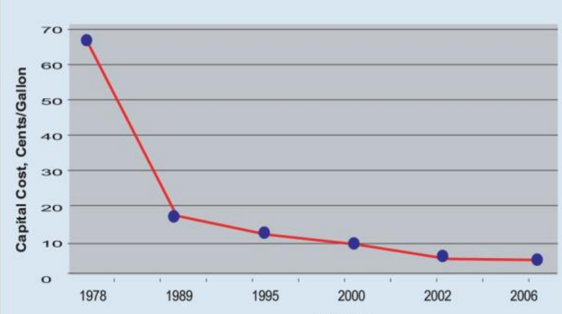


Figure 3: Seawater Element Price Reduction

Most US plants In coastal areas,desalt brackish waters, as local sources of fresh and brackish water are depleted. However there will be more large-scale seawater desalting plants built, most likely in California, Texas and Florida. Many growth opportunities exist in commercial, industrial and municipal applications for furthering the supply of good quality, low salinity water.

The most common objection to using desalted water to help meet the nation's growing water needs is that. "The process is too expensive." This is no longer valid since recent developments in both technology and processes have dramatically decreased the cost of desalting water using membrane technologies.

Desalting Cost as a Portion of Total Supply

In most cases, desalted water is not the sole source of a community's supply. It is usually combined with water from less expensive sources. For instance, as shown in Table 1, if a community paying $2.50/1,000 gallons for its existing water decides to double its supply with desalted brackish water, in a worse case scenario, a typical family's monthly water bill would increase by about $3 per month. Similarly, if the augmented supply is 10% from desalted seawater, the monthly increase would be less than $6.60.

TABLE 1: TOTAL WATER COSTS

SUPPLY TYPE	Consumer[1] $ per 1000 gallons	Total Family To Cost[2] $ per month
Existing Traditional supply	$0.90-2.50	$10.80-$30.00
New Desalted Water:		
Brackish[3]	$1.50-3.00	$18.00-$36.00
Seawater[4,5]	$3.00-8.00	$36.00-$96.00
Combined supply[6] Traditional + brackish	$1.20-$2.75	$14.40-$33.00
Traditional + seawater	$1.11-$3.05	$13.32-$36.60

1. Price includes all costs to consumers for treatmentand delivery.
2. Cost is based on a family of four using 100 gallonsper day per person, for a total monthly use of 12,000 gallons. Cost is based on the average of the "To Consumer" cost shown.
3. Brackish is moderately salty-1,000-5,000mg/Ltotal dissolved solids (TDS).
4. Seawater contains 30,000-35,000mg/L TDS.
5. Cost is for typical urban coastal community in theUSA. Costs for inland communities may be higher.
6. Combined supply costs are for the traditional supplyaugmented with 50% of desalted brackish water, or 10%. of desalted seawater.

Desalting Versus Traditional Water Development

In the US, most inexpensive traditional water resources have already been developed. New sources of supply will be more expensive than the existing ones. Of the potential new treatment options, in many cases, desalting a local resource is financially and environmentally competitive with the traditional methods such as building dams, aqueducts, canals and waste treatment plants. Cost comparisons are often made to existing water supplies. Actually, since desalted water represents a new source of supply, comparisons should be made to the cost of developing other new sources, such as surface water impoundments, remote deep well fields, dams and long distance pipelines.

In the last decade, desalting technology has improved significantly and costs have decreased by over 50 percent. At the same time, the cost of developing traditional water sources has escalated, as drinking water quality and environmental standards have become more stringent. Inflation affected prices and the distances from source to consumer have also increased. In many watershort areas, the costs for desalted water are already competitive with the tapping of new traditional supplies. As alternative energy sources and improved processes and equipment are developed, additional desalting cost reductions can be expected.

Cost Factors and Graphs

The cost factors of desalting include capital costs and operating and maintenance costs. Costs can vary considerably from one locality to another based on a number of issues. In general, the amount of salt to be removed greatly affects the cost of desalting plant operation. The more salts to be removed, the more expensive the desalting process. The capacity of the facility also impacts costs, with larger plants generally being more economical. As shown in Figure 4, the larger the facility, the more cost efficient will be the utilization of equipment, labor and funds.

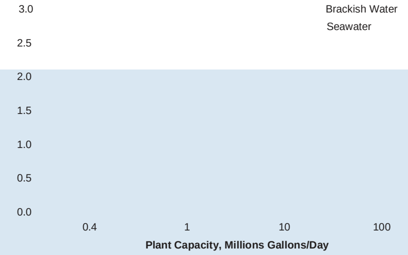


Figure 4: Typical Operation and Maintenance Costs for Brackish and Seawater Desalination Plants

Energy and recovery of capital are the main ingredients of the total cost of water, amounting to about 75% of the total, as shown in Figure 5. To these values, 10-15% can be added for profit, if the desalting project is contracted as a sale of water. The energy cost portion of the total cost greatly depends on the power/fuel pricing.

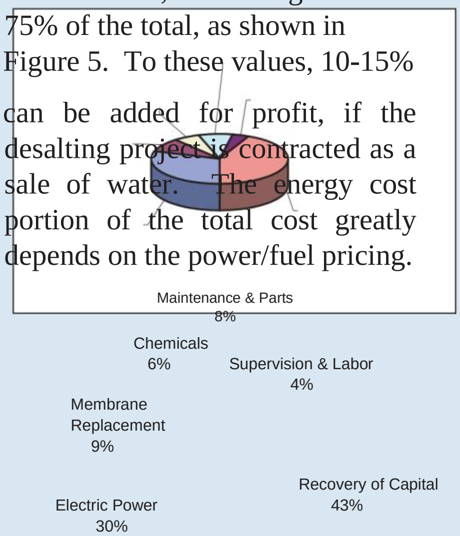
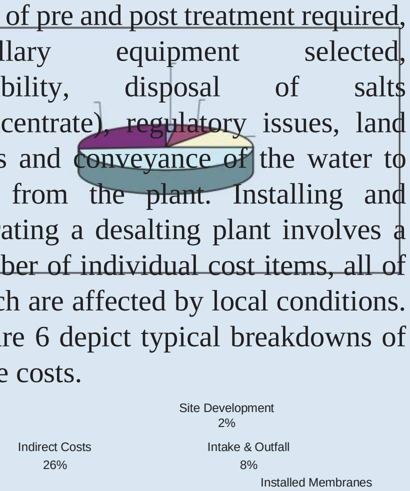
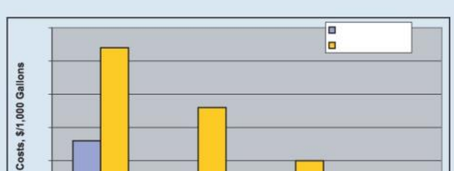


Figure 5: Breakdown of Total Cost of Desalinated Water

Other factors include the amount and type of pre and post treatment required, ancillary equipment selected, reliability, disposal of salts (concentrate), regulatory issues, land costs and conveyance of the water to and from the plant. Installing and operating a desalting plant involves a number of individual cost items, all of which are affected by local conditions. Figure 6 depict typical breakdowns of these costs.





15%

Process Equipment

49% ***Figure 6: Breakdown of Desalination Plant Capital Costs***

1. Indirect Costs Include: working capital, taxes,insurance, land, engineering and project management.
2. Outfall cost does not include concentrate dischargetreatment which sometimes could be a significant portion of the cost.

This material has been prepared as an educational tool by the American Membrane Technology Association (AMTA). It is designed for dissemination to the public to further the understanding of the contribution that membrane water treatment technologies can make toward improving the quality of water supplies in the US and throughout the world.

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The Economics of Desalination

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Cost is a major factor in implementing desalination technologies and usually is site specific. This chapter provides an overview of factors that determine desalination cost, typical desalination cost estimation models, various cost factors, and approximate costs based on a review of case studies and available literature.

Factors Affecting Desalination Costs

Several factors affect desalination cost. In general, cost factors associated with implementing a desalination plant are site specific and depend on several variables. Major cost variables are briefly described below. Details are provided in various documents (Cost Estimating Procedures 2003).

Quality of Feedwater. The quality of feedwater is a critical design factor. Low TDS concentration in feedwater (e.g. brackish water) requires less energy for treatment compared to high TDS feedwater (seawater). Low TDS allows for higher conversion rates and the plant can operate with less dosing of antiscalant chemicals. The pre-treatment of surface waters such as tidal waters will be more costly compared to brackish groundwater because of the potential existence of more contaminants in these waters.

Plant Capacity. Plant capacity is an important design factor. It affects the size of treatment units, pumping, water storage tank, and water distribution system. Large capacity plants require high initial capital investment compared to low capacity plants. However, due to the economy of scale, the unit production cost for large capacity plants can be lower.

Site Characteristics. Site characteristics can affect water production cost. For example, availability of land and land condition can determine cost. The proximity of plant location to water source and concentrate discharge point is another factor. Pumping cost and costs of pipe installation will be substantially reduced if the plant is located near the water source and if the plant concentrate is discharged to a nearby water body. Also, costs associated with water intake, pretreatment, and concentrate disposal can be substantially reduced if the plant is an expansion of an existing water treatment plant as compared to constructing a new plant.

Regulatory Requirements. These costs are associated with meeting local/state permits and regulatory requirements.

Desalination Implementation Costs

Desalination plant implementation costs can be categorized as construction costs (starting costs) and operation and maintenance (O & M) costs.

Construction Costs

Construction costs include direct and indirect capital costs. The indirect capital cost is usually estimated as percentages of the total direct capital cost. Indirect costs may include freight and insurance, construction overhead, owner's costs, and contingency costs. Below is a description of various direct and indirect costs associated with constructing a desalination plant.

Direct Costs.

- ***Land.*** The cost of land may vary considerably, from zero to a sum that depends on site characteristics and plant ownership (public vs. private).

- ***Production wells.*** The cost of well construction depends on plant capacity and well depth. Also, see auxiliary equipment below.

- ***Surface water intake structure.*** The cost of water intake structures depends on plant capacity and meeting environmental regulations. Also, see auxiliary equipment below.

- ***Process equipment.*** The process equipment includes water treatment units (membranes), instrumentation and controls, pre- and posttreatment units and cleaning systems. Process equipment costs depend on plant capacity and feedwater quality.

- ***Auxiliary equipment.*** Auxiliary equipment includes open water intakes, wells, storage tanks, generators, transformers, pumps, pipes, valves, electric wiring, etc.

- ***Buildings.*** Building costs include the construction of structures such as control room, laboratory, workshops, and offices. Construction cost is site-specific depending on site condition and type of building.

- ***Concentrate disposal.*** The cost of concentrate disposal system depends on the type of desalination technology, plant capacity, discharge location, and environmental regulations.

Indirect Costs.

- ***Freight and insurance.*** Freight and insurance (or premium) cost is typically estimated as 5% of total direct costs.

- ***Construction overhead.*** Construction overhead costs include labor costs, fringe benefits, field supervision, temporary facilities, construction equipment, small tools, contractor's profit and miscellaneous expenses. This cost is typically estimated as 15 percent of direct material and labor costs.

- ***Owner's cost.*** The owner's cost includes land acquisition, engineering design, contract administration, administrative expenses, commissioning and/or startup costs, and legal fees. It is estimated as approximately 10 percent of direct materials and labor costs.

- ***Contingency cost.*** This cost is included for possible additional services. It is generally estimated at 10 percent of the total direct costs.

Operating and Maintenance Costs

The operating and maintenance (O & M) costs consist of fixed costs and variable costs.

Fixed Costs. Fixed costs include insurance and amortization costs. Usually, insurance cost is estimated as 0.5 percent of the total capital cost. Amortization compensates for the annual interest payments for direct and indirect costs and depends on the interest rate and the life-time of the plant. Typically, an amortization rate in the range of 5-10 percent is used.

Variable Costs. Major variable costs include the cost of labor, energy, chemicals, and maintenance. Labor costs can be site-specific and also depend on plant ownership (public or private) or special arrangements such as outsourcing of plant operation. Energy cost depends on availability of inexpensive electricity (or other power source). For example, energy cost can be reduced if the desalination plant is co-located with a power generation plant. Chemical use depends mainly on feedwater quality and degree of pre-/posttreatment and cleaning process. The cost of chemicals is affected by type and quantity of such chemicals as well as global market prices and special arrangements with vendors.

The major maintenance cost pertains to the frequency of membrane replacement, which is affected by the feedwater quality. For low TDS brackish water, the replacement rate is about 5% per year. For high TDS seawater, the replacement could be as high as 20%. The cost for maintenance and spare parts is typically less than 2% of the total capital cost on an annual basis.

Cost Estimation Models

Several models are available for estimating desalination costs. Model applications are mostly limited to site specific conditions and give approximate estimates. Nevertheless, cost models can be used as an indicator of potential costs for planning a desalination facility. Three typical cost models are described below.

WTCost© Model

The Bureau of Reclamation, with the assistance of I. Moch & Associates and Boulder Research Enterprises has developed WTCost©, a computer program that estimates the capital and operation & maintenance costs (Cost Estimating Procedures 2003). The model provides estimates for the following desalination technologies: Brackish water reverse osmosis (BWRO), seawater reverse osmosis (SWRO), mechanical vapor compression (MVC), multiple effect distillation (MED), multi-stage distillation (MSF), nanofiltration (NF), and electrodialysis reversal (EDR). The model provides a set of default values for all input parameters, but default parameters can be overridden when more accurate information becomes available.

WTCost© model provides estimates of capital costs and indirect costs described above. Capital costs include start-up costs for desalination technologies, various pretreatment and posttreatment options, and concentrate disposal options (surface water discharge, disposal to sewer system, land application, evaporation ponds, deep well injection, and zero discharge (using concentrators). Other capital costs include feedwater intake infrastructure (seawater and brackish surface water, seawater and brackish well water), feedwater pipeline, general site development, auxiliary equipment, and buildings. The model gives estimates of indirect depreciating and non-depreciating capital costs. Depreciating costs include freight and insurance, interest during construction, construction overhead, owner's expenses, and contingency. Nondepreciating costs (costs that do not lose value or expense) include land and working capital costs (ready cash on hand to cover the day-to-day expense of operating the facilities).

WTCost© estimates annual costs. Annual costs vary directly with the quantity of water produced and are indexed to the price levels at the date of estimate. Annual cost estimations are provided for labor (for staff requirements and plant size), chemical costs (for type of desalination technology), energy (cost of electricity in $/kWh), type of desalination technology including plants co-located with power plants, replacement parts and maintenance materials, membrane replacement cost, insurance (assuming 5% of total capital costs), annual cost of capital, and plant factor (the percent of time the units will operate during the year at the percent design capacity.

Desalination Economic Evaluation Program (DEEP)

The International Atomic Energy Agency (IAEA) has developed the Desalination Economic Evaluation Program (DEEP) to perform economic analysis of desalination using nuclear energy versus alternative sources of energy (International Atomic Energy Agency 2004). The model is applicable to largescale (>25 MGD capacity) desalination plants and is designed for research purposes, not industrial cost analysis. Information about DEEP is available on the IAEA Nuclear Desalination Unit's website at www.iaea.org. Currently, DEEP version 2.1 is available on CD-ROM at no charge from the IAEA, but license agreement and use permission is required. A brief description of DEEP follows.

DEEP is based on hybrid Microsoft Excel spreadsheet and Visual Basic methodology. There are three categories of input requirements: Model Data, User Input Data, and Default Data. Model Data refers to certain specified technical parameters that are built within the model and cannot be changed by the user. User Input Data are parameters that should be input by the model user. User Input Data are mostly site specific and include information such as plant location, type of technology, plant capacity, and feedwater salinity. Default Data are parameters that characterize plant performance (e.g. energy recovery efficiency) and economic parameters (e.g. interest rate). Default Data are specified by DEEP, but can be changed by the user as more accurate information becomes available. DEEP Output includes plant performance indicators such as recovery ratio, energy consumption, daily and annual water production, product water TDS, various cost factors that include levelized cost of water and power ($/m³ or $/kWh), and breakdown of cost components for various scenarios.

WRA RO Desalination Cost Planning Model

Water Resources Associates (WRA) has developed the Reverse Osmosis Desalination Cost Planning Model (Water Resource Associates, Inc. 2005). The WRA model facilitates the cost analysis of a range of desalination project implementation options based on capital, O & M, and life cycle costs. The Version 2.0 model is Windows-based with userfriendly features. Major components of the model include: Master Data Input Form (for a user less knowledgeable about desalination process or its economic components), Advanced Input Form (which allows the user to customize the model by inputting 38 different default settings and make appropriate assumptions), Capital Cost Output, and O & M Cost Outputs. The model input requirements include 33 parameters or default values. The O & M cost output displays the annual O & M costs based on input or default values and a total annualized O & M cost based on the interest rate, inflation rate and life cycle period.

Desalination Approximate Cost Estimates

Desalination cost is affected by several factors such as type of technology, energy availability, geographic location, plant capacity, and feedwater quality. Other important factors include costs associated with transporting water from source to desalination plant, distribution of treated water, and concentrate disposal. Factors such as financing options and subsidies also affect the product water cost.

A 2003 Sandia National Laboratories Report provides a comprehensive review of literature and information on desalination costs (Table 1). It should be noted that because costs documented in various reports are not calculated in a consistent fashion and therefore they are approximate at best and do not represent a conclusive picture.

Table 2 shows the percent cost of various factors for desalination of brackish water and seawater in RO plants. These data are reported in the Sandia National Laboratories report compiling data from other sources (Miller 2003).

Table 1. Desalination Costs for Various Desalination Technologies ($/m^3 freshwater – multiply by 3.8 for $/1000gal)

Reference Sources	MSF (Seawater)	MEE (Seawater)	TVC (Seawater)	RO (Seawater)	RO (Brackish water)	ED ED(Brackish water)
A	1.10-1.50	0.46-85	0.87-0.92	0.45-0.92	0.20-0.35	-
B	0.80	0.45	-	0.72-0.93	-	-
C	0.89	0.27-0.56	-	0.68	-	-
D	0.70-0.75	-	-	0.45-0.85	0.25-0.60	-
E	-	-	-	1.54	0.35	-
F	-	-	-	1.50	0.37-0.70	0.58
G	1.31-5.36	-	-	1.54-6.56	-	-
H	1.86	1.49	-	-	-	-
I	-	1.35	-	1.06	-	-
J	-	-	-	1.25	-	-
K	1.22	-	-	-	-	-
L	-	-	-	-	0.18-0.56	-
M	-	-	0.46	-	-	-
N	-	-	-	1.18	-	-
O	-	1.17	-	-	-	-
P	-	-	0.99-1.21	-	-	-
Q	-	-	-	0.55-0.80	0.25-0.28	-
R	-	-	-	0.59-1.62	-	-
S	-	-	-	1.38-1.51	-	-
T	-	-	-	0.55-0.63	-	-
U	-	-	-	0.70-0.80	-	-
V	-	-	-	-	0.27	-
W	-	-	-	0.52	-	-

Source: (Miller 2003). Other sources for cost estimates are documented in Appendix 1.

Table 2. Percent Distribution of Cost Factors

	Brackish water(%)	**Seawater**(%)
Fixed costs	54	37
Electric power	11	44
Labor	9	4
Membrane-replacement	7	5
Maintenance and parts	9	7
Consumables (chemicals)	10	3

Source: Miller 2003

Several observations can be made from these data.

1) For both, brackish water and seawater, fixedcosts are a major factor;
2) The major difference in cost betweendesalination of brackish water and seawater is energy consumption, while the remaining factors are decreased proportionally, but remain about the same; and
3) Costs associated with membrane replacement,maintenance & parts and consumables are relatively small. These costs depend on the status of technology and may be further reduced as technology evolves, but will not have significant impact on the overall cost of desalination.

Treatment costs are affected by salinity and overall water quality. High salinity water (e.g. seawater) consumes more energy and is therefore more costly to desalinate. It can be noted that cost efficiency of seawater desalination is a critical parameter in order to make it economically viable. From a water source perspective, desalination of brackish groundwater is the least costly. Surface waters (e.g. tidal waters) contain higher salinity and other impurities. Treatment of high salinity water will require more pre-treatment and perhaps a combination of various technologies, therefore making it more costly.

Desalination plant capacity is a major cost factor. Literature shows that in general, large capacity plants require a high initial capital investment compared to low capacity plants. Also, the increase in cost of product water (per 1000 gallons) is proportional to energy cost (per KwHour). However, due to the economies of scale, operation and management costs, the unit production costs for large capacity plants can be lower (LBGGuyton Associates 2003, Younos 2004).

Concentrate disposal is a major economic factor and is affected by several factors that include site characteristics (geologic features, soil conditions, proximity to potential disposal site), regulatory requirements, public approval, and the type of concentrate disposal method. Based on those limitations, concentrate disposal cost can range from 5 to 33 percent of the produced water cost (Tsiourtis 2001).

In general, surface water disposal is the most common and affordable option when costs associated with concentrate transport, post-treatment, and outfall structures are considered. However, disposal costs for inland desalination plants are generally higher than those for coastal plants because inland plants cannot dispose to surface waters unless the concentrate can be treated to an acceptable quality. The second common and economic concentrate disposal method is combining the concentrate with effluent from wastewater treatment plants. Costs associated with land application techniques (evaporation ponds, spray irrigation, and percolation) depend on the site characteristics. The cost of deep well injection depends on the volume of the concentrate to be disposed of and is considered most expensive at very small volumes. The Zero liquid discharge (ZLD) method is the most expensive option due to the high energy requirement, whereas with other techniques the energy associated cost is insignificant (Mickley 2001).

Table 3 shows design parameters and capital cost factors for various concentrate disposal options. This table can be used to compare available options and to determine the most appropriate method of disposal for a selected desalination plant (Mahi 2001).

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Table 3 Design Variables and Capital Cost Items for Different Methods of Disposal

	Methods of Disposal						
	Surface Water Disposal	Sewage Treatment Plant	Deep Well Injection	Percolation	Spray Irrigation	Evaporation Pond	Zero Discharge
Design Variable							
Distance	Y	Y	Y	Y	Y	Y	Y
Volume	Y	Y	Y	Y	Y	Y	Y
Depth	—	—	Y	—	—	—	—
Number of tubing transitions	—	—	Y	—	—	—	—
Evaporation rate/ hydraulic loading	—	—	—	Y	Y	Y	—
Land availability, type, cost	—	—	—	Y	Y	Y	—
Storage time	—	—	—	Y	Y	—	—
Sprinkling spacing	—	—	—	—	Y	—	—
Reject flow	—	—	—	—	—	—	Y
Energy cost	—	—	—	—	—	—	Y
Capital Cost Item							
Transport system (pipe, pump)	Y	Y	Y	Y	Y	Y	Y
Treatment system (includes blending)	Y	Y	—	Y	Y	—	—
Outfall structure	Y	—	—	—	—	—	—
Injection well (depth, pump, materials)	—	—	Y	—	—	—	—
Monitoring wells	—	—	Y	Y	Y	Y	—
Land, land preparation	—	—	—	Y	Y	Y	—
Distribution system (pipe, pump)	—	—	—	Y	Y	—	—
Wet weather storage	—	—	—	Y	Y	—	—
Alternate disposal system	—	—	Y	—	—	—	—
Subsurface drainage system	—	—	—	(Y)	Y	—	—

Disposal fee	—	Y	—	—	—	—	—
Skid mounted system	—	—	—	—	—	—	Y

Methods with 'Y' must consider the design variable or cost item when used for concentrate disposal.

Source: Mahi 2001

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Desalination: Can it be greenhouse gas free and cost Competitive?

MEM Masters Project

by: ! John Frederick "JF" Thye

advisor: ! Marian Chertow

date: ! 9 May 2010

- Yale School of Forestry and Environmental Studies

Table of Contents

Executive Summary

This paper reviews the current status of global water scarcity, water price, and desalination processes, as well as their efficiencies and associated economics. Given rapidly growing desalination energy demands and the seriousness of the associated greenhouse gas emissions, this paper's goal is to determine the current and future technological and economic competitiveness of high efficiency desalination technologies and non-fossil fuel powered renewable energy system (RES) integration with commercial desalination plants.

This paper estimates the world average cost of fresh water, including sanitary services, to be approximately USD 1.14/m^3, derived from from 2008 GWI and 2009 OECD report data. Recent published levelized desalination plant cost structures show water delivery between USD 0.61/m^3 and USD 3.00/m^3. In comparison to operating desalination plants, renewable energy desalination system (REDS) water costs are more difficult to estimate. Currently, the most cost competitive technology matchup, the "Wind-Reverse Osmosis" REDS, is thought to have hypothetical costs between USD 1.25/m^3 and USD 1.50/m^3. All REDS models, should be noted, are still officially in a theoretical model or pilot project stage. Cost data on these constructs is therefore limited and incomplete.

The buzz around desalination technologies is fierce, as governments and investors are competing in a race to create the next great breakthrough technology. In the near term, most promise is shown by combinations of wind or solar energy with desalination technologies that are in the osmosis category, such as reverse osmosis (RO) or forward osmosis (FO). This is especially true if FO is able to respond well to variable power inputs.

FO is being pioneered by the Modern Water company and Oasys, who seem to be the current category leaders. Rumors about carbon nanotubes whisper of their serious potential, particularly interesting because of the technology's high flux rate and seeming ability to cooperate well with varying flow rates and power on-off cycling, but the technology is still in the R&D stage.

Introduction

Clean water resources are rapidly being reduced around the world through human consumption, yet water is one of the most abundant elements on earth. Three-fourths of the planet's surface is covered by water, but only three percent is fresh water fit for human consumption, held in ground water, rivers, and lakes. Less than one percent of fresh water is actually within human reach.[1]

97% of the earth's water is in the ocean, where it maintains a salt content too high for human ingestion. In order to tap this seemingly boundless resource, desalination technologies that remove salt from brackish and seawater sources have been deployed in limited capacity since ancient times. Major advances over the past 40 years have led to a steep increase in desalination technology deployment, and technologies are continuously evolving for commercial and household consumption.

[1] Eltawil, 2009

The separation of salts from seawater remains energy intensive, however. Since the primary direct and indirect energy source for desalination has been fossil fuels (where indirect energy is electricity produced from fossil fuel power plants), the concern over climate change has steered much attention to how renewable energy sources (RES) could be coupled with desalination technologies. Water resource planing committees and venture capital investors therefore consider the economically viable synergy between RESs and desalination technologies that can draw on a virtually infinite water source, the ocean, one of the great technological races of our time to solve the world-wide water shortage crisis.

Combining renewable energies with desalination also has an inherent advantage beyond basic potable water production. Water is an excellent storage medium and can be held in vast quantities for extended periods of time. Therefore, it is possible to produce water and store excess production when a large amount of power supply is available. Consequently, when power is not available, no wind to spin a turbine or sun to generate solar electricity, stored water serves as an intermediate source. This alleviates the need for expensive large-scale back-up energy systems that plague most commercial applications of RESs.

This paper reviews the current status of global water scarcity, water price, and desalination processes, as well as their efficiencies and associated economics. Given rapidly growing desalination energy demands and the seriousness of desalination associated greenhouse gas emissions, this paper’s goal is to determine the current and future technological and economic competitiveness of non-fossil fuel RES integration with commercial desalination plants.
Commercial fresh water production is generally considered to be able to provide fresh water for population sizes between multiple families to large municipalities. In summary, a successful integration between a RES and a desalination technology solves three preeminent challenges:

1. Virtually limitless access to water with zero fossil fuel inputs.
2. The integrated coupling of variable wind and solar power inputs with desalination plants, which have traditionally been designed for constant power inputs from fossil fuel plants.
3. The ability to store fresh water during high production periods, which is tapped during times when renewable energy is not available (no wind or sun), creating a constant supply availability to consumers.

Limitations to my research are due to incomplete economic and technological performance data, which makes true technology comparisons challenging. The performance of RES-desalination is site-specific, so the same system will perform differently depending on location, weather condition, water temperatures, as well as particle, chemical and salinity levels. Though some systems have already run for multiple years, many of the more promising new concepts are still in pilot phases, experimental lab settings, or in the theoretical constructs stage, modeled after virtual field conditions.

A note on this paper’s format:

Sections describing technologies and case studies are writing in a bullet point format. The objective is to distill the most essential technical attributes and considerations as clearly as possible. Standard text sections throughout the paper serve to introduce and discuss linking concepts.

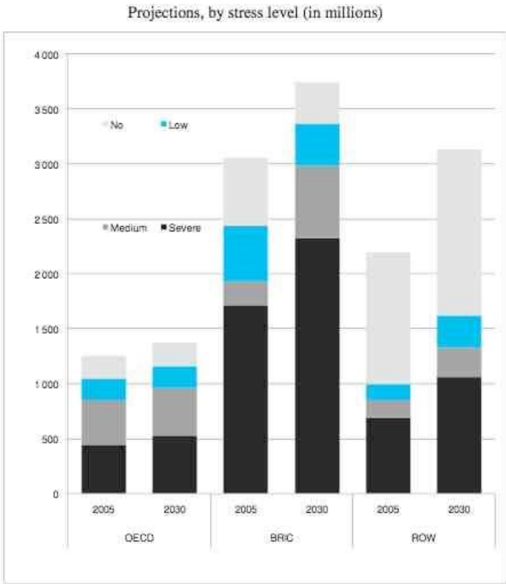
Global Water Economics

The price of water can be measured by its demand and economic cost. Water scarcity is a demand side analysis driven by the degradation of social fabric and quality of life associated with the lack of clean water. In essence we may conclude that access to a minimum amount of fresh water is a basic human right with zero demand elasticity and and infinite price. However, beyond the minimum standards, the water demand curve is downward sloping with regional specific slopes and characteristics. These are driven by the culture and industry that make up water demand.

Global Water Scarcity

As depicted in the Figure below, in 2005, 2.8 billion people lived in areas under severe water stress, which is defined in two ways.[2] The Falkenmark indicator defines it as less than 500 m^3 per capita per year, while the WTA (Withdrawal per Total Available Water Resource) defines severe water stress as more than 40%. By 2030, the OECD Environmental Outlook estimates that this number will increase by about 1 billion, to 3.9 billion (47% of the world population), without taking climate change into consideration.

[2] OECD, 2009a



Source: OECD Environmental Outlook baseline in OECD (2007), *Environmental Outlook to 2030*, OECD, Paris. The OECD baseline used for the *Environmental Outlook* is policy neutral, *i.e.* it assumes no new policies and projects current policies into the future to show what the world will be like in 2030 if currently existing policies are maintained, and no new policies introduced to protect the environment.

Water-scare countries in 1955	Countries added to scarcity category by 1990	Countries added to scarcity category by 2025 under all UN population growth projections	Countries added to scarcity category by 2025 only if they follow UN medium or high projections*
Malta	Qatar	Libya	Cyprus
Djibouti	Saudi Arabia	Oman	Zimbabwe
Barbados	United Arab Emirates	Morocco	Tanzania
Singapore	Yemen	Egypt	Peru
Bahrain	Israel	Comoros	
Kuwait	Tunisia	South Africa	
Jordan	Cape Verde	Syria	
	Kenya	Iran	
	Burundi	Ethiopia	
	Algeria	Haiti	
	Rwanda		
	Malawi		
	Somalia		

*Cyprus will have more than 1,000 cubic meters of renewable fresh water annually per person in 2025 if it follows either the UN low or medium population growth projection. Zimbabwe, Tanzania and Peru can avoid falling below 1,000 cubic meters per capita only if they follow the UN low projection.

Figure 1 *(left): Regional populations living under water stress as per WTA indicator (OECD countries: Organization of Co-operation and Development; BRIC: Brazil, Russian Federation, India, China; ROW: Rest of the world (countries which are neither OECD nor BRIC).*[3]

Figure 2 *(right): Countries experiencing water scarcity in 1955, 1990, and 2025 (projected), based on availability of less than 1,000 cubic meters of renewable water per person per year.*[4]

BRIC countries will see the highest increase in water scarcity in certain population pockets, while the country water scarcity figure above projects which countries are expected to experience nationwide severe water scarcity. Many oil rich countries, like Saudi Arabia, are already dependent on desalination for much of their fresh water capacity.

Climate change is expected to significantly affect the capacity of natural water systems to meet anthropogenic and ecological needs. The main water-related impacts from climate change are expected to be felt by shifting, and more variable, hydrological regimes, i.e. changes in water distribution around the world, changes in seasonal and annual variability, and an increase in the frequency and/or intensity of extreme events. Rising sea levels will threaten the world's megadeltas, while the vast populations dependent on glacial melt (one-sixth of the world's population) are losing their "water towers": the high altitude glacial reservoirs (e.g. Peru).[5]

[3] OECD, 2009a

[4] National Council for Science and the Environment 2005 (http://www.cnie.org/pop/pai/water-14.html)

[5] EEA, 2008

Global Water Prices

The Figure below shows the price per cubic meter of water and wastewater services faced by a households consuming 15 m^3 per month in 90 selected countries and eight regions. OECD defines the price of water indicator by the price paid by final (domestic) users. The data was adjusted using purchasing power parities for private consumption. This indicator choice over other possible measurements of “average tariffs” was motivated by the intention to ensure comparability across countries, given the extreme variability of tariff levels and structures not just across countries, but across different providers within each country.

Though water and wastewater bills differ between countries, clusters of countries reveal interesting average cost comparisons. OECD countries, on average, have a water cost approximately USD 0.50/m^3 higher than Central and South-East Europe, and USD 2/m^3 higher than most of the rest of the world. Within the OECD two counties are below the USD 1.00/m^3 cost, ten countries are below USD 2.00/m^3, and nine are around USD 3.00/m^3. Denmark (USD 4.41/m^3) and Scotland (USD 9.45/m^3) submitted much higher values. The OECD report assumes that these countries have made efforts to incorporate as much of the economic and other costs of waste water service provision and use into their tariffs, which other countries may not have to the same extent. US urban water cost, in comparison, are USD 0.55/ m^3, and less than USD 0.05/m^3 for agricultural use.

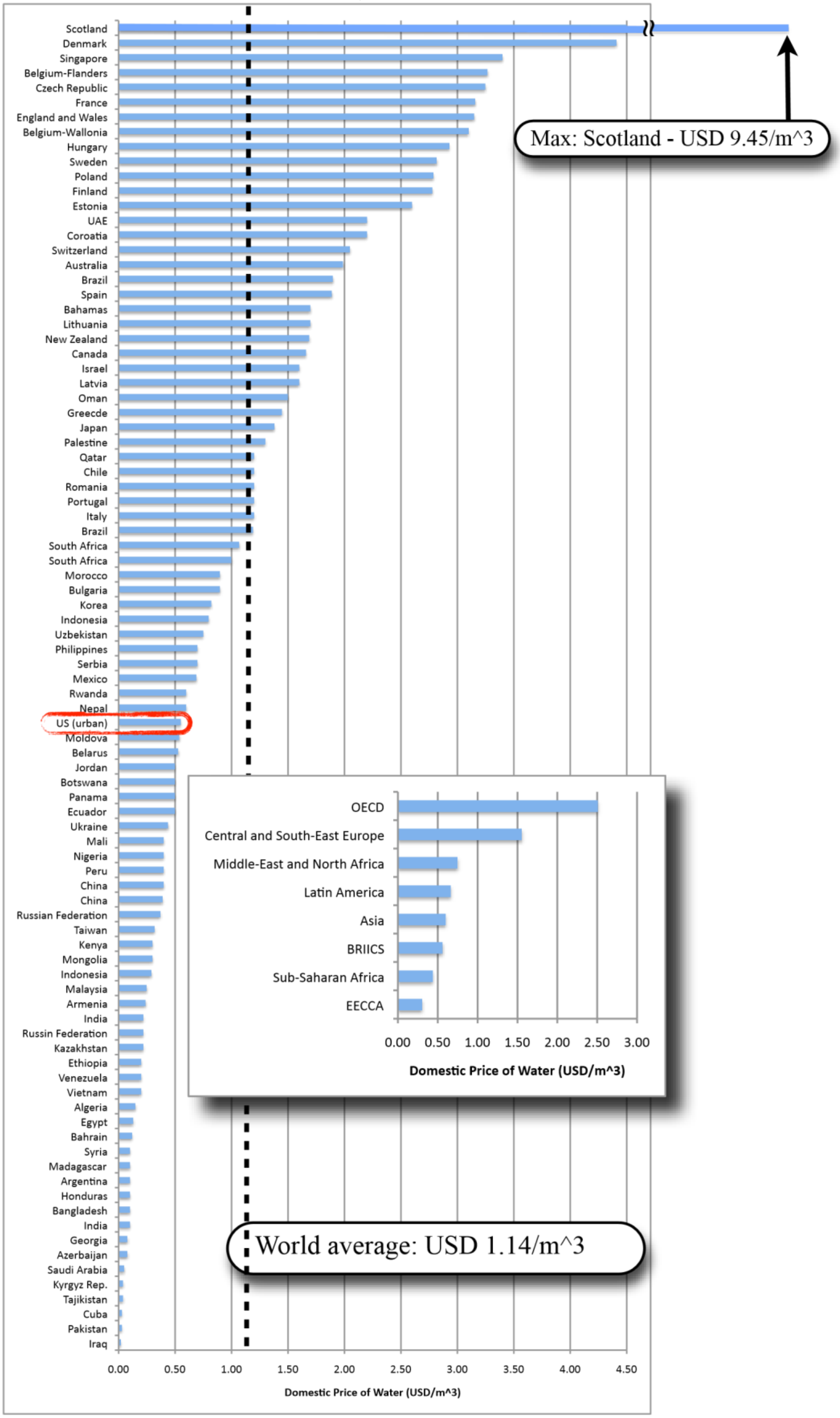
The world average cost of fresh water, calculated via the above analysis, and depicted graphically in the following figure, is roughly USD 1.14/m^3.

The OECD report argues that one should refrain from going too far in comparing water pricing levels across countries, which may really be of little use, sine averaging out local pricing levels can lead to price distortions. Within and across countries, prices might differ widely (e.g. the United States) because costs vary depending on the quality of available natural resources and other circumstances.

However, these rough numbers do provide a baseline against which desalination costs must be able to compete to be economically viable.

Figure 3 (next page)*: Domestic Price of water and wastewater services in USD/m^3 2009 adjusted for consumption purchasing power parity including taxes. The water and wastewater bill is computed based on an assumed national consumption of 15 m^3 per month per household. The data reported is estimated from information provided by utilities on average revenue per cubic meter, i.e. total annual revenue divided by the total volume of annual water sales, in different* *selected countries and regions around the world. (EECCA: Eastern Europe, Caucasus and Central Asia).*[5]

[5] Derived by JF Thye from data presented in GWI, 2008 and OECD, 2009a


Max: Scotland - USD 9.45/m^3
World average: USD 1.14/m^3
Scotland
Denmark
Singapore
Belgium-Flanders
Czech Republic
France
England and Wales
Belgium-Wallonia
Hungary
Sweden
Poland
Finland
Estonia
UAE
Coroatia
Switzerland
Australia
Brazil
Spain
Bahamas
Lithuania
New Zealand
Canada
Israel
Latvia
Oman
Greecde
Japan
Palestine
Qatar
Chile
Romania
Portugal
Italy
Brazil
South Africa
South Africa
Morocco
Bulgaria
Korea
Indonesia
Uzbekistan
Philippines
Serbia
Mexico
Rwanda
Nepal
US (urban)
Moldova
Belarus
Jordan
Botswana
Panama
Ecuador
Ukraine
Mali
Nigeria
Peru
China
China
Russian Federation
Taiwan
Kenya
Mongolia
Indonesia
Malaysia
Armenia
India
Russin Federation
Kazakhstan
Ethiopia
Venezuela
Vietnam
Algeria
Egypt
Bahrain
Syria
Madagascar
Argentina
Honduras
Bangladesh
India
Georgia
Azerbaijan
Saudi Arabia
Kyrgyz Rep.
Tajikistan
Cuba
Pakistan
Iraq
0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50
Domestic Price of Water (USD/m^3)
OECD
Central and South-East Europe
Middle-East and North Africa
Latin America
Asia
BRIICS
Sub-Saharan Africa
EECCA
0.00 0.50 1.00 1.50 2.00 2.50 3.00
Domestic Price of Water (USD/m^3)

History of Desalination

Desalination technologies treat seawater and brackish waters to produce freshwater, and in the process discharge a saltier wastewater concentrate stream. Global desalination water production capacity has increased exponentially since 1960, as shown in the Figure. Current online production capacity is estimated to exceed 42 million m^3/day[7], of which 37 million m^3/day are considered operational. This adds up to approximately 0.3 percent of average total anthropogenic freshwater use per day.[6]

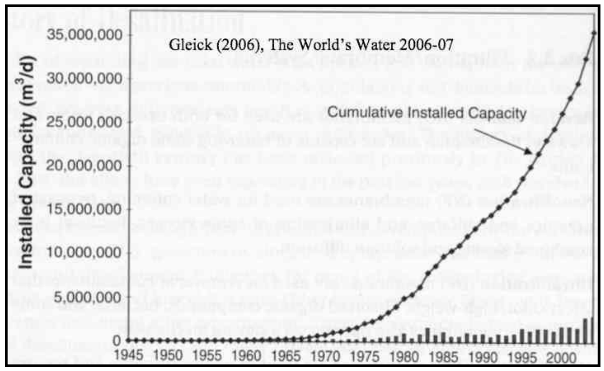
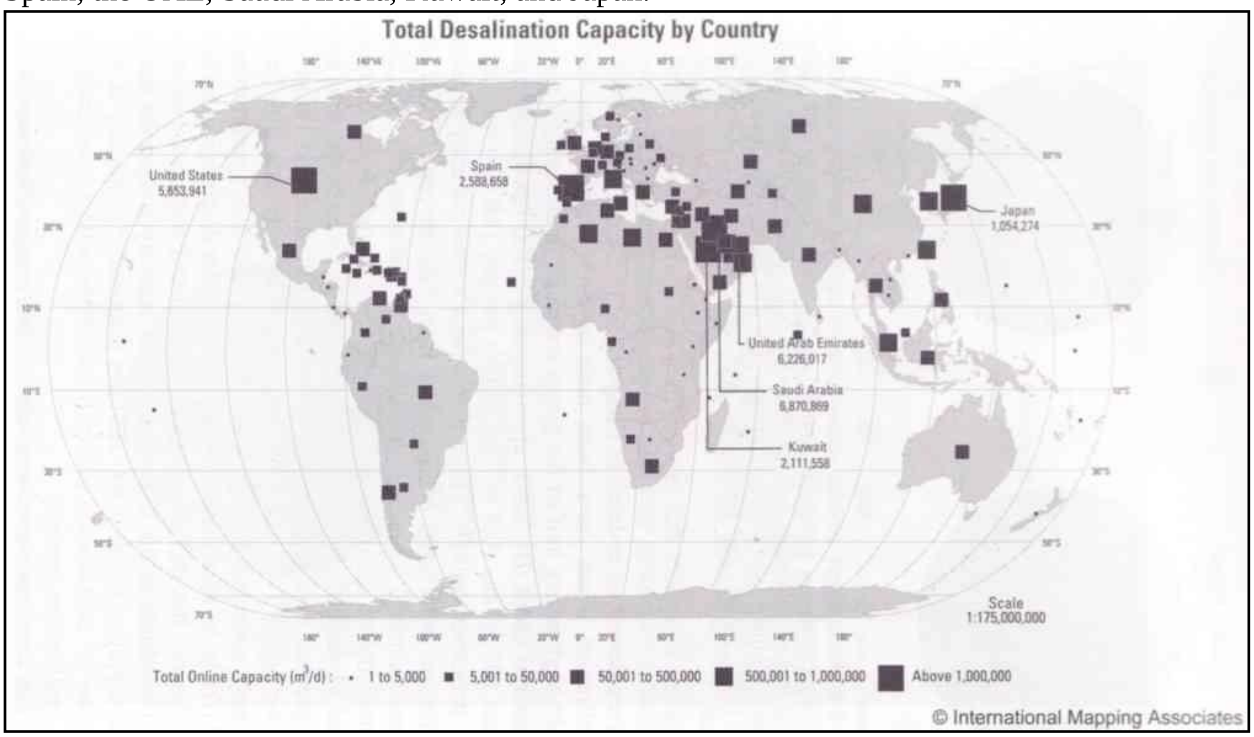


Figure 4*: Time-series of global desalination capacity to 2005.*

47 percent of the current online global desalination capacity is located in the Middle East. North America, Europe, and Asia each have about 15 percent of desalination capacity. The figure below illustrates the countries with the largest capacities, over 1 million M^3/day. These include the US, Spain, the UAE, Saudi Arabia, Kuwait, and Japan.



[7] GWI, 2006b

Figure 5*: Global online desalination capacity.*[7]

[6] Cooley et al., 2006

[7] GWI, 2006b

60% of global desalination capacity uses seawater, though this varies by country. In the US, for example, seawater desalination accounts for only 8%, with the majority of US desalination (77%) treating brackish water. As the figure below indicates, currently 18 countries have an installed capacity of more than one percent of the global total, of which the oil-rich nation of Saudi Arabia has the highest capacity with 6.9 million m^3/day, and the US and United Arab Emirates the second and third highest.

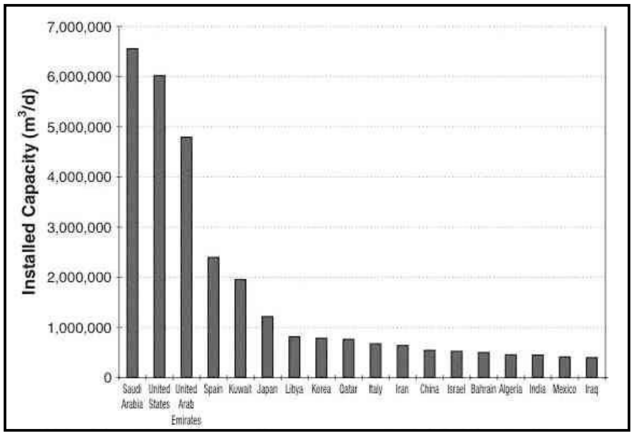


Figure 6*: Countries with more than 1% of global desalination capacity, January 2005. Total installed capacity in cubic meters per day.*[8]

Most of US desalination plant installations operate on the arid west coast and have benefited from a history of government subsidies and grants. The most significant US federal funding for desalination R&D, topping USD 180 million in 1966, was deployed between 1965 to 1973. Currently R&D is heavily funded through venture capital activity and financed through private, municipal, state, and sovereign wealth funds. The present private funding climate is a sign that the investment community and capital markets have recognized the urgency of water scarcity and the depletion of traditional clean water sources.

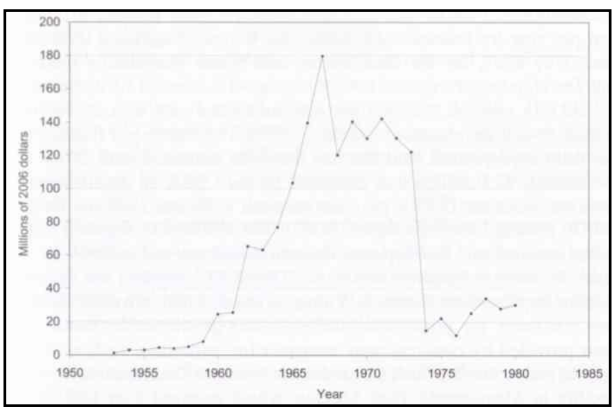


Figure 7*: Yearly US federal funding for desalination R&D between 1953 to 1980, as appropriated in constant 2006 USD. Based on data from the US General Accounting Office (1979) and the Bureau of Labor Statistics Consumer Price Index.*[9]

[8] Gleick et al., 2006-2007
[9] NRC, 2008

Desalination Water Quality Standards

Water salinity is defined and categorized by salt concentration and ranges from fresh, to brackish, to saline water. Most non-seawater resources have salinity up to 10 ppt (parts per thousand). Seawater salinity ranges from 35 to 45 ppt in total dissolved salts (TDS).[10] The figure below summarizes the parts per thousand salinity definitions for water. Of note is that seawater salinity has to be reduced approximately one hundred fold to be considered fresh drinking water. This ratio foreshadows the large amount of work, or energy, demanded to produce fresh water.

Fresh water	Brackish water	Saline water	Brine
< 0.5	0.5 – 30	30 – 50	> 50

***Figure 8**: Water salinity based on dissolved salts in parts per thousand (ppt).*[11]

The World Health Organization (WHO) states that a permissible salinity limit for potable drinking water is 0.5 ppt and 1.0 ppt under limited consumption.[12] The US Environmental Protection Agency (EPA) states that drinking water with TDS greater than 500 mg/L (0.5 ppt) can be distasteful. Brackish water has a salinity between that of fresh and and saline sea-water, and usually results from mixing of seawater with fresh water, as in estuaries, or in brackish fossil aquifers. In addition to removing salt, some desalination processes, like reverse osmosis, can remove many forms of minerals, suspended solids, viruses and organic compounds, such as algae and bacteria.[13]

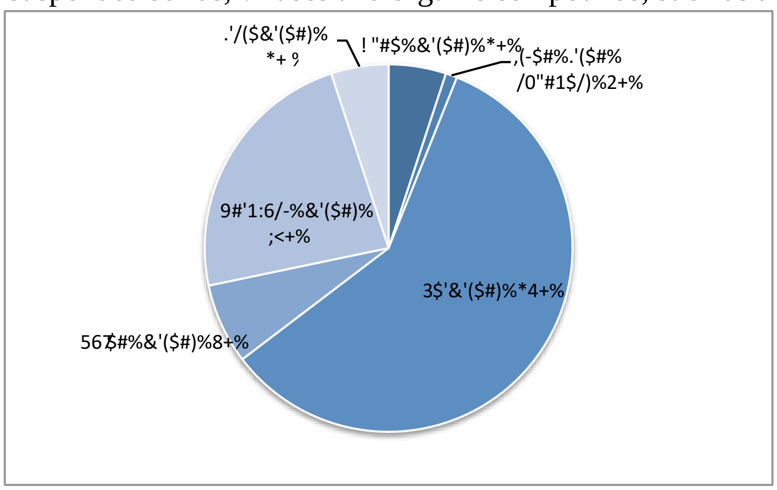


***Figure 9**: Global installed desalination capacity by feed water sources.*[14]

The figure above summarizes global feed water sources used by desalination plants. Of note is that currently 59% of operational desalination capacity uses seawater as a a primary source. Since seawater has the highest salt concentrations, it also requires the most energy to produce fresh water. However, its advantages are its virtually infinite abundance, as well as the proximity of desalination plants to the ocean, which allows for the dilution of the high density salt streams that

[10] Stumm and Morgan, 1996

[11] NRC, 2008

[12] WHO, 2003

[13] California Ocean Resources Management Program, 1997; Pantell, 1993

[14] IDA

are discharged from desalination plants as brine. The ecological impact of these waste streams are not within the scope of this paper, but should be carefully considered in the siting of any plant.

Desalination Technologies Review

Desalination plants and RESs are two completely different technology concepts that can be combined in a multitude of ways. Not all combinations of RES-powered desalination systems are practical or economic. To find optimal combinations between the systems, both technologies have to be evaluated for their behavioral and performance characteristics, which are then matched to create seamless interconnectivity.

RES and desalination technology matches are very site-specific, and optimal technology combinations are selected based on requirements and conditions, which include:

- geographic conditions
- topography of the site
- capacity requirements and plant size
- type and cost of fossil fuel energy available
- condition of local infrastructure, including ability to plug into the electricity grid
- feed water salinity and temperature

This section summarizes the key operational aspects of the current eight most popular desalination technologies, their strengths and weaknesses, their capacities, as well as their economics. The section is purposefully written in bullet points and tables in order to break out the most essential facts that carry weight in matching desalination systems to RESs.

Desalination System Key Operational Aspects

Desalination technologies are categorized into two main groups, thermal and membrane desalination. These are then broken down into subgroups that process salt water in technically very different ways. The following section discusses the operational aspects of the current eight most prominent desalination technologies, Multi-stage flash (MSF), Multi-effect Distillation (MED), Mechanical Vapor Compression (MVC) and Thermal Vapor Compression (TVC), Solar Distillation (SD), Reverse Osmosis (RO), Electro-dialysis (ED) and Electro-dialysis Reversal (EDR):

1. **<u>Thermal desalination includes:</u>**

▸ **Multi-stage flash (MSF)**

- MSF is the most dominant in the thermal category, at 90% of all thermal production and 42% total world desalination production.[15]
- It is the most robust of all desalination technologies, able to process water at a very high rate with little maintenance.[18]
- MSF is capable of very large yields. Currently the largest plants are operating and under construction in Saudi Arabia and the United Arab Emirates, having design capacities of 600,000 to 880,000 m^3/day (Saudi Arabia’s Shuaiba III, Ras Al-Xour and Al Jobail II Ex plants being the largest at 730,000 to 880,000 m^3/day and The UAE’s Jebel Ali M plant operating at a 600,000 m^3/day capacity).[16][17]
- Globally MSF is among the most commonly used desalination technology.
- It operates using a series of 4 to 40 chambers, or stages, each with successively lower temperature and pressure, to rapidly vaporize water, which is condensed afterwards to form fresh water.
- MSF operates at top brine temperatures of 90-120 degC. Higher temperature than this induces scaling, the precipitation and formation of hard mineral deposits such as manganese oxides, aluminum hydroxide, and calcium carbonate.
- Cost of plant depends on the performance ratio, water production over levelized cost.
- Capital and energy costs are the highest of all desalination technologies.

▸ **Multi-effect distillation (MED)**

- This is a thin-film evaporative technology, where vapor produced by 8-16 chambers (the “effect”) subsequently condenses into distillate in the following chamber group

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[15] IDA, 2002

[18] He et al.

[16] Pacific Institute, 2005

(the “second effect”) by reducing ambient pressure. MED plants utilize low grade input steam to produce the distillate through repetitive steps of evaporation and condensation, each at a lower temperature and pressure.[18]

- Operates at lower temperatures than MSF. The newest max out at 70 degC.
- MED is actually the first desalination technology used for seawater, and was developed by the chemical industry.
- Units are generally built at capacities of 600 to 30,000 m^3/day.
- Cost of plant depends on the performance ratio, water production over levelized cost.
- Capital costs are slightly lower than MSF, but and energy costs are generally the same as MSF and therefore significant.

▸ **Mechanical Vapor Compression (MVC) and Thermal Vapor Compression (TVC)**

- VC was used since late 19th century.
- It operates at small and medium scale capacities between 20 to 25,000 m^3/day.
- Units are very compact and transportable, making them attractive for the military.
- *Mechanical vapor compression (MVC)*:
  - The high pressure blower of the MVC plant are fluid flow machines with similar characteristics to wind turbine mechanics, aligning them theoretically well for a RES-desalination technology match on a stochastic interconnectivity basis. There is therefore a natural affinity between the technologies. By variation of the compressor speed and the evaporation temperature, the power consumption can be adapted to rapid changes in energy input (i.e. wind conditions).
- *Thermal vapor compression (TVC)*:
  - The hot feed water enters evaporator, where it is heated (rather than compressed as in the MVC) to boiling point and some of it evaporated. The vapor formed goes to compressor where pressure and saturation temperature is raised. Compressed vapor is fed back to evaporator to be condensed, providing the thermal energy to evaporate the seawater in a separate loop.
- Power consumption is significant and depends on this pressure difference. The compressor therefore represents main energy consumption in the system.

▸ **Solar Distillation (SD)**

- In and SD solar radiation is trapped in solar still, a shallow basin lined with black energy absorbent material with a transparent roof acting as condenser. This technology therefore operates under principals of greenhouse effect. Vapor produced by seawater is condensed on the cool surface of the roof.
- SD is simple and robust in operation and was deployed mainly in 1960s and 70s.
- It has been used in small scale applications, producing approximately 2.5 liters per m^2 of panel surface, at a thermal efficiency of 50%.

[18] IDE-Tech: http://www.ide-tech.com/files/990b0fa01310a9c82f841f2183e9ebcb/downloadchapter/2010/01/MED%20Brochure.pdf

- Though electricity retirements for pumping are minimal, construction costs and large land area requirements have led to the fall of its popularity.

2. <u>Membrane desalination:</u>

▸ **Reverse Osmosis (RO)**

- RO is the most dominant membrane desalination technology, at 88% of all membrane production and 46% total world production capacity.[19] It is also said to be the most commonly deployed technology, not taking capacity into account.
- RO has four subsystems: 1) pre-treatment; 2) high pressure pump; 3) membrane modules; and 4) post-treatment.
- Feed water pre-treatment involves filtration, sterilization, and addition of chemicals to prevent scaling and biofouling. Pre-treatment is critical due to membrane sensitivity.
- The desalination event happens when water is forced across a membrane surface at 17-27 bar for brackish water (BWRO) and 55-82 bar for sea water (SWRO). The *product*, or *permeate,* water passes through the membrane, having the majority of its dissolved solids removed. The salt concentrated *reject stream*, or *brine*, emerges at high pressure. In large plants the brine pressure energy is recovered by a turbine or Clark Pump (common in new stand-alone RES-desalination hybrids), recovering 20%-40% of energy.
- Membranes are designed to yield a permeate water of approximately 500 ppm TDS.[20][21]-Two types of RO membranes are used: 1) Spiral wound (SW); and 2) Hollow fiber (HF). Their use is dependent on cost, feed water quality and product water capacity.
- RO systems are available in a wide range of capacities due to their modular design with the largest operational plant having a capacity of 320,000 m^3/day in Israel at Ashkelon. The smallest capacity is approximately 0.1 m^3/day for marine and household purposes.
- RO systems may have one to hundreds of thousands of modules in racks and therefore exhibit an attractive scalability. Reverse osmosis is, with regard to pretreatment, membrane fouling, after-treatment and efficiency of the high pressure pumps, a process that is rather sensitive to a stop- and-go operation.
- Generally, RO has low capital cost, but significant maintenance costs due to the high cost of membrane replacement. The Cost of energy (which is all electrical) used per m^3 is significant, but less than MSF and MED. The majority of RO energy is required to drive the high pressure feed water pump system.

▸ **Electro-dialysis (ED) and Electro-dialysis Reversal (EDR)** - ED and EDR are low cost method for brackish water desalination.

- Both technologies are *Economically unattractive for seawater* due their drastically increased energy costs at higher ppm total dissolved salts (TDS).

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[19] IDA, 2002

[20] Loupasis, 2002

- The process works by transporting ions through a membrane by an electrical field that is applied across the membrane, creating a region of low salinity water.
- ED and EDR produce water around 20 ppm TDS.[22]
- EDR induces a membrane self-cleaning process by inhibiting the deposition of inorganic scales and colloidal substances. [23]
- ED went commercial in 1954 and EDR in the 1970s, and 31% of US desalination capacity is ED/EDR.
- ED and EDR is economically attractive only for low salinity brackish water.

[22] Loupasis, 2002

[23] ibid

Global Installation of Desalination Technologies

The figure below is an incomplete summary of globally deployed desalination technologies, as the United Arab Emirates, Israel and Japan, who individually have some of the world's largest country-wide desalination capacities, are not included. However, the table demonstrates that MSF is by far the most popular installed technology, measured by capacity. MSF is the primary technology used in Saudi Arabia. Of note is that oil rich nations, such as Saudi Arabia and Kuwait, have higher MSF installations, while nations with smaller or no oil reserves prefer RO, expect for Italy, who has a fairly large MSF installation of of 55% total capacity.

Country	MSF	MED	VC	RO	ED	Total	%
Saudi Arabia	2700		50	1000	94	3844	48.8
USA	50	50	130	1600	280	2110	26.8
Kuwait	350			50		400	5.1
Libya	400			130	67	597	7.6
Spain	56		40	230	45	371	4.7
Italy	200		75	40	50	365	4.6
Algeria	60		30	80	16	186	2.4
Total	3816	50	325	3130	552	7873	100
Percent (%)	48.5	0.6	4.1	39.8	7.0	100	

Figure 10*: Installed Desalination Plant Capacity (000s m^3/day).*[24]

Desalination System Operational Economics

This paper explores the private costs of desalinated water production. These are costs that are internalized within the operation of the project and are borne by the operator. They include the initial investment cost plus the operating and maintenance costs, which break up into wages, interest payments, energy, and equipment upgrades. As a rule of thumb, seawater desalination costs are 3 to 5 times higher than brackish water costs.[25]

Public costs, on the other hand, are real costs externalized by the plant operator. These are borne by the public at large, and may include operational nuisances or environmental damages caused by the desalination process. Public costs may include environmental impacts from brine discharge, feed water intake, or wind turbine or solar panel nuisances. These costs vary by project and range from zero to very significant, depending on location. Public costs are not discussed in this paper, as they are still widely debated. Public benefits, beyond the basic demand for clean water, are also not discussed in detail, as the paper's objective is to quantify the private costs and technical capabilities of modern desalination plants and their coupling costs to RES.
Factors that have the largest effect on the cost of desalination:

[24] Loupasis, 2002

[25] ibid

1. Feed water quality (i.e.. the salinity level) [26]
2. Product water quality specifications [27]
3. Energy costs
4. Economies of scale

Costs of desalinated water production have dropped considerably over the years as a result of reduced property plant and equipment (PP&E) costs, improved desalination efficiency, and improvements in system design, robustness, and operational ease. Input energy prices have risen, however, countering decreasing operational costs. Even so, total net levelized project costs have experienced a significant downward trend with time. As conventional water prices rise due to pollution and overexploitation of water resources, desalinated water is becoming a viable alternative water source.

The figures below compare the total capital and operations cost per m^3 of water for 100,000 m^3 seawater RO, MSF, MED (the three most popular commercial world-wide desalination technologies) desalination plants. The left figure below shows levelized costs, while the right figure summarizes the percentile costs breakouts for RO, MSF, MED.

Of note is that RO has no thermal energy costs, as only electric energy is used. This is a powerful aspect of the technology that enables effective coupling with RESs. RO electrical energy costs are high at 38% total costs and USD 0.23/m^3, while MSF and MED only have 21% and 8% total electricity costs, USD 0.19 and USD 0.06/m^3 respectively.

For MSF and MED electricity meets only part of the plant’s energy requirements, while thermal energy inputs represent anther 30% and 38% of total production cost respectively. In comparison, energy costs are not only lower for RO, but represent a smaller portion of the production cost. However, the variable cost of labor is slightly higher for RO, by approximately 6% of project cost and USD 0.02/m^3. This is a reflection of the membrane maintenance requirements and lack of RO plant robustness.

Besides the RO pure electricity energy requirement, another vital point for considering RO matching with a RES, is that RO is an overall cheaper technology by approximately USD 0.30/m^3 compared to MSF and USD 0.10/m^3 compared to MED.

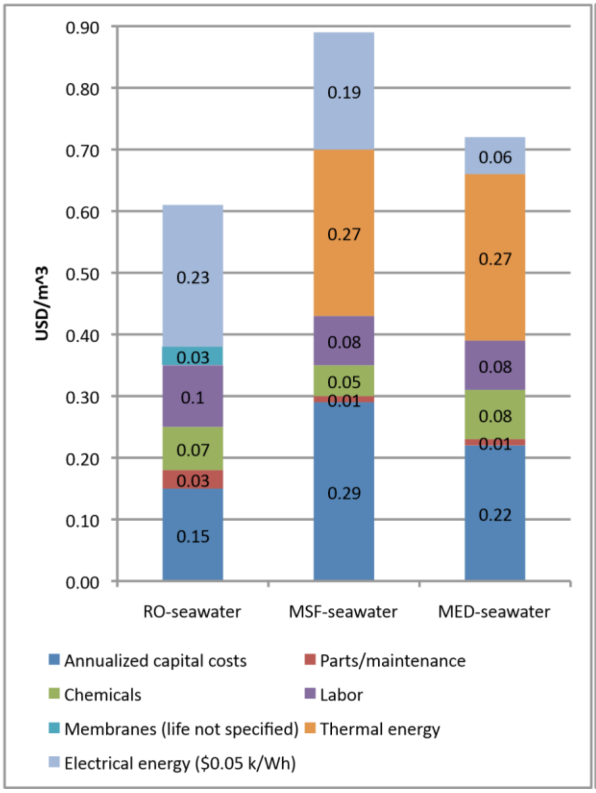
Additionally, as shown in the figure below, RO annualized capital costs have a lower percentile and total cost. They are lower for RO compared to other traditional desalination technologies for a number of reasons. First, RO depend on electric energy prices usually set by the open market on the grid, which arguably is cheaper than owning your own power plant (required for MSF and MED) due to the grid’s ability to diversify operator risk and create market and price efficiency.

[26] Alatiqi et. al., 1999

[27] Dore, 2005

Second, MSF and MED desalination technologies have a larger upfront construction cost, compared to RO membrane banks and pump systems.

A serious consideration in RO financing and RES matching is that, net of the electricity cost, the annualized capital cost (25% total cost) is the next largest cost item per m^3. A study by Zejli on Moroccan RO-wind projects, discussed later in the paper, finds that in a RO-wind match the project's total economic cost is actually more sensitive to annualized capital cost variability than to changes in wind patterns and RES electricity inputs.[28]



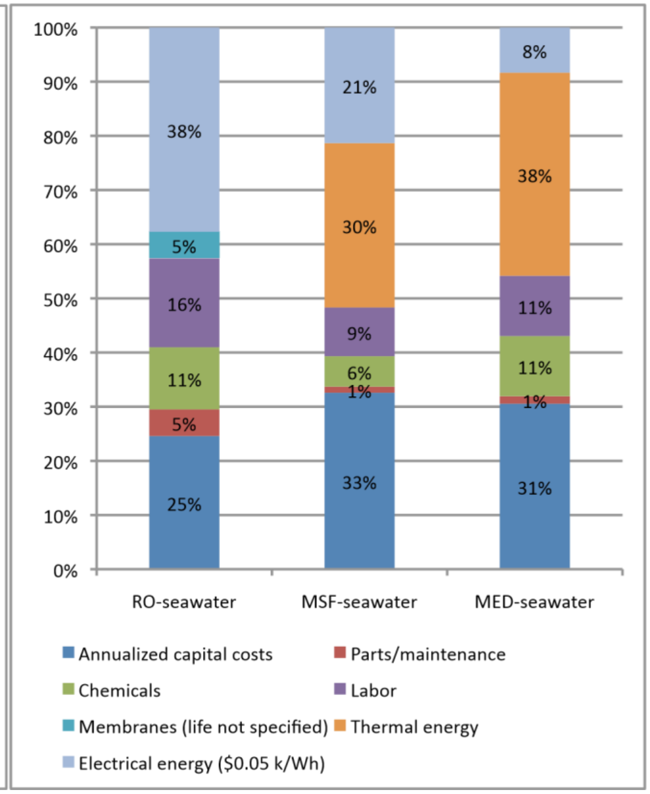


Figure 11 *(left): Comparative total capital and operations cost data for 100,000 m^3 of seawater by reverse osmosis, multistage flash, and multi-effect distillation.*[29]

Figure 12 *(right): Comparative percentile capital and operations cost for 100,000 m^3 of seawater by reverse osmosis, multistage flash, and multi-effect distillation.*[30]

The figure below highlights additional desalination plant cost data presented by Loupasis.[31] A significant conclusion from this table is the large spread of total costs per m^3 of permeate in the last column, as well as the difference in cost for RO sea- and brackish water. Loupasis costs are generally higher than the NRC-based costs in the figure above, presumably because Loupasis's the

[28] Zejli et al., 2004

[29] Derived by JF Thye from data presented in NRC, 2008

[30] Derived by JF Thye from data presented in NRC, 2008

[31] Derived by JF Thye from data presented in Loupasis, 2002

data is six years older. The table also underscores the variability of project costs due to geographic location, technology, time horizon, and source water that was alluded to earlier.

	Investment in plant capacity		Energy		Consumable		Labour		Maintenance		O&M		**Total Cost, w/o Investment**	
	USD/m^3 day		USD/m^3		USD/m^3		USD/m^3		USD/m^3		USD/m^3		USD/m^3	
Process	low	high	low	high	low	high	low	high	low	high	low	high	**low**	**high**
MSF	1,000	2,000	0.60	1.8	0.03	0.09	0.03	0.20	0.02	0.06	0.68	2.15	**1.36**	**4.30**
MED	900	1,800	0.38	1.12	0.02	0.15	0.03	0.20	0.02	0.06	0.45	1.53	**0.90**	**3.06**
VC	900	2,500	0.56	2.4	0.02	0.15	0.03	0.20	0.02	0.08	0.63	2.83	**1.26**	**5.66**
SWRO	800	1,600	0.32	1.28	0.09	0.25	0.03	0.20	0.02	0.05	0.46	1.78	**0.92**	**3.56**
BWRO	200	500	0.04	0.4	0.05	0.13	0.03	0.20	0.004	0.02	0.12	0.75	**0.24**	**1.50**
ED	266	328	0.06	0.4	0.05	0.13	0.03	0.20	0.006	0.009	0.15	0.74	**0.30**	**1.48**

***Figure 13**: Total specific costs of the major desalination processes (assume USD/Euro exchange rate was approximately 1:1 in 2002).*[32]

Desalination plants in California have shown a significant degrease in cost from $1.60/m^3 in 1990 to $0.63/m^3 in 2002.[33] In 2004 Abu Dhabi completed a 190,000 m^3/day MSF plant with which they claim to produce water at $0.70/m^3,[34] though certainly cheap local oil supply subsidizes this low cost.

The figure below is a compilation of seawater desalination project costs per m^3 of freshwater production in 2009 USD. This cost data is derived from projects built since 2000 and is therefore partly influenced by the decrease in technology costs and the increase of energy costs. However, the graph depicts the importance of project scalability, demonstrating a dramatic decrease of cost between zero and 20,000 m^3/day of permeate. Therefore, in considering RES-desalination technology matches at commercial capacity levels we need to consider the dramatic marginal savings that occur over 10,000 m^3/day. The Mechanical Vapor Compression Curve (MVC) is a serious contender to the RO curve, as MVC costs are significantly below RO costs at 20,000 m^3 by approximately USD 0.75/m^3.

However, as the technology review above demonstrated, MVC plants are currently limited in capacity to under 25,000 m^3, making RO the most cost effective desalination capacity currently available for yields above 40,000 m^3/day.

[32] Derived by JF Thye from data presented in Loupasis, 2002

[33] Chaudhry, 2004

[34] Awerbuch, 2004

Type of system: capacity in m^3/day	Unit product cost, $/m^3
MVC	
114	5.00
492	3.22
4,013	2.48
4,542	2.43
19,987	0.46
RO	
114	2.37
4,013	1.98
4,542	1.29
37,816	1.09
39,974	0.83
45,425	0.68
113,562	0.55
MSF	
26,990	1.57
31,987	1.44
37,816	1.25
MEE	
22,712	1.24
37,816	1.08
TVC	
22,145	1.55

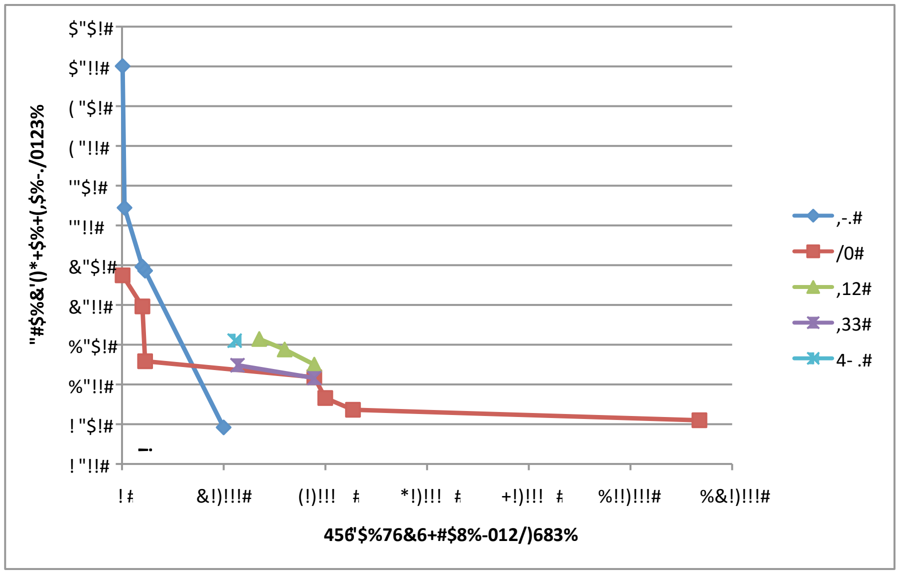


***Figure 14**: Unit product costs for seawater desalination processes.*[35]

Appendix III includes a summary of reported first year cost of product water from RO Plants.[36]

Desalination System Energy Economics

The Figure below, reveals that VC, RO, and ED have the lowest energy requirements per m^3 of permeate. For compatibility with a REDS this technology characteristic is critical. ED technology can only be deployed in brackish water, leaving us to compare the next two most efficient technologies, VC and RO. As a baseline comparison, the theoretical minimum energy requirement for desalination is 0.83 kWh/m^3.[37]

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[35] Derived by JF Thye from data presented in Eltawil et. al., 2009

[36] Gleick et al., 2006-2007

[37] NRC, 2008

Process	Feed Water Type	Energy Source	Product Water Quality (ppm TDS)	Typical Max Plant Capacities (m^3/day)	Typical Energy Requirements (kWh_e/m^3)
Multi-Stage Flash Distillation (MSF)	Seawater	Steam	~10	5,000-60,000	10-14.5
Multiple-Effect Distillation (MED)	Seawater	Steam	~10	5,000-20,000	6-9
Vapor Compression (VC)	Seawater	Electricity	~10	2,400	7-15
Sea Water Reverse Osmosis (SWRO)	Seawater	Electricity	~350-500	128,000	4-6* 7-13**
Brackish Water Reverse Osmosis (BWRO)	Brackish	Electricity	~350-500	98,000	.5-2.5
Electrodialysis (ED)	Brackish	Electricity	~350-500	45,000	.7-2.5

Note: *with energy recovery **without energy recovery

Figure 15*: Characteristics of the major desalination processes.*[38]

Traditionally, VC plants have operated under smaller maximum plant capacities than RO (2,400 m^3/day for VC vs. plants up to 100,000 to 200,000 m^3/day for RO). Compared to VC, RO is also 1 to 9 kWh/m^3 of water more energy efficient with seawater as feedstock. Assuming a commercial electricity cost of 0.05 $/kW, RO can be approximately 0.05 $/m^3 to 0.45 $/m^3 cheaper than VC just by energy demand costs, highlighting RO as the clear frontrunner in energy efficiently.

Summary of Pros and Cons of Desalination Technologies

This sections tabulates that advantages and disadvantages of desalination technologies. Bolded sentences mark significant technology characteristics that note compatibility (in the Pros column) and non-compatibility (in the Cons column) for RES matching. The water recovery and total dissolved solids (TDS) column is included to evaluate the system’s productivity and versatility. High water recovery means a low brine stream and high permeate to brine ratio.

Energy efficiency is improved by higher water recovery percentiles. Energy efficiency is a fundamentally important characteristic for matching, as high efficiencies allow for use of smaller RES plants, which lowers the project and ultimately water production cost.

Process	Recovery and TDS	Pros	Cons

[38] Loupasis, 2002

RO	• 30–60% recovery possible for single pass (higher recoveries are possible for multiple pass or waters with lower salinity) • <500 mg/L TDS for seawater possible and <less 200 mg/L TDS for brackish water	• **Lower energy consumption** • **Relatively lower investment cost** • No cooling water flow • **Simple operation and fast start-up** • High space/production capacity • Removal of contaminants other than salts achieved • Modular design • Maintenance does not require entire plant to shutdown • Energy usage proportional to salts removed not volume treated • Higher membrane life of 7–10 years • **Operational at low to moderate pressures**	• Higher costs for chemical and membrane replacement • Vulnerable to feed water quality changes Adequate pre-treatment a necessity Membranes susceptible to biofouling • Mechanical failures due to high pressure operation possible • Appropriately trained and qualified personnel recommended • Minimum membrane life expectancy around 5–7 years
ED/EDR	• 85–94% recovery possible • 140–600 mg/L TDS	• Energy usage proportional to salts removed not volume treated • Higher membrane life of 7–10 years Operational at low to moderate pressures	• **Only suitable for feed water up to 12,000 mg/L TDS** • Periodic cleaning of membranes required Leaks may occur in membrane stacks • Bacterial contaminants not removed by system and post-treatment required for potable water use
MSF	• 25–50% recovery in high temperature recyclable MSF plant • <50 mg/L TDS	• Lends itself to large capacity designs • Proven, reliable technology with long operating life Flashing rather than boiling reduces incidence of scaling • Minimal pre-treatment of feed water required High quality product water Plant process and cost independent of salinity level • Heat energy can be sourced by combining with power generation	• **Energy intensive process** • Large capital investment required • Larger footprint required (land and material) • Corrosion problems if materials of lesser quality used • Slow start-up rates • Maintenance requires entire plant to shut-down • High level of technical knowledge required • Recovery ratio low
MED	• 0–65% recovery possible • <10 mg/L TDS	• Large economies of scale • Minimal pre-treatment of feed water required • Very reliable process with minimal requirements for operational staff • Tolerates normal levels of suspended and biological matter • Heat energy can be sourced by combining with power generation • Very high quality product water	• **High energy consumption** • High capital and operational cost • High quality materials required as process is susceptible to corrosion • Product water requires cooling and blending prior to being used for potable water needs
VC	• VC (Vapor Compression Desalination) - mechanical and thermal • 50% recovery possible • <10 mg/L TDS	• Developed process with low consumption of chemicals economic with high salinity (>50,000 mg/L) • Smaller economies of scale (up to 10,000 m3/d) • **Relatively low energy demand** • Lower temperature requirements reduce potential of scale and corrosion Lower capital and operating costs Portable designs allow flexibility • **Ability to rapidly adjust to flux changes.**	• **Limited to smaller sized plants** • Start-up require auxiliary heating source to generate vapor • **Compressor needs higher levels of maintenance**

Figure 16 (previous page): *Desalination characteristics comparison table with recovery and total dissolved solids (TDS) treatment capability, and pros and cons of desalination processes.*[39]

As a result, an initial review of the desalination technology characteristics table above indicates that RO, from an engineering perspective, is a leader in RES matching due to its lower energy consumption, lower investment cost, simple operation, fast start-up capability, and operational ability at low to moderate pressures, all of which indicate a superior ability to handle low to high electric energy inputs from stochastic renewable energy sources.

The VC technology is also attractive for RES matching due to its relatively low energy demand and ability to rapidly adjust to flux changes. However, VC is limited to smaller plant sizes and its compressor requires higher levels of maintenance (i.e. exhibits a low level of robustness).

Appendix I includes a more detailed comparison table between distillation (MSF and MED) and RO desalination processes.[40]

[39] Eltawil, 2009 with added comments by JF Thye

[40] Al-Mutaz, 2000

RES Economics

Figure 17, on the next page, is a summary of RES 2005 estimated- and 2020 projected costs. The wind electricity per kWh costs are highlighted with a red circle because they are clearly much lower than other renewable energy sources. It should be said, that the wind cost numbers are optimistic, as the US wind industry estimates the current cost of on-shore wind power to be between 5 to 7 cents/kWh (including subsidies such as production tax credits and renewable energy certificates), depending on wind resource conditions (i.e. flat and windy central plains vs. hilly and less predictable New England terrain).[41] However, even the revised wind cost numbers are still competitive with expensive coal. In comparison, solar thermal electricity is approximately twice as expensive as wind energy, and PV electricity is currently three times more expensive than wind per kWh.[42] Though PV and solar thermal are expected to become cheaper, wind energy remains an economic front runner at approximately twice to three times the US grid cost.

[41] http://www.awea.org/faq/wwt_costs.html#How%20much%20does%20wind%20energy%20cost

[42] Jefferies, 2009

Technology	Current Cost (US cents/kWh)		Projected future costs beyond 2020 (US cents/kWh)	
	Min	Max	Min	Max
Biomass Energy				
Electricity	5	15	4	10
Heat	1	5	1	5
Wind electricity				
Onshore	3	5	2	3
Offshore	6	10	2	5
Solar thermal electricity				
Insulation of 2,500 kWh/m^2/year	12	18	4	10
Hydro-Electricity				
Large scale	2	8	2	8
Small scale	4	10	3	10
Geothermal energy				
Electricity	2	10	1	8
Heat	0.5	5	0.5	5
Marine energy				
Tidal barrage (e.g. the proposed seven barrage)	12	12	12	12
Tidal stream	8	15	8	15
Wave	8	20	5	7
Grid connected photovoltaics, according to incident solar energy (insulation)				
1,000 kWh/m^2/year (e.g. UK)	50	80	8	8
1,500 kWh/m^2/year (e.g. Southern Europe)	30	50	5	5
2,500 kWh/m^2/year (most developing countries)	20	40	4	4
Stand alone photovoltaics				
2,500 kWh/m^2/year (incl. batteries)	40	60	10	10
Nuclear Power				
Average grid supply	4	6	3	5
Electricity grid supplies fossil fuels (incl. T&D)				
Off-peak	2	3 *		
Peak	15	25		
Average	8	10		
Rural electrification	25	80		
Cost of central grid supplies, excl. transmission and distribution				
Natural gas	2	4 *		
Coal	3	5		

Notes:
*Capital costs will come down with technical progress, but many technologies already mature may be offset by rising fuel costs.

Figure 17: *Cost of RES compared to fossil fuels and nuclear power.*[43]

Taking into account that stand-alone REDS are often operated far away from grid interconnectivity, or are powered by municipal diesel generator plants that have risk exposure to oil price fluctuations, as well as high transport costs, wind power offers an overall attractive economic package for REDSs.

Coupling RES with Desalination

Historically RES-desalination system (REDSs) match-ups were designed to operate under constant energy inputs, coupled to the grid or powered by backup diesel powered generators in remote location to supply power during low RES production. Off-grid, stand-alone, or autonomous REDSs pose the problem of renewable energy input variability, or stochastic energy production. Unpredictable and stochastic energy inputs force the desalination plant to operate in non-optimal conditions and may cause operational and technical problems. Today's RES lack the vital large-scale energy storage capacity (i.e. large battery or fuel cell banks) that could levelize electric energy production and enable an even and predictable power supply. High capacity electricity

[43] Derived by JF Thye from data presented in RES, 2005

storage is under development, but is still many years away from being an economically competitive solution.

Commonly today the grid acts as a buffer and battery for commercial wind and solar electricity production, and a number of commercial RO plants around the globe use this solution as a component of power purchase agreements with large scale wind farms, such as the 140,000 m^3/ day Australian Perth Seawater RO plant.[44] The Perth RO plant is actually connected to the grid and uses grid electricity, which is provided by the wind farm and other traditional power plant sources. On low-wind days, the RO plant is not forced to scale back production, as grid thermal power plants can scale up electricity production and meet the RO plant energy needs beyond the power available from the wind farm. Similarly, on high-windy days, wind farm electricity production may exceed the RO plant needs, causing overflow wind-generated electricity to be absorbed and sold into grid. This net metering-type energy sharing arrangement is estimated to break even over time, allowing wind-generated electricity to match the annual RO plant electricity input requirements.

A stand-alone REDS has two choices to manage its energy flow:

1. **To store excess power** availability, as power production levels vary with time due to wind speed or solar irradiance changes. If power is not consumed immediately, and can not be stored due to inadequate storage capacity, it must be shed via a resistor bank and will be lost. Currently, this large scale energy storage option is the less optimal choice due to a lack of economically viable technological solutions.
2. **To optimize desalination mechanics through power matching** by scaling desalination system electricity demand and production capacity in relation to electricity load availability, while also considering power requirements for the desalination system startup and shutdown sequences, which are essential to maintaining most desalination systems’ integrity and longevity (except for vapor compression desalination). A small energy storage system, such as gravity water storage, a hydrogen fuel cell, a battery bank, a small natural gas or diesel generator, or thermal bank (for solar thermal energy) may be used to power system management controls and provide the temporary energy needed to enable system startup and shutdown cycles. Though this solution adds to total system cost, which will be discussed in greater detail in the case study section below, it is currently the more viable economic alternative for REDSs. This solution, in essence, allows the water storage facility that is fed by the desalination plant to become a battery, which is charged by excess production and used in low energy and low output cycles.

REDS Technology Matching

RESs that are generally considered as energy sources for desalination are wind, solar thermal, photovoltaic and geothermal. The matching of renewable energy sources to desalination processes is a technical and economic challenge with problems caused primarily by RES stochastic power

[44] http://www.water-technology.net/projects/perth/

outputs and the RES significant up-front capital costs, which is generally larger per kilowatt compared to traditional thermal plants. However, once constructed, RESs require no fuel inputs. It is therefore important to compare total levelized RES costs with those of their thermal counterparts, which must include fuel inputs.

As concluded above, the principal of power matching is of paramount importance in designing an autonomous REDS. Power supplied by the RES must equate to that being consumed by the desalination process. The central challenge is to create a system architecture and control mechanism that will achieve this balance.

The following three power matching strategies are currently implemented to optimize RES and desalination technology combinations:[45]

1. **Power side management** provides the desalination plant with power on demand. Therefore the power supply is designed to produce a fixed output independent of prevailing energy conditions. For this a hybrid power package with numerous power sources is required (e.g. RES combined with batteries, flywheels, or non-renewable power units). Power side management implies redundancy in the power plant.
2. **Load side management** dissipates excess power. In this architecture power is produced by a stand-alone RES and load matching is achieved by 1) switching desalination modules bundled in clusters on and off or 2) adjusting and over designing the desalination plant to deviate from its optimal operating levels (i.e. head difference and/or flow rate) without breaking. Load side management implies redundancy in the desalination plant.
3. **Integrated management** minimizes dependance on non-RESs by determining long-term averages for RES power inputs and then controlling the system to limit power delivery to these lower levels for which the desalination plant is optimized.

The relative capital costs between all three options determines how applicable a match is. The figure below summarizes feasible RES and desalination technology combinations. Geothermal technologies are not discussed in this paper.[46] This decision tree technology chart summarizes technology match limitations and will be used as a guide for later discussions on wind, PV, and solar thermal REDS matches. For example, wind-electric RESs can be matched with RO, ED, and MVC. Wind-shaft RESs (a non-electrical purely mechanical link between the systems) can only

[45] Al-Alawi, 2004

[46] Geothermal electric power plants produce constant and non-stochastic thermal loads and electricity, similar to that of fossil fuel power plants and grid electricity. They therefore do not pose the stochastic power match challenge and are typically matched with traditional desalination technologies. Geothermal power production drawbacks is its high cost of capital and geographic constraints. Of note is that geothermal RESs my supply power in the form of heat and electricity, as well as allow for a co-generative waste heat capability. A geothermal energy source would therefore be ideal for a standard electric RO or low grade thermal energy connection, such as a MED or VC desalination technology.

function with RO and MVC, as ED requires electricity for the separation of salts from water, while RO and MVC are mechanical processes whose pumps can be powered by either an electric input or a mechanical drive shaft.

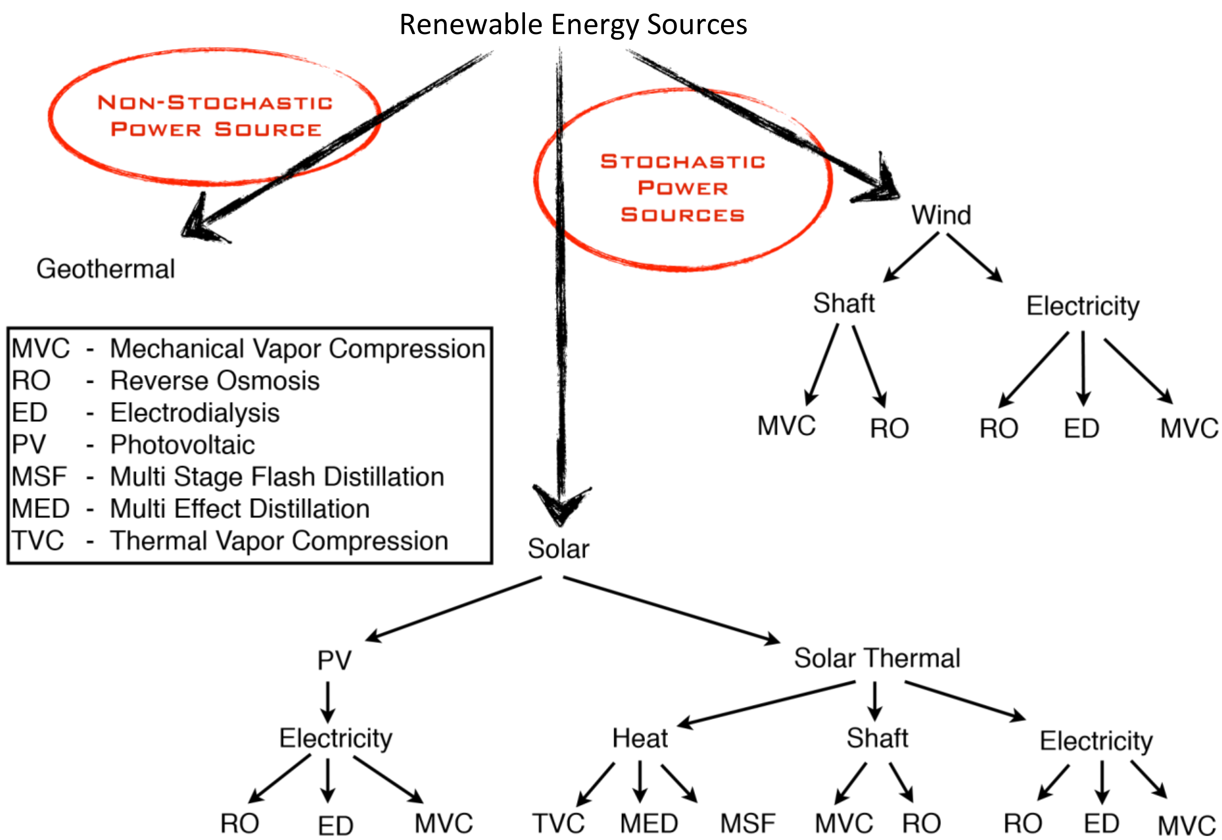
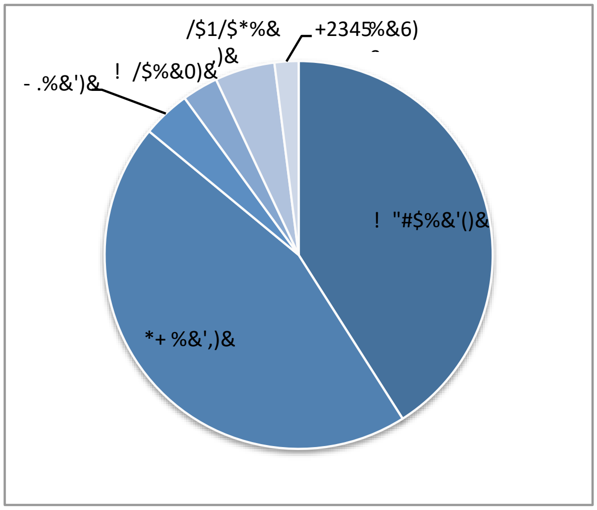


***Figure 18**: Technology chart for renewable energy system desalination combinations*[47]

REDS Technology Implementation

For large scale wind and solar RESs (renewable energy systems) the most suitable desalination combinations are MED and MSF for solar RESs, and RO, ED, MVC for wind RESs.[48] Figure 19 shows the global installed desalination capacity by technology, irrespective of the connected power plant. Clearly RO and MSF are currently the most popular desalination options, with both together taking 86% of the market. In comparison, Figure 20 breaks out the global installed desalination capacity powered by RESs. Tzen and Morris do not discriminate in Figure 20 on how much of a desalination plant’s energy is derived from RESs, but rather lump projects into RES categories if any energy is supplied by these.

[47] Eltawil et. al.
[48] Delyannis, 1996



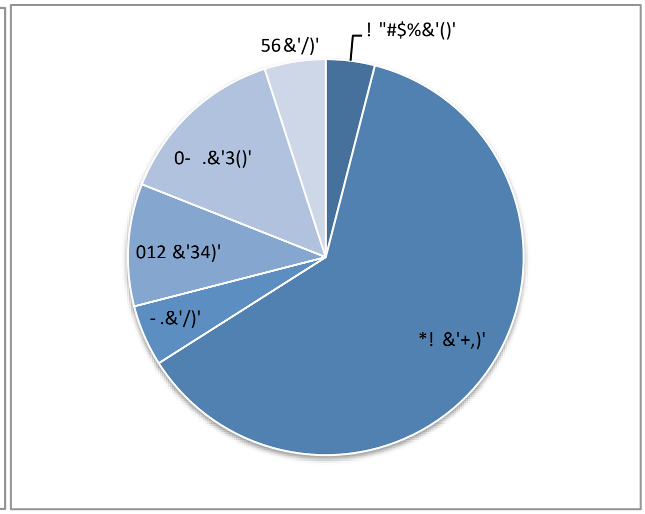


Figure 19 *(left): Global installed desalination capacity by technology (irrespective of power source).*[49]

Figure 20 *(right): Global RES-powered installed desalination capacity.*[50]

At 62% market share, clearly RO is the primary user of renewable energy, as depicted in Figure 20 above. In 2005 32% of renewable energy supplied is PV for RO and 19% is wind for RO, as shown in Figure 21 below. This means that 63% of RO (32%/51% by Figure 21) renewable energy was from PV and 37% from wind. Figure 21 shows that the third most popular REDS match is solar and MED, at 13%.

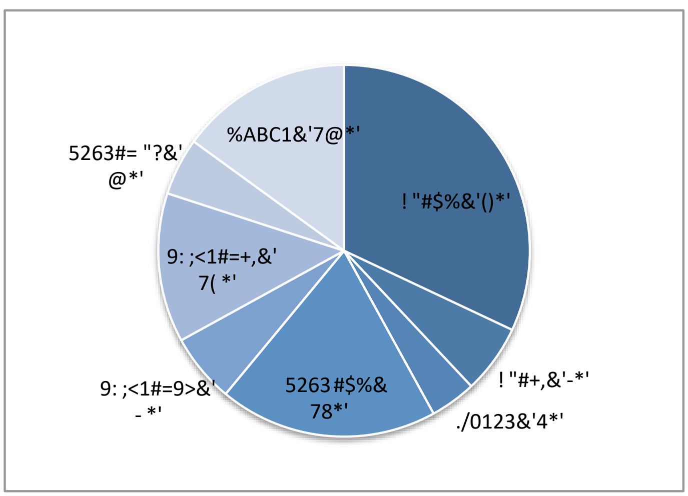


Figure 21*: Distribution of renewable energy powered desalination technologies, percent is installed capacity.*[51]

[49] IDA, 2002

[50] Tzen and Morris, 2003

[51] Tzen, 2005

MSF plants (6% of RES with solar-MSF), due to their better efficiencies and reduced costs, pushed out MED systems (13% of RES with solar-MED) in the 1960s, and only small size MED plants were built since then. However, in the late 1990s, interest in MED increased again and currently MED processes are said to compete technically and economically with MSF technologies for solar powered RES matches. Recent advances in MED low temperature processes and increased technology robustness have spurred this comeback, allowing MED plants to perform at 94% to 96% capacity due to decreased corrosion and scaling susceptibility.[52]

RES Technology Matching Pros and Cons

The viability of any of the above outlined combinations depends on:

- RES site capacity and the useful energy available after conversion from renewable sources (photo, thermal, mechanical, electrical energy forms)
- Water demand and system capacity determine the size of the energy collection system and desalination energy input requirements.
- Maintenance personnel availability and experience for on-site plant operation.
- Total REDS cost.

Figure 22, below, presents a crude rating system for RES and desalination technology matching, using stars. Ignoring the geothermal energy column, excluded in this discussion for the noted reasons above (but included in the table as a reference for its high rating due to ints consistent thermal load), both the PV and Solar Thermal column are given higher cumulative ratings by Oldach (stars added up by column) than wind energy. However, this table does not include project economics, which heavily favors wind and steers us back to favoring wind powered desalination technologies.

Criterion	**PV energy**	**Solar Thermal energy**	**Wind energy**	**Geothermal energy**
Suitability for powering desalination plants	Suited for desal requiring electrical power***	Suited for desal plants requiring thermal power***	Suited for desal plants requiring electrical power***	Suited for desal plants requiring thermal power.***
Site requirements and resource availability	Good match with high need for desal.***	Good match with high need for desal.***	Resource is locationdependent.**	Resource is limited to certain locations.*
Continuity of power output	Output is intermittent, & energy storage is required.*	Output is intermittent, & energy storage is required.*	Output is intermittent, & energy storage is required.*	Continuous power output.***
Predictability of power output	Output is relatively unpredictable.**	Output is relatively unpredictable.**	Output is very unpredictable with large fluctuations.*	Output is predictable.***

52 http://www.idswater.com/Common/Paper/Paper_46/INNOVATIVE%20IDEAS%20TO%20REDUCE%20CURRENT%20COST.htm

*** excellent match
** good match
* poor match
Figure 22*: Rating for RES for Desalination.*[53]

A more detailed comparison between solar thermal, PV, and wind RES follows.

Solar Thermal

Solar Thermal RESs have REDS operational drawbacks, but produce high quality product water, making solar thermal processes particularly suitable when pure distilled water is required for industrial or agricultural uses. As solar thermal storage depends on day radiation, significant heat storage reservoirs are required to smooth operations in REDS match-ups, adding an extra layer of complexity and capital costs.[54]

Evaporators in the heat category such as TVCs, MEDs, and MSFs require accurate process controls. These systems are found to be unstable in small sizes. Therefore medium and large size evaporators (thousands m^3/day capacity) are commonly used, which require larger energy inputs than standard size RES can provide, unless massive solar fields are built. A large solar RES, in turn, requires a large ground surface for deployment, which complicates its deployment due to potential sub-optimal terrains or the high expense of large land tracts.

Photo Voltaic

PV modules convert solar energy into direct current (DC) electricity. Small desalination systems operating directly off of electricity are most optimal. PV-REDSs have been deployed around the world as stand-alone systems, in which the ED process, which is approximately 16% of deployed PV-REDSs (6%/38% by Figure 21) is applicable only to brackish water. Due to the PV array's large land requirements, PV-RO combinations have been limited to small capacity systems, as well, though they have been deployed in high number. This is partly due to the correlation of historical water-scarcity to hot sunny regions.

Wind

Pairing between the best matching desalination technology for wind-RESs depends on the:

- Feed water salinity quality
- Required product water salinity quality
- Wind velocity distribution
- Power distribution - grid accessibility and independent generator power systems
- Desalination system energy demands

[53] Oldach, 2001

[54] Loupasis, 2002

Power matching with wind RESs requires energy dissipation and storage devices, as well as power control systems that include load-dumps, flywheels, batteries banks, fuel cells, or combinations thereof.

Wind and PV REDSs combinations are currently considered the newest and state of the art approaches. In both technologies the cost barrier is in their large initial capital costs. Though both technologies have become dramatically more economical in recent years, wind power is currently approximately half the solar RES cost per kilowatt of energy production. Wind's economic competitiveness over solar, and PV's need for large expanses of land has made technology developers particularly interested in the wind-REDS combination.

However, wind and PV system architectures can be applied separately or in tandem. Their economic and technical compatibility with RO desalination has recently shown the most promise.[55] The figure below is a compilation of Delyannis's recommendations for REDS matching. For seawater sources and potable product water systems, he recommends that wind RESs can be used for system sizes from small to large, versus solar RES, which should be used for small systems. Interestingly, Delyannis notes that MVC systems, rather than RO and ED, should be used for large systems, a notion contradictory to Eltawil's 2009 review on REDSs. I expect that Delyannis's work is mostly theory and technology focused, rather than inclusive of the project's economic aspects. I make this conclusion because MVC requires approximately twice as much operational energy compared to RO, as per Loupasis.[56]

Feed water quality	Product water	RE resource available	System size Small (1-50 m^3/d)	Medium (50-100 m^3/d)	Large (100-200 m^3/d)	Suitable combination
Brackish water	Distillate	Solar	*			Solar distillation
	Potable	Solar	*			PV–RO
	Potable	Solar	*			PV–ED
	Potable	Wind	*	*		Wind–RO
	Potable	Wind	*	*		Wind–ED
Seawater	Distillate	Solar	*			Solar distillation
	Distillate	Solar		*	*	Solar thermal–MED
	Distillate	Solar			*	Solar thermal–MED
	Potable	Solar	*			PV–RO
	Potable	Solar	*			PV–ED
	Potable	Wind	*	*		Wind–RO
	Potable	Wind	*	*		Wind–ED
	Potable	Wind		*	*	Wind–MVC
	Potable	Geothermal		*	*	Geothermal–MED
	Potable	Geothermal			*	Geothermal–MED

Figure 23*: Recommended RES-desalination combinations.*[57]

[55] Delyannis, 2006

[56] Loupais, 2002

[57] Delyannis, 2006

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Seawater Desalination Costs

White Paper

September 2011; Revised January 2012

The WateReuse Desalination Committee's White Papers are living documents. The intent of the Committee is to enhance the content of the papers periodically as new and pertinent information on the topics becomes available. Members of the desalination stakeholder community are encouraged to submit their constructive comments to white-papers@watereuse.org and share their experience and/or case studies for consideration for inclusion in the next issuance of the white papers.

WATEREUSE ASSOCIATION
DESALINATION COMMITTEE

Seawater Desalination Costs

White Paper

I Introduction

One of the most sensitive and critical aspects of any water project is cost. For membrane desalination, decreasing costs and producing superior water quality are among a number of significant reasons why this technology continues to be the water treatment technology of choice in the United States and around the world. This white paper serves to: provide an overview of cost drivers and components of the desalination process; present costs associated with desalination compared to other water supply alternatives; discuss challenges and perceptions; and highlight recent advances in desalination technology that affect the total delivered cost of water.

Although membrane desalination was first commercialized in the United States in the late 1960’s, reverse osmosis membrane technology was not widely implemented until the 1980’s, largely due to the relatively high costs compared to other potable water treatment alternatives. Why have these costs decreased or appeared more reasonable and competitive over time? Although there are a number of reasons, the reduction in costs are primarily related to improvements in manufacturing methods, the changing facets of the regulatory environment in the United States, the increased market demand and competition for membranes, and the gradual depletion of more conventional groundwater sources.

Since the early 1990’s, one example of the successful implementation of reverse osmosis desalination technology is its designation as a “best available technology” (BAT) by the United States Environmental Protection Agency (US EPA) for removal (and/or reduction) of numerous inorganic contaminants (e.g., antimony, arsenic, barium, fluoride, nitrate, nitrite, boron, selenium, radionuclides), endocrine disrupting compounds (e.g., synthetic and natural hormones), and several pharmaceutical compounds.

Together with a reduction in the membrane technology costs beginning in the 1980’s, BAT designation became one other (albeit significant) technical component to consider in the process of developing and potentially implementing a desalination facility. Other decision factors are rooted in both technical and nontechnical components of water supply projects such as timing, available space, and other specific locallydriven concerns. However, the determination of meaningful costs associated with membrane (including seawater membrane) desalination has proven a bit more elusive when applied without consideration of site specific issues or how the costs compare with other viable, reliable, and long-term water supply alternatives in the same locale.
For many years, planners have used tools generally available in the marketplace to determine relative costs for desalination. Most costing models for desalination plants have been developed by agencies such as the US EPA and the US Department of the Interior.

Engineering consultants have contributed select project cost experience gained from their clients or from trade journals and publications; and although this information can be very helpful, the data can at times be either too generalized or too project site-specific to be particularly helpful to project planners for specific guidance or to those interested in gauging costs compared to their particular project or environment.

A consolidated list of representative examples includes:

1. In 1979, the US EPA published *Estimating Water Treatment Costs.* This document is still used by some industry professionals as a reference guide to compute cost estimates for pretreatment, post-treatment, and conventional treatment technologies.
2. Previous to the US EPA document, the Department of the Interior developed in 1967 and 1969 the *Guideline for Uniform Presentation of Desalting Costs Estimates* (Research and Development Progress Report No. 264), which is sometimes still referenced yet, by today's standards, appears quite dated.
3. In 1999, the Department of the Interior's Bureau of Reclamation developed the *Water Treatment Evaluation Routine* program and manual (based on the US EPA *Estimating Water Treatment Costs).*
4. In 2003 and updated in 2008, a Water Treatment Cost Estimation Program was jointly developed by I. Moch & Associates and the Bureau of Reclamation (WT Cost II©)[58] to estimate costs and is partially based on updated cost curves generated by the US EPA (*Estimating Water* Treatment *Costs*, EPA-600/2-79-162a, EPA-600/2-79-162b, EPA-600/2-79-162c, August 1979) and is an upgraded version of the WaTER (Water Treatment Estimation Routine) excel spreadsheet developed by the Bureau of Reclamation in 1999.
5. In 2009, Global Water Intelligence[59] developed a desalination cost estimation program available on their website for reference by professionals interested in capital, operations and maintenance costs associated with desalination plants.

The water treatment industry continues to work towards standardization; however, there is no single resource or programming tool to capture all of the particular nuances materially affecting Seawater Reverse Osmosis (SWRO) facility costs.

Some of the above referenced models look at the cost of the technology in a "stand-alone" fashion, while others consider the impacts associated with other ancillary factors which can be site-specific. Costing sources are one tool in the planner/designer's toolbox, and a typical planning approach could incorporate use of computer programs, established cost curves, other bid costs for comparison, and similar applications for comparison

[58] Moch, I., Querns, W, M., and Steward, D.; WT Cost II, Desalination and Water Purification Research and Development Program Report No. 130, February 2008.
[59] GWI/DesalData Cost Estimator: www.desaldata.com.

purposes. Therefore, it is important to gain a comprehensive understanding of the costs associated with desalination when utilizing these models or developing the costs for desalination projects. Additionally, common sense is necessary when using these tools insofar as a particular project may have some unique components that cannot be modeled in a computer program alone. In any given situation, water industry planners, managers, and engineers can best serve the needs of the water stakeholder community through an awareness of the design and expected operating conditions of the proposed water treatment plant, as well as the validity and accuracy of the costing sources.

II Cost Trends

The unit costs for desalination processes have fallen considerably over the last three decades[60]. Figure 1 further exemplifies the downward trend[61].

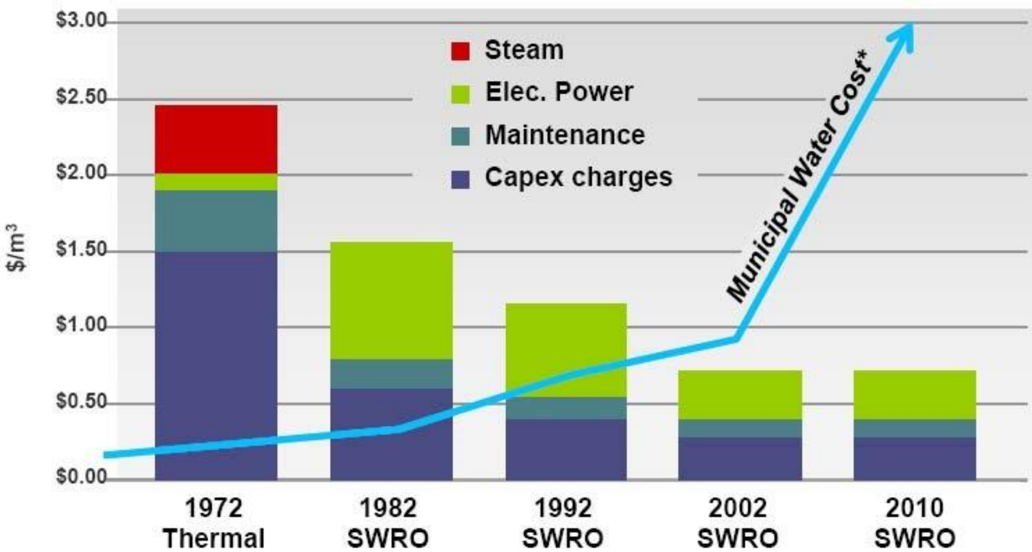

Figure 1
SWRO Cost Trend[62]
** Water costs for San Diego, Monterey, Perth, Sydney, and Barcelona*

As shown in Figure 2, there is also an economy of scale cost-benefit associated with increasing plant capacity to effectively lessen membrane desalination plant unit construction costs.

[60] Zhou, Y., and R. S. J. Tol (2005), Evaluating the Costs of Desalination and Water Transport, *Water Resources Res.*, 41, W03003, doi:10.1029/2004WR003749.
[61] Tom Willardson, CFO: Energy Recovery Incorporated reference presentation material, February 24, 2011.
[62] Ibid.

Figure 2
Unit Construction Cost vs. Capacity[63]

The historic downward trend of the cost of desalination is generally associated with technology improvements such as improved SWRO membrane performance and significant advances in the ability to recover more energy from the desalination process. However, considering other unassociated factors, Figure 3 shows that the costs have remained flat in recent years (even in consideration of increased production capacities) and, in a few cases, trended upwards. Identification of the various key project components that make up costs, as described in Section III, explains this trend and the drivers behind facility costs and the cost to supply water to end-users.

[63] Wilf, M., Awerbuch, L., Bartels, C., Mickley, M., Pearce, G., Voutchkov, N., 2007. *The Guidebook to Membrane Desalination Technology: Reverse Osmosis, Nanofiltration and Hybrid Systems Process Design, Applications and Economics*. Balaban Publishers, Rehovot, Israel.

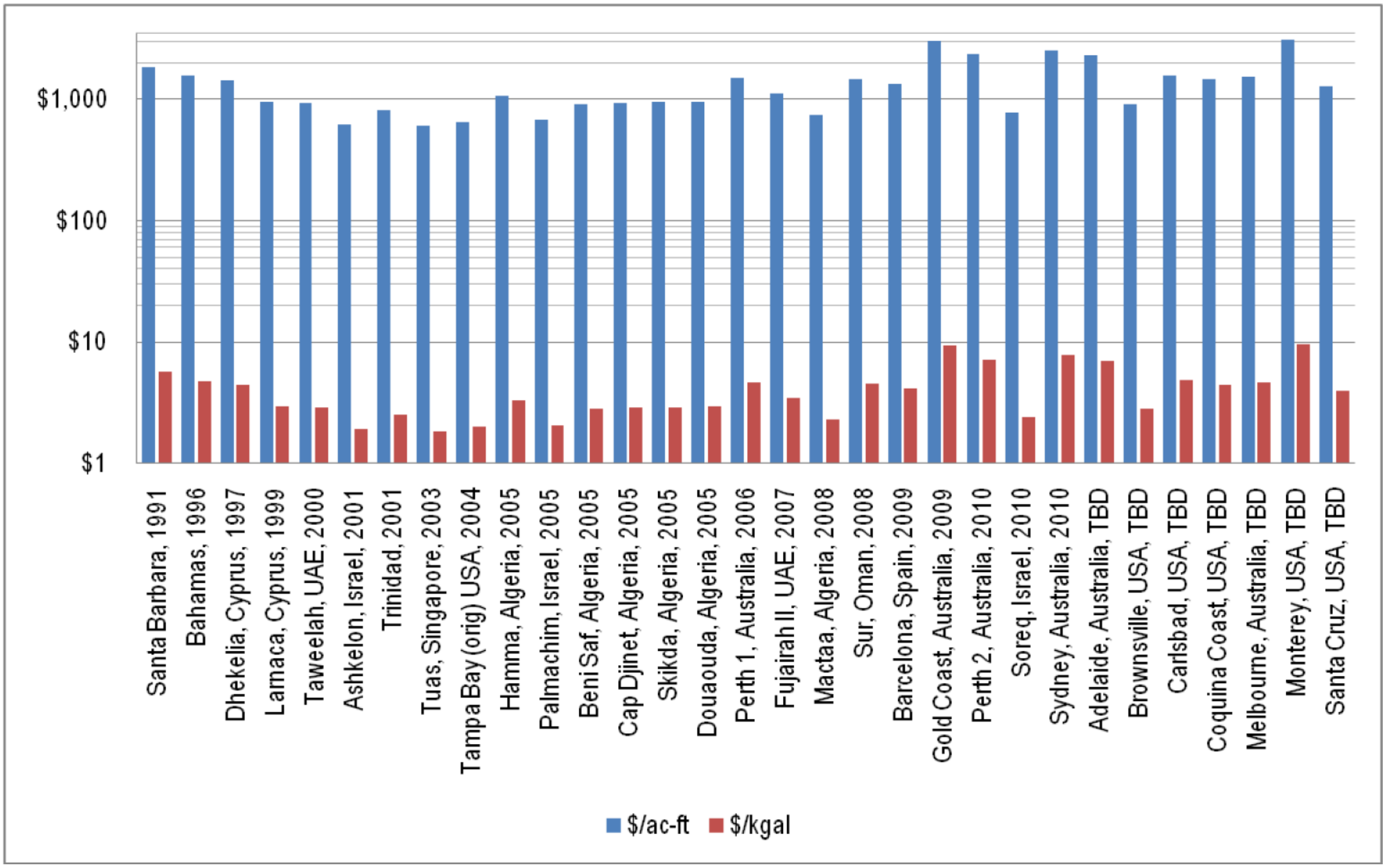

Figure 3
SWRO Cost Trends, Annualized[64]

III Project Capital Cost Drivers

What drives the overall cost of a desalination facility? The individual, categorical factors causing and contributing to the overall cost of a project are largely the same regardless of the project. However, the magnitude of these factors can vary significantly amongst differing projects and, therefore, result in cost differences. Figure 4 shows the cost categories associated with a SWRO desalination project.

[64] Courtesy of Water Desalination Report; Presented at the Texas Innovative Water Workshop, San Antonio, Texas, October 11, 2010.

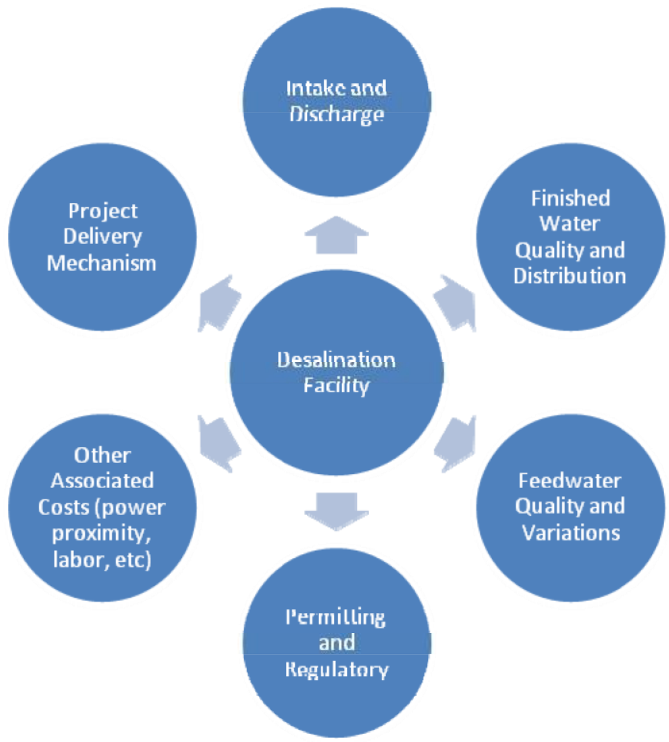

Figure 4
Cost Categories Contributing to SWRO Projects[65]

The level of accuracy desired with cost estimates is dependent on the end purpose of using the estimate and the degree of effort invested. The AACE categorizes the level of effort in five estimate classes[66].

Using an AAC-defined assumption that the conceptual screening process has been completed (Class 5; 20% to -50% low to +30% to +100 high), the potential impact that each cost category in Figure 4 should be assessed in order to gain a reasonable understanding of the associated, overall capital and operating costs.

A. Selection of Intake and Concentrate Discharge

Feed water intake configuration directly affects capital and operational costs of the treatment process. For example, open intake costs will represent approximately US$ 0.5 – 1.5MM per MGD and up to US$ 3.0MM per MGD for complex tunnel and offshore intake systems. Without consideration for the cost of land associated with each option, beach well intakes are usually less costly on an equipment basis. However, once land acquisition and easements are factored into the process, this intake type is typically 40 to 50% more costly than an open intake of similar capacity. Horizontal and slant wells are comparable to open intake (yet more costly than co-located open intakes using existing

[65] Dietrich Consulting Group, LLC.

[66] AACE International Recommended Practice No. 18R-97. Cost estimate classification system-as applied in engineering, procurement, and construction for the process industries.

infrastructure), and infiltration galleries typically cost more than open intakes. Of all the intake options, only open intakes have the longest-running installation history and reliability necessary to support the full-scale development of a large desalination facility at a new site. As a result, there is a significant depth of understanding related to the costs associated with constructing open intakes as well as the associated discharge pipeline.

The intake and feed water source selection cost impact is demonstrated in Figure 3. In Australia, for example, costs for newly constructed intake/outfall structures can approach a third of the total project cost (based on distance to the facility and related infrastructure costs) and are much more expensive than the proposed 50 MGD Carlsbad, California seawater desalination project, largely due to this project's access to the adjacent power plant intake and discharge infrastructure. Alternatively, for the proposed 50 – 150 MGD Camp Pendleton project, which is currently in the development phase with the San Diego County Water Authority (SDCWA), cost estimates approach US$ 1.3B to US$ 1.9B (2009 constant dollars) for Phase 1 that incorporates dedicated intake and outfall structures approximately 2-miles offshore, and 13 miles of conveyance pipeline. This is more than two times the construction cost of the Carlsbad facility[67].

Few SWRO facilities exist employing an intake type differing from the conventional open-intake. This lack of available installations for use as a qualitative benchmark for costing same-site alternatives is important for planners and engineers focused on process considerations and/or cost comparisons. However, published information is limited and can be site-specific. Generalized guidance is contained in Table 1. Source types range from beach wells to open-ocean intakes.

[67] Lopez, Cesar (SDCWA): "Camp Pendleton SWRO Feasibility Study", AMTA Annual Conference and Exposition, San Diego, CA, July 12, 2010.

Table 1
Comparative Water Quality, Cost, and Reliability from Various Intake Types

Intake Type	Relative Cost (for equal capacity)	Relative Intake Space Requirements	Relative Pretreatment Space Requirements	Reliability
Beach Wells	Low	High	Theoretically Less	Variable based on subsurface lithology
Horizontal Directional-Drilled Wells	Medium	High	Theoretically Less	Unknown
Radial Wells	Medium	High	Theoretically Less	Unknown
Constructed Seabed / infiltration Gallery	High	Medium	Theoretically Less	Unknown
Submerged Open Intake	Medium-Low	Low	More	High
Surface – Open Intake	Low	Low	More	High
Co-located Intake	Low	Low	More	High

By definition, the reverse osmosis desalination process creates two flow streams at a ratio of approximately 50:50. The “concentrate” stream is about twice as salty as the feed water.

Various methods are available to dispose of the concentrate stream, and the availability of alternatives will vary due to many site-specific variables. With that consideration, conveyance alternatives and a range of costs associated with each alternative are contained in Table 2. The costs do not include conveyance attributable to connecting the desalination plant to the disposal location (in the case of discharge to the ocean, this would be from the desalination plant to the shore line) because the conveyance distance, terrain, and associated costs are site-specific and highly variable, and this conveyance cost can dominate disposal costs.

Table 2
Concentrate Disposal Costs[68]

Disposal Method	Construction Cost	
	(US$ MM / MGD)	(US$ MM /acre-foot/day)
New Outfall w/Diffusers	2.0 – 5.5	0.7 - 1.8
Power Plant Outfall	0.2 – 0.6	0.07 - 0.20
Sanitary Sewer	0.1 – 0.4	0.03 - 0.13
WWTP Outfall	0.3 – 2.0	0.1 - 0.7
Deep Well Injection	2.5 – 6.0	0.8 - 2.0
Evaporation Ponds	3.0 – 9.5	1.0 - 3.1
Zero-Liquid Discharge	5.5 – 15.0	1.8 - 4.9

Regarding cost trends and the upward spikes observed in the most recent Australian SWRO projects in Figure 3, the plant discharges were located in the vicinity of marine habitats with high sensitivity to elevated salinity (compared to those encountered by the US projects). These designs resulted in the need to build complex concentrate discharge diffuser systems, with costs, in most cases, exceeding 30% of the total desalination project expenditures. By comparison, most of the desalination plants yielding the lowest water production costs have concentrate discharges either located in coastal areas with very intensive natural mixing or are combined with power plant outfall structures which use the buoyancy of the warm power plant cooling water to provide accelerated initial mixing and salinity plume dissipation at lower cost. The intake and discharge facility costs for these plants are usually less than 10% of the total desalination plant costs, which is much less significant compared to the US projects' cost estimates as a total percentage of costs.

B. Feed and Finished Water Quality

[68] Adapted from Wright and Missimer, 1997.

The type of pretreatment system and type of pretreatment technology selected are very dependent on the feed water quality. Because open ocean feed water (compared with well water, for example) will typically contain a greater level of suspended material and impurities that could possibly foul a reverse osmosis membrane, the capability of the pretreatment necessary to suitably pre-condition the feed water is crucial to ensure a long, sustainable membrane service life. For example, some coastal well water supplies and certain open ocean sources are generally expected to contain very low levels of foulants and particulates; therefore, a lesser-degree of pretreatment may be warranted. It is important to keep this point in context, because suspended material content (e.g., iron, sulfur, manganese) of coastal ocean locations is sitespecific and could eliminate the potential benefit of a lesser-degree of pretreatment and the associated capital and operational costs.

Typical costs associated with pretreatment will range from US$ 0.5MM to US$ 1.5MM per MGD. The lower range of costs is representative of a conventional single-stage media filtration system, which is a technology that has been in service treating public water supplies since the 1700's. Costs will increase as additional pretreatment process steps are added, such as two-stages of media filters, or media filtration followed by a micro- or ultrafiltration membrane system which approaches the higher end of the cost range.

Additionally, as with any seawater desalination project, the feed water temperature, source water
"cleanliness" (such as suspended biomass or turbidity), and ambient salinity fluctuations also affect project costs. For example, if a SWRO facility planned along the Northern California coast treats seawater that is on average 10 degrees colder than a SWRO facility located in Southern California, the necessary feed pressure would increase 10 to 15% over the warmer water to achieve the equivalent production value, thereby increasing energy consumption and associated operating costs.

Base-line costs for the desalination component of a facility usually range from US$ 1.5MM to US$ 4.0MM/MGD. The lower range of costs represents a single stage, single pass SWRO system which is capable of reliably meeting a TDS of less than 450 mg/L. Individual analyte concentration limitations such as boron or chloride (for horticultural water quality purposes) can also affect costs, because at very low concentration limits an additional membrane treatment step might be necessary. If this is the case, additional costs associated with producing a lower TDS product water will increase from 15 to 30% of the cost of the single stage, single pass system. Table 3 contains relative finished water treatment costs within the fence line of a desalination facility compared to base-line desalination system costs.

Table 3
Target Finished Water Quality and Relative Cost; $MM/MGD

Target Finished Water Quality	Construction Costs, $MM/MGD	Operation and Maintenance Costs, $MM/MGD	Cost of Water, $MM/MGD[69]
TDS:Cl = 500[70]:250 mg/L Boron = 1 mg/L	1.0	1.0	1.0
TDS:Cl = 250:100 mg/L Boron = 0.75 mg/L	1.15 – 1.25	1.05 – 1.10	1.10 – 1.18
TDS:Cl = 100:50 mg/L Boron = 0.5 mg/L	1.27-1.38	1.18-1.25	1.23-1.32
TDS:Cl = 30:10 mg/L Boron = 0.3 mg/L	1.40-1.55	1.32-1.45	1.36-1.50

C. Distribution

Throughput (or “production”) capacity of a desalination facility (as with any other type of production facility) affects the size and number of the equipment needed, as well as the space necessary to locate a treatment plant. Coastal communities utilizing desalination as a source of drinking water are usually in close proximity to the treatment facility; therefore, land is usually priced at a premium. The cost of locating a facility closer to the point of use and a suitable power source should be weighed against the costs associated with additional intake and discharge pipeline easements, transmission line costs, materials used for construction, permits, labor, and maintenance associated with moving a plant farther away from an intake/discharge or distribution service area. By material cost alone, a 20-mile distribution system delivering 50 MGD could increase by 15 to 30% of total project capital costs (or more) when compared to a 2-mile pipeline based on available easements, rights of-way, and existing subsurface utilities.

The project sites in Australia are between 10 and 50 miles from the points of delivery, and, in the case of the 66 MGD Sydney SWRO facility, the cost of the product water delivery system was greater than the cost of the SWRO treatment plant (Plant cost

[69] Dietrich Consulting Group, LLC.

[70] 500 mg/L drinking water quality limitation is a United States EPA Secondary Water Quality Standard. 14 Water Desalination Report, Volume 46, Issue 29, August 2, 2010.

$7.80/kgal14; US$ 586MM[71] vs. US$ 490MM). The cost breakdown is also similar for the Melbourne, Australia plant.

D. Permitting and Regulatory Issues

The regulatory landscape differs vastly in the communities served by desalination facilities. These differences can have a profound impact on project delivery timelines, legal costs, and in some cases alter the design of the SWRO facility. Without question, each country has its own set of environmental criteria which must be met by any single project. And in consideration of laws in the United States, each State and region has its own set of rules, regulations, and standards, all of which conform to federal laws and guidelines while potentially being more restrictive, and usually related to site-specific nuances. For example, permitting costs for the Tampa, Florida 25 MGD SWRO project are estimated to have been
US$ 2.5MM – US$ 5MM while permitting costs for 10 – 50 MGD projects in California can exceed US$ 10MM –20MM. Permitting costs can also be bracketed by project complexity. For low-complexity projects, the permitting cost is 0.5 to 3.5% of the total capital cost of SWRO projects. For high-complexity projects, permitting is estimated at 4.5 to 5.0% of the total project capital costs. Finally, actual permitting costs will also depend on degree of membrane piloting or demonstration work (if necessary), extent of local/state permit hearings, and Federal CWA Section 401/404 offshore permitting, as applicable16.

Whereas Australia has invested upwards of US$ 13 billion in numerous large-scale desalination projects producing 500 MGD over the last six years, the US has only been successful at bringing online one 25 MGD SWRO desalination facility in Tampa, FL at US$ 150MM. Additionally, major California projects such as Carlsbad and Huntington Beach have taken over 11 years to develop and permit, mainly due to permitting challenges and land use considerations.

E. Project Delivery Mechanism

A number of project delivery methods and financing tools have proven to be successful in the SWRO desalination industry. The size of the project, expected contract duration, location, competition, risk allocation, and project (owner) preferences all dictate by what means the project is delivered. For example, the combination of large capacity SWRO facilities, enhanced competition, and owner preferences for lowrisk have enabled the design- build- own- operate (DBOOT) project delivery community to commission SWRO projects at an exceptionally low all-inclusive cost of US$ 800 – US$ 1,000/ac-ft. in North Africa. Without exception, the lowest cost desalination projects to date have been delivered under turnkey DBOOT contracts where private sector developers or consortia share risks with the public sector based to their ability to control and mitigate the

[71] Water Desalination Report, Volume 46, Issue 16, April 26, 2010.

respective project related risks. A contributing cause to the lower costs are that the insurance and contingencies in DBOOT contracts are between 10 and 20% of the total capital cost of the project; whereas similar costs for the more traditional project design/bid/build projects can be higher.

One other delivery method, recently applied to large SWRO projects in Australia, is the Owner-EngineerContractor "Alliance" approach. The alliance model is an alternative means to further minimize and isolate the owner risks involved in procuring large-scale desalination plants. The alliance model incorporates a two-stage bidding process involving selection of qualified private sector companies and then engages the top-two companies in a competitive project development phase (which is paid for by the owner). Although the risk and reward mechanisms between the owner and engineer/contractor are negotiable, the insurance and contingency premiums are historically more than 30% of the total project costs.

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16 Wilf, M., Awerbuch, L., Bartels, C., Mickley, M., Pearce, G., Voutchkov, N., 2007. *The Guidebook to Membrane Desalination Technology: Reverse Osmosis, Nanofiltration and Hybrid Systems Process Design, Applications and Economics*. Balaban Publishers, Rehovot, Israel.

F. <u>Other Associated Costs</u>

Other associated project costs include proximity to a power supply, the availability of skilled labor, and environmental mitigation. These cost impacts may be the result of market conditions or issues unknown during the conceptual design process. For example, the overlapping schedules of the series of large Australian SWRO projects created a temporary shortage of skilled labor, which in turn resulted in an increase in unit labor costs. Because skilled labor expenditures can consume up to 50% of the construction costs, a facilities' construction cost can increase by 20% or more.

In several instances involving Spanish desalination projects, substantial project delays were caused by the inability of the local power company to install power substations and transmission lines; or, the receiving water authority did not adequately plan system integration and distribution pipelines for the product water, thereby substantially increasing the total project costs. This has also been a challenge in some regions of South Africa.

IV Capital Cost Breakdown

Costs associated with a desalination plant can be annualized to provide a frame of reference to the total cost of water produced, and in some cases, delivered to the actual point of use for each particular project. These annualized costs can be quite complex and are based on a number of variables including the amount financed, interest rate, loan period, inflation, depreciation, plant utilization, and more. For a frame of reference, the typical annualized costs for seawater desalination projects vary widely from US $2.00/1,000 gallons (kgal) to $12.00/kgal. The higher end of the cost range is associated with smaller capacity plants (less than 1 MGD), because economies of scale cannot be realized, or can be attributed to site-specific intake, discharge, and conveyance. If the intake, discharge, and conveyance components are removed from the annualized cost, the range narrows from US $2.00/kgal to approximately $6.00/kgal. By comparison, the range for brackish water membrane desalinating processes (BWRO) is US $0.40/kgal to $4.00/kgal.

Because of the potentially wide-ranging cost differences between projects, unit cost contributions associated with the overall plant cost can be clarified by breaking down plant costs by contribution type. For example, as seen in Figure 5, the intake and discharge costs associated with construction are approximately 10 to 12% of the total plant costs. Please note that Figure 5 is an example of typical project plant costs, and site specific cost contributions associated with key components such as the unit cost of power, distance for distribution, and labor, for example, will alter the ratio accordingly.

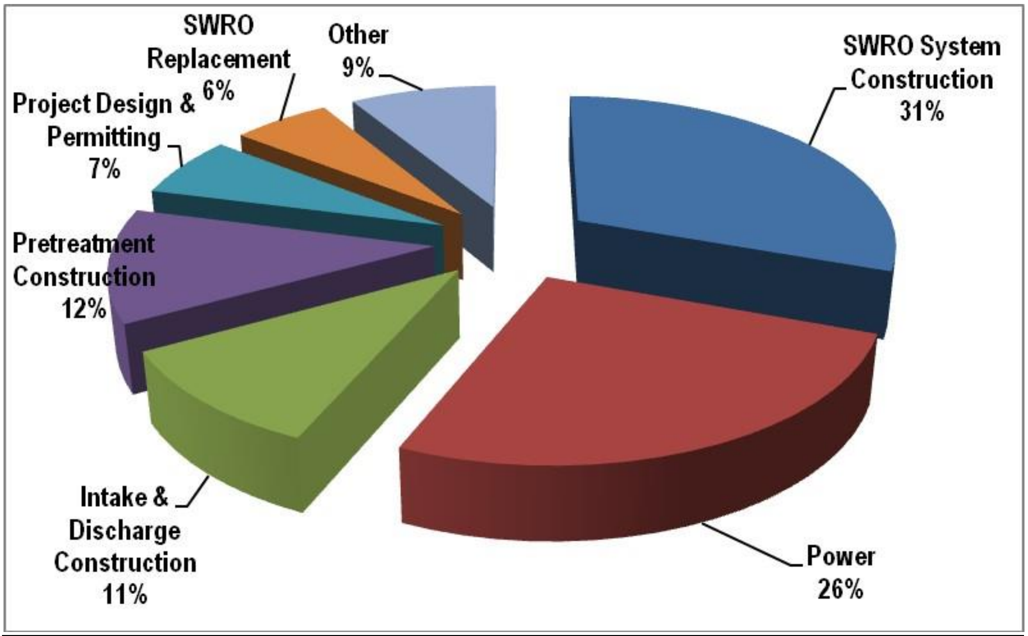

Figure 5[72]
Typical SWRO Plant Construction Cost Breakdown

V Operation and Maintenance Cost Breakdown

All drinking water production facilities require operational attention and regular maintenance to ensure a long, productive and efficient plant. A typical design lifespan for a water production facility is 20 to 30-years, based on the size of the facility; financial terms and arrangements; and procurement method (such as BOOT, DBO, D-B, etc.). However, regardless of procurement type, the typical plant operation and maintenance costs (O&M) are associated with the parameters described in Table 4.

Table 4
Operation and Maintenance Parameters for Desalination Plants (*Typical Example*)[73]

Cost Association	Parameter	Percentage of Total O&M Costs
Maintenance	Instruments Pump upkeep Facility upkeep including intake pipeline pigging	6%

[72] Dietrich Consulting Group, LLC.
[73] Dietrich Consulting Group, LLC.

	Minor equipment replacement Video/CCTV intake/wells and associated cleaning	
Legal/Permitting	Environmental monitoring Permit compliance	2%
Operations	Labor	6%
	Sludge and solids waste disposal Bar rack and band screen solids waste disposal	4%
	Cartridge Filters and RO Membrane Replacements	11%
	Power (Energy)	55%
	Chemicals	6%
	Other Related	10%

Some examples of the sub-components contributing to the total percentage of O&M costs contained in Table 4 are affected by locale. Trends such as increasing power; solid waste disposal, or increases in chemical costs would shift the allocation. Regarding power, typical costs for labor and power associated with water treatment production are 45% (labor) and 25% (power) higher in California, compared to Florida or Texas.

VI Cost Comparison with Other Water Supply Alternatives – a California Perspective

The cost of desalinated water has decreased significantly over the last two decades; and, all indicators are that the costs associated with the technology will continue to decrease as technology and efficiencies improve. However, similarly sized facilities do not always offer comparative costs for a number of reasons, including feed water and finished water quality goals, intake type, and distance to service area. All of these factors can have a marked effect on the overall cost of water. The importance of understanding these differences cannot be overemphasized when describing costs related to various desalination projects and treating different source waters.

Although there is only one large-scale seawater desalination facility in the United States, those that are in the planning and budgetary cost stage appear to be highest in California compared to the majority of the United States. Due to the large number of plants under consideration in California compared to the rest of the country, the cost warrants further discussion. The cost of desalination in California is relatively higher than that of traditional low-cost water sources (groundwater and river water), as well as water reclamation and reuse for irrigation and industrial use purposes. In fact, the cost of traditional local groundwater water supplies in some parts of the state is as “low” as US $0.50/1,000 gallons ($160/AF, annualized). However, the quantity of such low-cost sources is very limited (less than 30% of the water resources statewide), and water quality has become an issue in certain areas.

In California, many water agencies have embarked on exploring seawater desalination because of the diminishing capacities of fresh surface and ground water. Most of the water utilities in Southern California currently purchase imported water from the Bay Delta and Colorado River at a rate of US $2.30 to $2.45/1,000 gallons ($750 to $800/AF), and the cost of these water supplies is very likely to increase by 15% or more through 2015 due to additional expenditures needed to comply with more stringent drinking water quality regulatory requirements promulgated by the US EPA.

Based on the 2006 California Water Charge Survey published in July 2006 by Black & Veatch (http://www.bvaeservices.com/news/articles/jul06/ca_survey_businesswire.htm), the average residential monthly charge for 1500 cubic feet of drinking water was US $36.39 (US $3.24/1,000 gallons or $1,058/AF). The survey also indicates that the cost of residential water supply has increased by 16.7% since 2003.

The great majority of projects included in the California desalination initiative were at one time considered “premature.” However, water utilities and stakeholders are once again considering whether desalination product water today at a cost of US $2.91 to $3.7/1,000 gallons ($850 to $1,200/AF)[74] is too expensive. If the cost comparison of desalination versus other traditional supplies is made on a “comparable basis” suggesting that all components affecting the cost of water are accounted for, then the costs for production of desalinated seawater would be similar to the future total costs for delivery of new incremental water supplies to many parts of the state (especially to municipalities and utilities in Southern California relying on imported water supplies). For example, the commodity charge for one large California municipal water district is US $935 to $1,060/AF without a desalination component[75]. Another example is Figure 6, which contains a projection of the comparative costs associated with importing water into San Diego in the southernmost region of California in 2020[76].

[74] In 2005 dollars; based on asset life of 30 years and unit power costs of US$0.08/kWh to US$0.11/kWh.

[75] West Basin Municipal Water District FY 2010-2011 Water Rates and Charges; includes MWD RTS and Reliability Service Charge.

[76] San Diego County Water Authority, September 2010 Planning Committee.

Figure 6
2020 Imported Water Supply Costs, Southern California[77]

The argument was made at one time that desalinating seawater and brackish water is generally more expensive than the production of reclaimed water and the implementation of water conservation measures. However, with the exception of potable reuse, water conservation and recycling do not create new sources of drinking water. Also, under conditions of prolonged drought when the available water resources cannot be replenished at the rate of their use, aggressive reuse and conservation can help but may not completely alleviate the need for new water resources and water rationing. Simply put, if your backyard well is dry, you cannot solve your household water supply challenges by reusing or conserving more of the well water which you do not have.

The primary differences stem from the significant reduction of the costs for seawater and brackish water desalination since the early 2000's and the incrementally higher costs associated with achieving goals such as dramatic increases in water reuse and conservation after such measures have already been implemented.

In the early nineties, comprehensive conservation and reuse were uncommon for the majority of the municipalities in California, as the prolonged drought during this period forced many utilities to implement low-cost water reuse and conservation measures that now comprise 5 to 15% of their water portfolios. Utilities already having comprehensive water reuse and conservation programs simply cannot squeeze an additional 10 to 15% of water savings via the same low-cost reuse and conservation measures. Implementing the next tier of more sophisticated equipment and technology-intensive reuse and conservation measures to reach water-saving goals of 20 to 25% comes at a price which, in some cases, may approach that of desalination.

[77] REGIONAL STRATEGIES: PEAK DEMAND GAP & CRITICAL PEAK PRICING, Shahid Chaudhry, California Energy Commission, August 2005. Energy Workshops for W&WW Agencies.

Without normalizing data from foreign desalination plants for the site specific conditions in California (labor, construction, equipment costs, etc.), electrical energy accounts for between 30 and 40% of the total water production costs of a typical membrane seawater desalination plant. Due to site-specific differences, the power costs for seawater desalination in California contribute closer to 20 to 30% of the total costs of water production. Therefore, fluctuations in international fuel markets will not have a dramatic effect on the viability of desalination as has been assumed previously. It should also be noted that unit energy cost increases affect all water supply alternatives, largely due to the energy intensive nature of transporting water from Northern California to Southern California.

VII Challenges and Perceptions

During a period of prolonged drought in California in the early nineties, emergency fast-track implementation of a number of water desalination projects began, setting the stage for many potentially biased perceptions at the time concerning the relatively high cost of seawater desalination. Today, some of those perceptions about costs associated with seawater desalination remain, thus posing challenges to professionals, planners, and stakeholders alike.

The perception that seawater desalination can be a drought-proof alternative to other water supplies has enabled other utilities and water suppliers around the world to effectively incorporate seawater desalination as one alternative to dwindling (or unavailable) water supplies. In the US, for example, Tampa Bay, Florida has implemented seawater desalination as a drought-proof measure. In particular, and under consent order by the State of Florida and the Southwest Florida Water Management District, this measure was determined to be a necessity in order to alleviate wellfield over-pumping and devastation of wetlands[78]. By some arguable accounts, thousands of acres of wetlands that had virtually "dried up" over many years began to fill with water.

There is also the perception that the site-specific costs associated with intake or concentrate disposal may develop (or trend) upward, and may not outweigh the potential benefit of a drought-proof resource. This trend will be influenced by the regulatory environment (specifically regarding the intake facility) and is not associated with the cost of the desalination processes or concentrate disposal. For example, in Tampa, a comprehensive environmental study beginning in 2002[79] revealed that, to date, there is no indication that the SWRO desalination facility concentrate has had an adverse impact on Tampa Bay. Therefore, the costs associated with co-locating with a nearby power plant

[78] Southwest Florida Water Management District (http://www.swfwmd.state.fl.us/) wetland recovery strategy.

[79] Study commissioned by Tampa Bay Water and administered by PBS&J.

and the associated mixing and dilution can be reliable when applied to other similar co-located projects.

VIII Concluding Remarks

One of the most sensitive and critical aspects of any water project is cost. Membrane desalination has experienced an overall downward trend in overall costs, and technological advances will continue to bring costs down even further. Additionally, when investigating the costs associated with desalination compared to other supplies, comparable cost estimating practices will tend to level the playing field when all of the costs associated with delivering water are considered.

However, as with any infrastructure project, it is important to recognize that the various components supporting the overall desalination treatment facility can vary significantly and are based on site location. For membrane desalination, decreasing technological costs, the drought-proof nature of the process, and producing superior water quality are among a number of significant reasons why this application is the water treatment technology of choice in the United States and around the world.

FAC 8421 Water Distribution Line, Potable

FY25 SUC:	$1.00 / LF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8422 Water Pump Facility, Potable

FY25 SUC:	$5.57 / KG
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8431 Water Well, Fire Protection

FY25 SUC:	$0.62 / GM
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8432 Water Distribution Line, Fire Protection

FY25 SUC:	$1.00 / LF
Source:	Set to FAC 8421, CostWorks Model

FAC 8433 Water Impoundment, Fire Protection

FY25 SUC: $0.00 / GA

Source:

FAC 8434 Water Pump Facility, Fire Protection

FY25 SUC:	$5.98 / KG
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8435 Water Tank, Fire Protection

FY25 SUC:	$0.06 / GA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8442 Water Storage, Non-Potable

FY25 SUC:	$0.01 / GA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8443 Reservoir, Water

FY25 SUC:	$0.00055 / GA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Multiple Government Sources

Modeling Notes 28 October 2020

Prepared by R&K Solutions

Subject

Reevaluation of Sustainment Unit Cost for FAC 8443 Reservoir, Water

Background

For the FY21 run of Sustainment Unit Cost modeling, the FSM Configuration Support Panel (C/SP) requested that FAC 8443 be reexamined for sustainment modeling. Since the inception of the Facilities Sustainment Model, FAC 8443 had no sustainment costs associated to it, as the majority of sustainment activities near or associated with water reservoirs were resident in the definitions of other FACs (dams). As the body of knowledge of how to upkeep a lake or reservoir has grown, it is evident that there are maintenance tasks specific to the reservoir that merit a “non-zero” modeling effort.

Findings

The USACE research center for hydrology, ERDC’s Coastal and Hydraulics Laboratory report that there are maintenance activities for reservoirs. The Environmental Protection Agency has Best Management Practices (BMP) for inspection and maintenance of reservoirs. The two primary documents used to aid in the selection of sustainment activities for a reservoir are:

Stormwater Best Management Practice, Design Guide Volume 3, Basin Best Management Practices by Clar and Barfield

Managing Lakes and Reservoirs, Prepared by the North American Lake Management Society.

BMP Modeling Concepts and Simulation, EPA/600/R-06/033 by Huber, Cannon and Stouder

Expected Service Life

The average age of a Reservoir in the 2019 RPAD is 35 years. This will be used as the designated “Estimated Service Life” Activities, such as major dredging, performed after this date will be considered restoration, and not be captured in sustainment modeling.

Nature of the Inventory

FAC 8443 Reservoir UM – MG

Definition: An impoundment for the storage of water that, in its natural condition, is not safe for drinking. 7 CatCodes; 2 each for Army, WHS, Navy and 1 CatCode for the Air Force.

There are 523 non-zero Asset Allocations in the 2019 RPAD. Mean size = 14.0 MG

Inputs

Analyzing service and independent sources, the following tasks are assessed as required for the typical facility over the life of a water reservoir, and meet the DoD definition of a sustainment activity:

- Maintenance Inspection, Debris Removal, and Mechanical Component Testing
- Repair Embankment and side slopes
- Removing accumulated sediment

- Repair or replacement of mechanical components; valve, piping, sluice gates, access hatches

The following activities are associated with reservoirs, but are excluded form being incorporated into SUC modeling:

- Wildlife, fish, pest, or mosquito management
- Aquatic vegetation management
- Water quality activities
- Grass mowing in the vicinity of the reservoir Trash, graffiti, or vandalism remediation.

Summary

With labor, material, and equipment costs for these activities, the SUC is $430.64/MG

FAC 8451 Water Distribution Line, Non-Potable

FY25 SUC:	$1.00 / LF
Source:	Set to FAC 8421, Cost Works Model

FAC 8452 Water Pump Facility, Non-Potable

FY25 SUC:	$5.40 / KG
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8511 Road, Surfaced

FY25 SUC:	$1.44 / SY
Source:	R.S. Means Cost Data

FAC 8511 SUC FY25 ROAD, SURFACED

UM SY
ESL 28
Model Size 14080

CostWorks 2024 Quarter 3 - FAC 8511 Road, Surfaced

Qty	Description	Frequency	Unit	Total Incl. O&P	Occurances	Total for Assembly	
36.0	Asphalt Overlay, Crack Sealing, Patching/Annual Mnt	5	M.S.F.	28,613.88	5	$	143,069.40
36.0	Asphalt road repair and resurface	10	M.S.F.	48,130.20	2	$	96,260.40
480.0	Remove and replace steel guard rail	7	L.F.	34,473.60	4	$	137,894.40
22.0	Raise MH or catch basin frame and cover	10	Ea.	8,741.70	2	$	17,483.40
14.0	Signs, reflective aluminum street type, doublefaced, 4-way	5	Ea.	2,014.04	5	$	10,070.20
5,560.0	Remove and replace concrete curb or berm	25	L.F.	161,573.60	1	$	161,573.60
				$283,547.02	Total M&R	$	566,351.40
					M&R per Year	$	20,226.84
					SUC	$	1.44

* Model size is based on 1 mile of road 24' wide; standard studied road

FAC 8512 Road, Unsurfaced

FY25 SUC:	$0.74 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Based upon published studies by USDOT, Kansas State University, State of Maine, State of Washington and City of Milton, GA

FAC 8512, UNPAVED ROADS

FY2018 SUC

Source	Data Year	Locality	Source Cost per mile	Source Width (ft)	Source SY	Source $/SY	Inflation Adjustment	ACF	FY 18 Cost
1	2014	Nat Ave	$ 18,065.00	40	23467	$ 0.77	1.105033	1.00	$ 0.85
2	2014	Kansas	$ 7,307.00	26	15253	$ 0.48	1.105033	0.87	$ 0.46
3	2015	Maine	$ 1,195.00	12	7040	$ 0.17	1.079993	1.02	$ 0.19
4	2015	Washington	$ 12,591.00	40	23467	$ 0.54	1.079993	1.12	$ 0.65
5	2009	Georgia	$ 4,160.00	28	16427	$ 0.25	1.232887	1.12	$ 0.35
Average									$ 0.54
SUC, FY18									$ 0.54

Sources Cited:

1 USDOT, FHWA August 2016, Gravel Roads Construction & Maintenance Guide, Apprendix D6, Figure 17

2 "Gravel Road Paving Guidelines", Sunanda Dissanayake, PhD, PE, Kansas State University Transportation Center, Report K-TRAN KSU-14-1, November 2016

3 State of Maine Gravel Road Maintenance Manual, Guide for Landowners on Camp and Other Gravel Roads, Maine Department of Environmental Protection, Bureaus of Land Resources and Water Quality, April 2016

4 Gravel Road Study, County Road Aministration Board, State of Washington, April 2016

5 "Gravel Road Maintenance Investigation", City of Milton Pavement Management and Recommendations, April 2009

Locality Adjustments taken from UFC 3-701-01, Ch 13, Table 4-1, Sustainment ACF

FAC 8513 Vehicle Bridge

FY25 SUC:	$32.79 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Three studies were used to revise the unit cost: The “Historical Life Cycle (LC) Costs of Steel and Girder Bridges” report was prepared for the American Iron and Steel Institute and the Short Span Steel Bridge Alliance by Dr. Michael Barker, Professor of Civil Engineering at the University of Wyoming, May 2016, using data for multiple bridges (PennDOT Database), projected to 2014.\n\n A Connecticut DOT life cycle cost study of the Moses Wheeler Bridge provides cost in 2009 dollars. A Kentucky life cycle cost study (dissertation) of the bridge carrying Huntertown Road over the Bluegrass Parkway provides a cost estimate from 2015.

The resulting average of these three studies is:

Study	Cost/SF	Cost/SY	Year	Inflation	FY17 SUC
Michael Baker		$ 3.52	2014	1.070819	3.76607
Connecticut	$ 2.91	$ 26.20	2009	1.163282	30.47799
Kentucky	$ 3.72	$ 33.50	2015	1.046557	35.05966
				Average	23.10124

Note: The Barker study is based data extracted from the Pennsylvania DOT database.

HISTORICAL LIFE CYCLE COSTS OF

STEEL & CONCRETE GIRDER BRIDGES

Prepared For
American Iron & Steel Institute
Steel Marketing Development Institute
Short Span Steel Bridge Alliance
National Steel Bridge Alliance
American Galvanizers Association

Michael G. Barker, PhD, PE
Professor
Civil & Architectural Engineering
University of Wyoming

May 31, 2016

The opinions, findings and conclusions in this
report are not necessarily those of SMDI, NSBA or the AGA

Executive Summary

Since the early 1990's, the Federal Highway Administration (FHWA) has promoted the consideration of Life Cycle Costs Analysis (LCCA) in the design and engineering of bridges. LCCA determines the "true cost" of bridge alternatives considering the time value of money. The Life Cycle Cost analyses employed in this study uses the Perpetual Present Value Cost (PPVC) of bridge alternatives for an equivalent comparison between the alternatives.

Over the years, the author has worked with state departments of transportations and local county engineers on effective and economical bridge construction. A frequent question that arises during meetings is the difference in Life Cycle Costs between steel and concrete girder bridges. Both the concrete industry and the steel industry site various anecdotal advantage above the other for the Life Cycle Costs over the life of the bridge. There has historically been a healthy competition between material types for new bridge construction. However, there is industry and owner confusion on how the different types of bridges compare on a Life Cycle Cost basis.

This study developed useful owner information on historical Life Cycle Costs for typical steel and concrete state bridges in Pennsylvania. Typical bridges are defined in the study as those with concrete decks supported by steel rolled beams, steel plate girders, precast concrete boxes, or precast concrete beams. PennDOT historical records for bridges built between 1960 and 2010 were used to develop a database for the Life Cycle Cost study. Initial and maintenance costs considered include total project costs (more than just superstructure) as recorded in the PennDOT records. The PennDOT database used for the Life Cycle Cost analyses only includes a subset of the total bridge inventory due to missing cost and date data for a majority of the individual bridges. The database consists of 1186 state bridges out of 6587 (18% of the eligible inventory) built between 1960 and 2010.

The initial costs, Life Cycle Costs, and future costs of the 1186 bridges in the database are examined with respect to variability in bridge type, bridge length, number of spans, and bridge life. The steel bridges in the database are also examined with respect to protective coating systems. Consideration of the specific numbers and any conclusions must be taken in the context that the results represent the bridges that made it into the database, and the database is not as comprehensive as desirable for drawing conclusions. Therefore, interpreting the tables and figures showing comparisons of initial costs, Perpetual Present Value Costs, maintenance and future costs, and bridge life is left to the reader.

A conclusion that can be drawn is that all the types of bridges are fairly competitive in both Initial Costs and Perpetual Present Value Costs. The average initial costs vary from $174/ft^2 to $226/ft^2 and the average Perpetual Present Value Costs vary between $218/ft^2 (Pretressed I Beam) and $278/ft^2 (Prestressed Adjacent Box). For bridge life, the lowest average life was 73 years (Pretressed I Beam) and the longest was 82 years (Steel I Beam). The coefficient of variation (standard deviation / mean) of the PPVC was approximately 20%, which is considerably high. With the relatively small differences in the PPVC averages, given the dispersion of the PPVC costs (standard deviation), any of the bridge types may have the least Perpetual Present Value Cost for a given project.

Even though this research was limited to only a subset of PennDOT bridges, the analyses demonstrate the potential benefits of LCC analysis for bridge construction and management. A study of a more comprehensive database of bridges on the initial costs, Life Cycle Costs and future costs of different types of bridges over a diverse set of circumstances would be very useful for bridge owners and managers. With a more comprehensive database, not only would there be a more accurate comparison of bridge types, an accurate comparison of design details, such as jointless decks, rebar coatings, steel protection systems, and other construction details could be completed.

Acknowledgements

This study is a result of the author's discussions with state and county bridge engineers' questions on Life Cycle Costs of bridges. The work is an attempt to give bridge owners Life Cycle Cost data so that they can make informed decisions in their bridge programs.

The author would like to acknowledge financial support from the Steel Marketing Development Institute, the National Steel bridge Alliance, and the American Galvanizers Association.

The professionals of the Pennsylvania Department of Transportation deserve special thanks. PennDOT Bridge Engineer Tom Macioce eagerly agreed to be part of the study, a welcome agreement given the difficulty the author had in securing bridge data. Gathering the necessary historical data was a daunting task. The engineers at PennDOT, and especially Civil Engineer Katherine Schopman, devoted many hours mining and verifying historical records so the author could develop an accurate bridge database for the Life Cycle Cost study.

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1 - Introduction

1.1 Background

Since the early 1990's, the Federal Highway Administration (FHWA) has promoted the consideration of Life Cycle Costs Analysis (LCCA) in the design and engineering of bridges. LCCA is an economic method to compare design alternatives over the entire life of the structure. The method considers not only initial costs, but also the future costs, their timing, and the service life of the bridge. LCCA determines the "true cost" of bridge alternatives, considering the time value of money, for an equivalent monetary comparison.

For instance, if one alternative has a high initial cost and no futures costs, LCCA can compare this to an alternative that has a lower initial cost and a major costly rehabilitation at 40 years. LCCA methods discount future costs to equivalent today costs for a direct economic comparison.

There has historically been a healthy competition between material types for new bridge construction. The most prevalent material types being used for typical bridges (those considered in this study) include steel rolled beams or plate girders and precast concrete box or beam superstructures with concrete decks. However, there is industry and owner confusion on how the different types of bridges compare on a Life Cycle Cost basis.

Both the concrete industry and the steel industry site various anecdotal advantage above the other for the Life Cycle Costs over the life of the bridge, and both are correct. Yes, given the competition between steel and concrete, different characteristics across the country's regions, diverse design and construction techniques employed by owners, varied maintenance program efforts, etc, sometimes steel may show an advantage and sometimes concrete may show an advantage. This is especially true for a bridge at an individual site, in a specific region, and with particular environmental characteristics.

Over the years, the author has worked with state departments of transportations and local county engineers on effective and economical bridge construction. A frequent question that arises during meetings is the difference in Life Cycle Costs between steel and concrete girder bridges. The discussion entails anecdotal information from the concrete industry and the steel industry. The concrete industry, using their projected maintenance and rehabilitation assumptions, can show that a precast beam bridge with integral abutments has lower Life Cycle Costs than a painted steel beam bridge with end deck joints in a northern state that uses road salt. The steel industry can show, with their assumptions, that a galvanized steel bridge with a jointless deck has a lower Life Cycle Cost in that same environment. Although the discussions are helpful, the issue remains unsettled. Owners want to consider LCC in bridge design decisions, but many are uncomfortable with this anecdotal discussion.

1.2 Objectives

The objective of this study was to develop useful owner information on historical Life Cycle Costs for typical bridges across the country. A database of bridges across the country was to be developed for the

Life Cycle Cost analyses. For each bridge in the database, the LCC analysis requires: the year built and the initial cost; dates and costs for repairs, maintenance and rehabilitations, and the reasons for the work; and the end-of-service life that may be actual or estimated. The intent was to develop historical Life Cycle Cost data for bridges owned by state departments of transportation (state) and those owned by counties (local). There is a significant difference between state and local bridges in both initial costs and maintenance costs.

The typical bridges in the study are simple- and multi-span "regular type" rolled steel, plate girder, precast I-beam, and precast box beam bridges. The years of inclusion were set to bridges built between 1960 (modern era for prestressed concrete and steel construction techniques) and 2010. Different geographical regions were to be included to examine wet and dry, cold and warm, and various environmental condition climates. For the steel bridges, the plan was to examine the influence of painted, weathering steel and galvanized protection systems. It was also desired to study the impact of other characteristics that would have an influence such as type of construction, deck material and joint details, deck rebar coatings, traffic volume and original design loads.

As stated above, the objective of this study was to develop useful owner information on historical Life Cycle Costs for typical state owned and local owned bridges across the country. The author worked with several select states and various select counties to develop a comprehensive database of bridges. However, the effort was, for the most part, unsuccessful. The data collection requirement of knowing each bridge's entire life of initial costs and future costs and dates was problematic for the owners due to the high amount of time and resources required to collect the data. Of the states contacted, only the Pennsylvania Department of Transportation had the necessary complete data for a subset of their bridge inventory. At the local level, although some counties had complete data for a few of their bridges, the number of bridges was small and using only a few bridges from a wide range of counties would not result in a consistent study, nor would the result be representative of county bridges.

Therefore, although the study was intended to examine state and local bridges across the country, the study was limited to state owned bridges in Pennsylvania. Also, the PennDOT database used for the Life Cycle Cost analyses only includes a subset of the total bridge inventory due to missing data for the majority of the individual bridges. The final Life Cycle Cost database consists of 1186 state bridges out of 6587 built between 1960 and 2010. This means the database represents 18% of the inventory. The report describes the criteria applied to development of the PennDOT bridge database that is used for the Life Cycle Cost analyses.

1.3 Summary of Results

The report presents the Life Cycle Cost analyses for the bridge database. The initial costs, Life Cycle Costs, and future costs of the 1186 bridges in the database are examined with respect to variability in bridge type, bridge length, number of spans, and bridge life. The steel bridges in the database are also examined with respect to protective coating systems.

The database must be considered only a snapshot of the total PennDOT bridge inventory. The criteria removed 82% of the eligible bridges built between 1960 and 2010, mostly due to incomplete initial cost, maintenance records and external contract records. If these records were complete, the database would be much larger and the resulting Life Cycle Cost analyses would more accurately represent the PennDOT bridge inventory. Consideration of the specific numbers and any conclusions must be taken in the context that the results represent the bridges that made it into the database, and the database is not as comprehensive as one would like.

However, the study shows that all the types of steel and concrete bridges are fairly competitive in both average Initial Costs and average Life Cycle Costs. With the dispersion of costs (standard deviation) any of the bridge types may have the least Life Cycle Cost for a given project.

1.4 Benefits and Future Work

This historical Life Cycle Cost study was limited to state bridges in Pennsylvania. Even though this research was limited to only a subset of PennDOT bridges, the analyses demonstrate the potential benefits of LCC analysis for bridge construction and management. A study of a more comprehensive database of bridges on the initial costs, Life Cycle Costs and future costs of different types of bridges over a diverse set of circumstances would be very useful for bridge owners and managers. Although extending this work would take considerable effort, other states and counties could be contacted in an effort to obtain a comprehensive bridge database.

2 - Life Cycle Costs

2.1 Introduction

Life Cycle Costs (LCC) analysis is an economic tool that allows comparison of competing project alternatives. For instance, does spending additional funds now that will reduce future maintenance costs make economic sense? A difficulty in comparing alternatives, even when represented in the same terms such as dollars, is that when the dollars are spent has an influence on equivalency due to inflation and discounting.

2.2 Time Value of Money and Discount Rate

Expenditures that occur at various times in the future will have values that depend on the time of the expenditure. A dollar in 1990 has more purchasing power than a dollar in 2014. This is called inflation. Expenditures that occur at various times in the future also must consider the opportunity value of time. Delayed expenditures (future) have the opportunity for economic return (for instance interest) that could be earned on the delayed monies. A dollar today is worth significantly more than a dollar in ten years because the dollar today could be invested and earn interest. This is called discounting. An effective Discount Rate (DR) that considers the effect of inflation (removes inflation) can be determined so that initial and future expenditures can be used to discount cash flow (time value of money) using constant (today) dollars. The DR (effective) will take care of the inflation (due to using constant today dollars) and the discounting for value of time (opportunity for economic return). The present value cost of a future cost (in today's constant dollars) occurring at year N with an effective discount rate of DR is:

$$Present\ Value\ Cost = Future\ Cost(1 + DR)^{-N}$$

For instance, if a concrete deck repair would cost \$1000 today, but it occurs 20 years in the future, at a discount rate of 2.3% the present value cost of that repair in the future is:

$$Present\ Value\ Cost = \$1000(1 + 0.023)^{-20} = \$634.58$$

With inflation, the actual cost in 20 years will exceed the constant dollar today cost of \$1000, but the \$634.58 invested today will grow over the 20 years at an interest rate (greater than the discount rate) that will be able to pay for the inflated actual cost at year 20. The effective Discount Rate allows Time Value of Money analysis using today's costs (constant dollars) and removes the need to consider inflation and discounting separately.

Discount rate has various meanings for different industries such as banking, the Federal Reserve, pensions and insurance companies. For LCC analysis, the discount rate represents the effective interest rate, accounting for inflation, used to discount cash flow (time value of money). The discount rate used in this work is taken from the Federal Office of Management and Budget Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, Appendix C.

The OMB Circular No A-94 defines nominal and real discount rates for current and past years. The real discount rate is the effective discount rate that accounts for inflation. Table 1 presents historical real discount rates based on interest rates on treasury notes and bonds of specified maturities.

Table 1: OMB Circular A-94 Historical Real Discount Rates

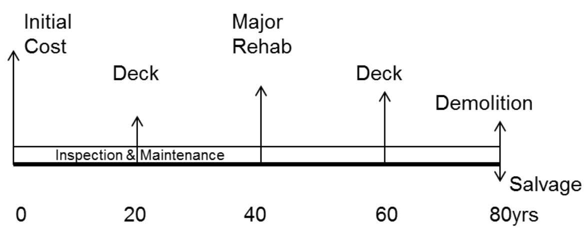
Year	Treasury Notes and Bonds Maturity					
	3 Year	5 Year	7 Year	10 Year	20 Year	30 Year
1979	2.8	3.4	4.1	4.6	#N/A	5.4
1980	2.1	2.4	2.9	3.3	#N/A	3.7
1981	3.6	3.9	4.3	4.4	#N/A	4.8
1982	6.1	7.1	7.5	7.8	#N/A	7.9
1983	4.2	4.7	5	5.3	#N/A	5.6
1984	5	5.4	5.7	6.1	#N/A	6.4
1985	5.9	6.5	6.8	7.1	#N/A	7.4
1986	4.6	5.1	5.6	5.9	#N/A	6.7
1987	2.8	3.1	3.5	3.8	#N/A	4.4
1988	3.5	4.2	4.7	5.1	#N/A	5.6
1989	4.1	4.8	5.3	5.8	#N/A	6.1
1990	3.2	3.6	3.9	4.2	#N/A	4.6
1991	3.2	3.5	3.7	3.9	#N/A	4.2
1992	2.7	3.1	3.3	3.6	#N/A	3.8
1993	3.1	3.6	3.9	4.3	#N/A	4.5
1994	2.1	2.3	2.5	2.7	#N/A	2.8
1995	4.2	4.5	4.6	4.8	#N/A	4.9
1996	2.6	2.7	2.8	2.8	#N/A	3
1997	3.2	3.3	3.4	3.5	#N/A	3.6
1998	3.4	3.5	3.5	3.6	#N/A	3.8
1999	2.6	2.7	2.7	2.7	#N/A	2.9
2000	3.8	3.9	4	4	#N/A	4.2
2001	3.2	3.2	3.2	3.2	#N/A	3.2
2002	2.1	2.8	3	3.1	#N/A	3.9
2003	1.6	1.9	2.2	2.5	#N/A	3.2
2004	1.6	2.1	2.4	2.8	3.4	3.5
2005	1.7	2	2.3	2.5	3	3.1
2006	2.5	2.6	2.7	2.8	3	3
2007	2.5	2.6	2.7	2.8	3	3
2008	2.1	2.3	2.4	2.6	2.8	2.8
2009	0.9	1.6	1.9	2.4	2.9	2.7
2010	0.9	1.6	1.9	2.2	2.7	2.7
2011	0	0.4	0.8	1.3	2.1	2.3
2012	0	0.4	0.7	1.1	1.7	2
2013	-1.4	-0.8	-0.4	0.1	0.8	1.1
2014	-0.7	0	0.5	1	1.6	1.9
2015	0.1	0.4	0.7	0.9	1.2	1.4

Table 1 shows that the discount rate was fairly high in the 1980s, lower in the 1990s, and considerably low in recent years. This work uses (somewhat arbitrarily) the discount rates from 2011 in the Life Cycle Cost analyses. The thought is that 2011 is fairly recent and the very recent discount rates (2015) will tend to increase as the economy improves. It is acknowledged that this selection is subjective, but realizing that as long as the discount rate is consistent across the bridge database, the difference between small changes of discount rate would be minimal. Where the value of the discount rate would have a significant impact would be where one bridge has a higher initial cost and lower future costs compared to a bridge with lower initial cost and higher future costs. These situations are not prevalent in the final LCC bridge database. This work also assumes a long term investment outlook and uses the 30 year maturity level. Therefore, from Table 1, the discount rate used for the Life Cycle Cost analyses in this work is 2.3%.

2.3 Life Cycle Cost Analysis

Life cycle cost analysis represents the "total" cost of a bridge over the life of the bridge and results in an equivalent life cycle cost amount. The cost amount is typically represented by either an Equivalent Uniform Annual Cost (EUAC) or a Present Value Cost (PCV). The EUAC is the life cycle cost amount annualized over the life of the bridge. The PVC represents a present amount that, at a given discount rate (DR), will be enough to pay the initial cost of the bridge and all future costs that are associated with the bridge over its life. This study uses the Present Value Cost in the Life Cycle Cost Analyses.

The data required for the LCC analysis are the initial cost and any future costs and their time frames associated with the bridge over the life of the bridge. Figure 1 demonstrates a LCC analysis for an academic bridge example that has an 80 year life. It assumes future maintenance and rehabilitation costs and the timing of those costs as shown in Figure 1.



For an Initial Cost (IC)
Assume:
Deck = 5% IC (every 20 years)
Rehab = 20% IC (every 40 years)
Demo = 10% IC
Salvage = -3% IC
Main/Ins = 0.1% IC per year

Figure 1: Life Cycle Cost Analysis Example Bridge

The initial cost of the bridge is IC. Deck repair is assumed to cost 5% of the initial cost and to occur every 20 years (except for a major rehabilitation year). The major rehabilitation occurs at 40 years and costs 20% of the initial cost. Demolishing the bridge at 80 years costs 10% of the initial, but there is salvage materials that return 3% of the initial cost (negative is to make the salvage a benefit). Yearly regular maintenance and inspection costs are assumed to be 0.1% of the initial cost. These cost numbers are only used here to demonstrate the LCC analysis and do not necessarily represent a real bridge example. The time value of money equations can be found in any economics book.

The present value cost for all costs associated with this example bridge is:

$$PVC = IC[1 + 0.05(1 + 0.023)^{-20} + 0.05(1 + 0.023)^{-60} + 0.20(1 + 0.023)^{-40} + 0.10(1 + 0.023)^{-80} - 0.03(1 + 0.023)^{-80} + 0.001\frac{(1 + 0.023)^{-80} - 1}{0.023(1 + 0.023)^{-80}}] = 1.17IC$$

The idea is that if the owner invested 1.17 times the initial cost now, the bridge could be built and all future costs would be covered with the extra 17% of the initial cost for a bridge lasting 80 years.

However, when comparing bridges that have different bridge lives, a present value cost by itself is not sufficient. For instance, if this bridge lasts 80 years with a PVC = 1.17IC, it cannot be directly compared to the present value cost of a bridge that lasts only 60 years. Therefore, a common method to directly compare bridges with different life spans is to use either Equivalent Uniform Annual Costs (EUAC) or a Perpetual Present Value Cost (PPVC). Both are equivalent in terms of use for alternative comparisons and the PPVC is used in this work.

The Perpetual Present Value Cost (PPVC) is determined by assuming that at the end of the bridge's life, it is replaced by an identical bridge into perpetuity. This is demonstrated in Figure 2.

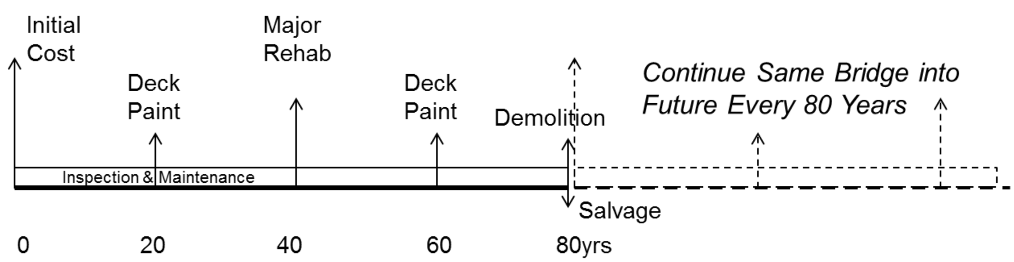


Figure 2: Perpetual Life Cycle Cost Analysis Example Bridge

The PPVC for all costs associated with this bridge into perpetuity is:

$$PPVC = PVC\left[\frac{(1 + 0.023)^{80}}{(1 + 0.023)^{80} - 1}\right] = 1.17IC[1.19] = 1.40IC$$

The idea is that if the owner invested 1.40 times the initial cost now, the bridge could be built and all future costs, including replacing the bridge every 80 years, would be covered with the extra 40% of the initial cost for a bridge lasting into perpetuity. The benefit of using the PPVC is that it allows direct comparisons between any set of bridges.

2.4 Sensitivity of PPVC

The Perpetual Present Value Cost will be sensitive to several variables in the Life Cycle Cost analysis. The primary variables are:

- Bridge Life
- Future Costs
  - Magnitude of Future Costs
  - Timing of Future Costs
- Discount Rate
- Within Steel Bridges – Coating Systems (Weathering Steel , Galvanized & Painted)

The next sections demonstrate the sensitivity using the example bridge from above. The Life Cycle Cost analysis of the PennDOT final LCC bridge database will attempt to examine these variables.

2.4.1 Bridge Life

Assuming the same generic future deck (5%IC @ 20 years), rehabilitation (20%IC @ 40 years), maintenance and inspection (0.1%IC yearly), demolition (10%IC) and salvage costs (-3%IC), Figure 3 shows the PPVC for bridges with a bridge life from 40 to 120 years.

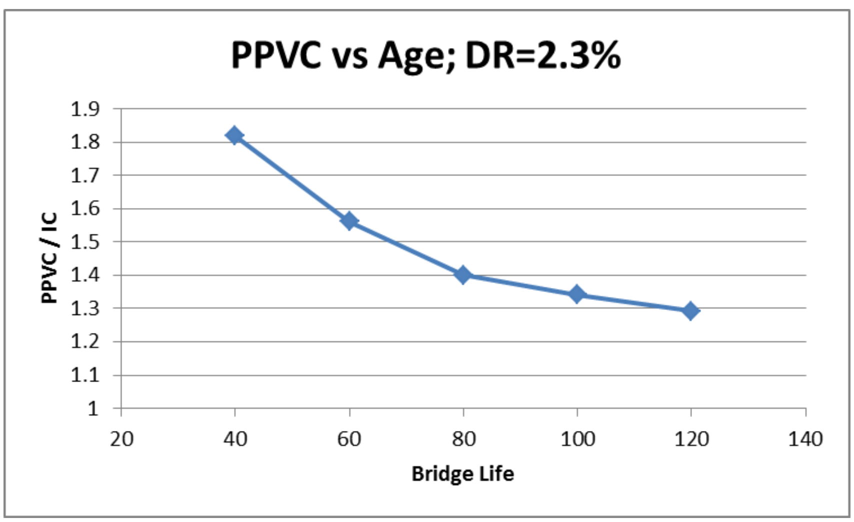


Figure 3: Perpetual Present Value Cost vs. bridge Life

It is clear that bridge life has a large impact on the PPVC. A bridge that lasts 80 years (previous example) has a PPVC of 1.40IC. But, if that bridge only lasts 40 years due to poor performance, the PPVC is over 1.80IC, a significantly large increase in Life Cycle Costs. However, if the bridge life can be extended to 120 years, the PPVC is lower than 1.30IC. This type of analysis can be used to analyze bridge preservation efforts.

2.4.2 Magnitude of Future Costs

To examine the sensitivity to the magnitude of future costs, Figure 4 compares the PPVC with 100% of all future costs considered to the PPVC where the future costs are assigned to be only 90% of the assumed values. The difference is rather small meaning that the PPVC is not all that sensitive to changes in the cost of the future cost.

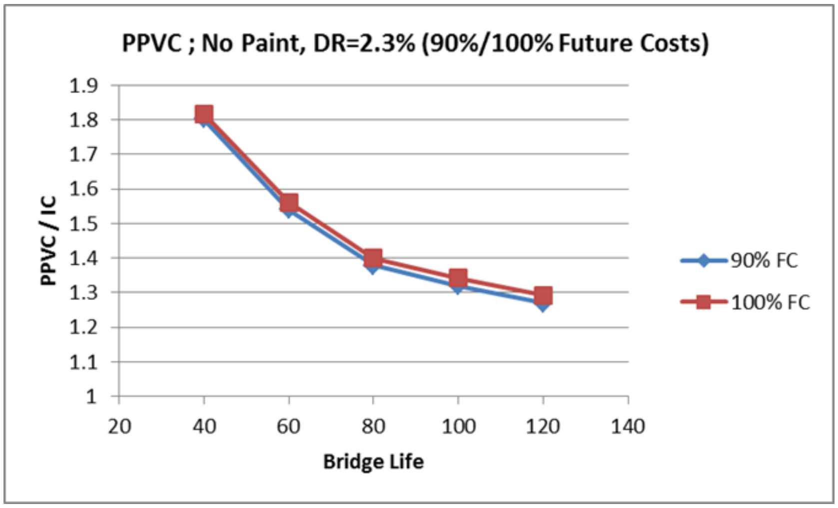


Figure 4: Perpetual Present Value Cost vs. Amount of Future Cost

2.4.3 Timing of Future Costs

Bridge preservation efforts and regular simple maintenance can extend bridge life and delay major rehabilitations and significant required maintenance. Life Cycle Cost analysis can determine the impact. Figure 5 demonstrates the effect for the example bridge.

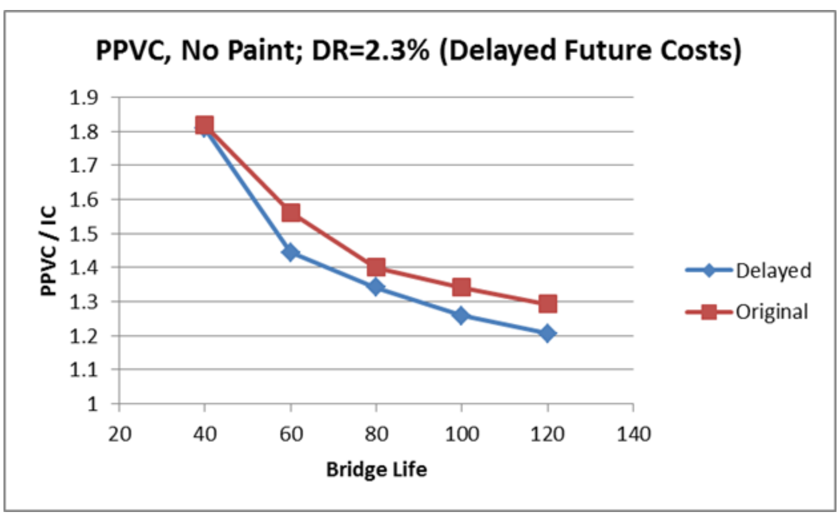


Figure 5: Perpetual Present Value Cost vs. Delayed Future Costs

If deck repair and major rehabilitation is delayed 50% (deck at 30 years vs. 20 and Rehab at 60 years vs. 40), the PPVC is significantly lowered. Of course at 40 years there is little difference since there is little future cost.

2.4.4 Discount Rate

The discount rate used for the PennDOT database is 2.3%. The decision to use 2.3% was explained earlier. However, there would be a direct impact on PPVC if the rate varied. Figure 6 illustrates a comparison of the PPVC between a discount rate of 2.3% and a rate of 5%. The 5% rate represents a similar set of circumstances used to select the 2.3% rate, except for the year 1995. In Figure 6, only the future costs (deck repair, rehabilitation, demolition and salvage) are considered to better show the comparison since initial costs would not change.

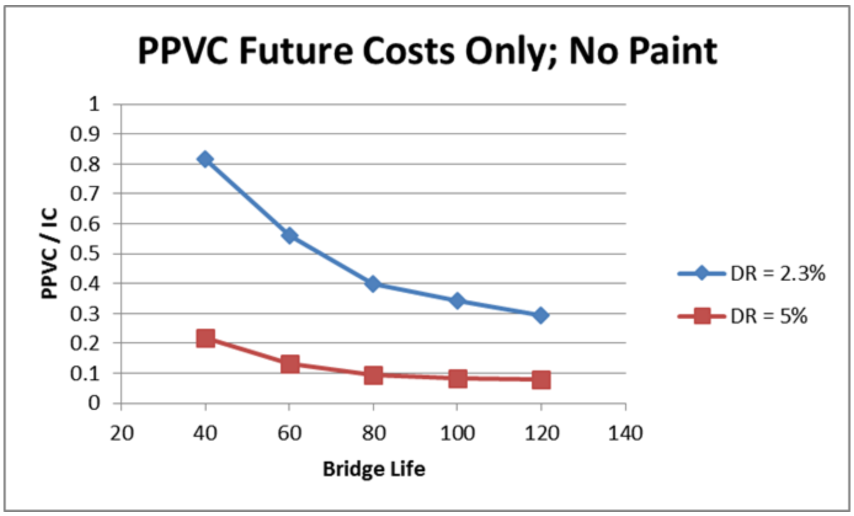


Figure 6: Perpetual Present Value Cost vs. Discount rate

The present value costs for the future maintenance significantly decrease with the higher discount rate. Using an accurate discount rate would be important for examining maintenance and rehabilitation alternatives within a bridge structure. However, when comparing bridges in a database, as long as the bridge histories are somewhat similar, the difference would be consistent over the bridge database. Where the value of the discount rate would have a significant impact in a database comparison analysis would be when one bridge has a higher initial cost and lower future costs compared to a bridge with lower initial cost and higher future costs. These situations are not prevalent in the final LCC bridge database.

2.4.5 Steel Bridge Coating Systems

Coating systems for steel bridges is an important maintenance and preservation issue. Using weathering steel, galvanizing or painting are required to protect the steel from corrosion. Each method of protection has initial costs and possibly required maintenance. Life Cycle Cost analysis can be used to examine the overall effectiveness of the different protection systems. For instance, galvanizing may have a higher initial cost, but if there is little to no future maintenance required, galvanizing may have a lower Life Cycle Cost than a lower initial cost system like painting that requires re-painting costs in the future. For the example bridge, Figure 7 compares the cost of future painting costs to the previous PPVC bridge. It is assumed that re-painting the bridge costs 7% of the initial cost and that is occurs every 20 years, except during the major rehabilitation year. This is not a true comparison of painted vs. galvanized or weathering steel since no difference in the initial cost was considered. However, it does demonstrate the impact from having to re-paint the bridge every 20 years.

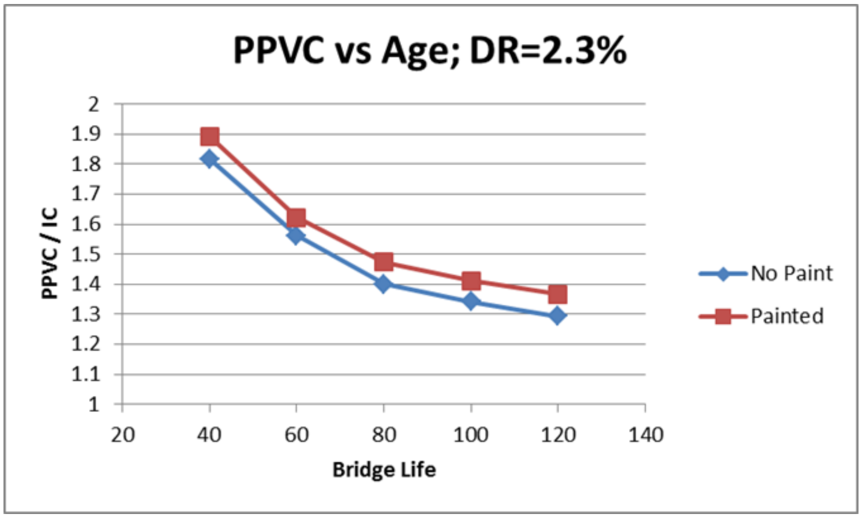


Figure 7: Perpetual Present Value Painted vs. Non-Painted

For a bridge that has an 80 year life, the PPVC for a non-painted bridge was 1.40IC. With a re-painting model of a 7%IC cost` every 20 years, the PPVC increases to 1.47IC, a 5% increase. Using Life Cycle Cost analysis, one can examine what additional initial cost would be "worth" not having to re-paint the bridge.

2.5 Summary of Life Cycle Costs

The Life Cycle Cost procedures developed in this chapter will be applied to the bridge database developed in Chapter 3. An example bridge was used here to study the sensitivity of the Perpetual Present Value Cost to variables that may have a significant impact on the PPVC. It is noted here that the example was not very realistic in terms of maintenance and rehabilitation that actually occurs on the nation's bridges. However, it develops considerations and concepts that will be applied to the PennDOT bridge database. The Life Cycle Cost analyses in Chapter 4 will examine different bridge types for the variables discussed in the sensitivity study as much as is possible for the bridge database developed in Chapter 3.

3 - The PennDOT Database

3.1 PennDOT Database Criteria

The database is developed from files supplied by the PennDOT Bridge Division. Inventory files, PennDOT performed department maintenance files, and external contractor maintenance and rehabilitation files were combined to develop the final database to use in the Life Cycle Cost study. Initial and maintenance costs considered include total project costs as represented in PennDOT records. Therefore, non-superstructure costs are included even though the study pertains to the superstructure only. It is assumed that the non-superstructure costs even out over the large database so the relative comparisons between bridge types is not affected. The following describes the development of the final LCC database. The final LCC database used for this Life Cycle Cost study was limited to the following criteria:

- Modern typical bridge structures
  - Precast I-Beam, Box Adjacent, and Box Spread bridges
  - Steel Rolled Shape and Welded Plate Girder bridges
- Bridges built between 1960 and 2010
- Bridges with complete and accurate department maintenance records
  - Known dates
  - Known costs
  - Consider any maintenance cost that is equal to or greater than $\$0.25/ft^2$
- Bridges with known initial costs
- Bridges with complete and accurate external contractor maintenance and rehabilitation records
  - Known dates
  - Known costs
- Initial cost limitation to bridges with initial cost less than $\$500/ft^2$ and greater than $\$100/ft^2$

For a bridge to be included in the final LCC database, all of the above criteria must be satisfied. If any one of the criterion are not, the bridge is not included in the LCC study. Although care was exercised in developing the database, errors may be present due to inaccurate or missing data in the PennDOT inventory and maintenance files. Individual bridge information was not reviewed by PennDOT state or district personnel for accuracy. It is assumed that any errors cancel out over the database so relative comparisons between bridge types is not affected. The following demonstrates the application of the criteria to develop the final LCC database.

3.2 Initial Database

The PennDOT inventory database includes 25,403 structures of which there are 8466 classified as Precast Box Beam – Spread, Precast Box Beam – Adjacent, Precast I Beam, Steel I Beam – Rolled Shape, and Steel I Welded Girder – Plate Girder bridges. All other types of bridge structures were not considered in this work. The Life Cycle Cost study examined the modern era of bridge construction defined as bridges built from 1960 to the present. The study is also limited to bridges built up to 2010. Table 2 shows the total number of bridges in each category in the PennDOT inventory file and also the number of bridges in each category built between 1960 and 2010. This initial database was the starting point in the process to develop the final database for the LCC study.

Table 2: PennDOT Bridge Inventory Initial Database

Bridge Type	Total Number of Bridges	Number of Bridges 1960 - 2010
Steel I Beam	1347	550
Steel I Girder	1112	1017
P/S Box - Adjacent	1814	1440
P/S Box - Spread	2648	2196
P/S I Beam	1545	1384
Total	8466	6587

3.2.1 Department Performed Maintenance Criterion

The initial bridge database was compared to PennDOT's department performed maintenance files. The criteria are that the maintenance performed must have valid dates and costs for all maintenance performed and that the maintenance costs are equal to or greater than $\$0.25/ft^2$. This removes a great portion of bridges in each category since there are many examples of maintenance that was performed that did not have accurate records. For example, a bridge may have 3 valid maintenance records, but one that did not have a valid date. This bridge would not be included in the final LCC database. One caveat to the acceptance is that any maintenance performed in 2015 was considered a valid date, but the date of that maintenance event was defined to be December of 2014. This is because the LCC study is based on the year 2014 (due to the Construction Cost Indices used) and any error in the time value of money conversions would be miniscule. There are also many bridges that did not have any department maintenance that are included in the intermediate database. The remaining bridges in this intermediate database are shown in Table 3.

Table 3: Intermediate Database with Valid Department Maintenance Records

Bridge Type	Number of Bridges with Valid Maintenance	Number of Bridges with No Maintenance	Intermediate Database Totals
Steel I Beam	99	362	461
Steel I Girder	131	574	705
P/S Box - Adjacent	151	1177	1328
P/S Box - Spread	381	1684	2065
P/S I Beam	204	937	1141
Total	966	4734	5700

There were 1853 bridges that had documented department maintenance that exceeded \$0.25/ft^2 performed. Of those, 966 had maintenance records that had known dates and known costs associated with the maintenance efforts. This means that 887 bridges were removed from the database due to incomplete department maintenance information. These are bridges that would certainly have an impact on the Life Cycle Cost analysis averages. Lower percentages of bridges with valid maintenance records would tend to decrease LCC averages over the database. However, the impact on the averages will be relatively small since future discounted maintenance costs are small compared to initial costs as will be demonstrated in the LCC analyses. Table 4 illustrates the number of bridges with documented department maintenance and those that had valid maintenance information.

Table 4: Department Maintenance Bridge Database Numbers

Bridge Type	Number of Bridges with Maintenance	Number of Bridges with Valid Maintenance	Percentage of Bridges with Valid Maintenance
Steel I Beam	188	99	52.7%
Steel I Girder	443	131	29.6%
P/S Box - Adjacent	263	151	57.4%
P/S Box - Spread	512	381	74.41%
P/S I Beam	447	204	45.6%
Total	1853	966	52.1%

There were also 4734 bridges that had no documented department maintenance that exceeded \$0.25/ft^2. This results in 83% (4734/5700) of the bridge database will be bridges where only the initial cost will be used in the LCC analyses. Higher percentages of no maintenance bridges will tend to lower Life Cycle Cost averages across the database. However, the impact on the averages will be relatively small since future discounted maintenance costs are small compared to initial costs as will be demonstrated in the LCC analyses. Table 5 presents the number of bridges with no documented department maintenance and the percentage of the total intermediate database.

Table 5: No Department Maintenance Bridge Database Numbers

Bridge Type	Bridges in Intermediate Database	Number of Bridges with No Maintenance	Percentage of No Maintenance Bridges in Database
Steel I Beam	461	362	78.5%
Steel I Girder	705	574	81.4%
P/S Box - Adjacent	1328	1177	88.6%
P/S Box - Spread	2065	1684	81.6%
P/S I Beam	1141	937	82.1%
Total	5700	4734	83.1%

The bridges considered in the database were built between 1960 and 2010. The department maintenance performed considered was any maintenance exceeding \$0.25/ft^2 up to the year 2014 (with a few in early 2015 back-dated to end of 2014). Any maintenance that may be performed on a bridge in the future, while a certainty, is not considered in the LCC analyses. This means that each bridge is assumed to have no additional future maintenance until its end-of-life. The impact of this will be a lowering of LCC cost averages across the database. However, each bridge type would have a similar impact as long as the average year built is similar (newer bridges would tend to have no early maintenance). It will be shown in the final LCC database that the average year built is similar for the different types of bridges.

3.2.2 Initial Cost Criterion

PennDOT records were searched to determine if the initial cost for the bridges in this intermediate database were available. This criterion also removed additional bridges from the database since there were many examples where initial costs could not be determined. Table 6 presents the number of bridges in the intermediate database that did have initial cost records that results in a new intermediate database.

Table 6: Intermediate Database with Valid initial Costs

Bridge Type	Number of Bridges with Valid Maintenance and Initial Costs	Number of Bridges with No Maintenance and Initial Costs	Number of Bridges with Valid Maintenance and Initial Costs
Steel I Beam	27	139	166
Steel I Girder	89	367	456
P/S Box - Adjacent	56	431	487
P/S Box - Spread	151	617	768
P/S I Beam	101	447	548
Total	424	2001	2425

The intermediate database has 5700 bridges with valid department maintenance records or bridges with no department maintenance. Of these 5700 bridges, the initial bridge cost for 2425 (42.5%) could be determined. As would be expected, many of the older bridges had incomplete records and were removed from the database. The removed bridges included a representative number from each bridge type. Therefore, the average year built was not affected and the impact of the reduction should be similar for all bridge types.

3.2.3 External Contract Maintenance and Rehabilitation Criterion

In terms of the Life Cycle Cost Analyses, there is no difference between department performed maintenance and external contract maintenance and rehabilitation. In the PennDOT records, the two types of efforts are located in different databases. The development of the final LCC database applied them separately as shown herein. To be included in the final LCC database, the criteria is that the external contract records must have valid dates and costs. The intermediate database that includes bridges with valid or no department maintenance and valid initial costs includes 2425 bridges (Table 6). There were 603 instances of bridges in the intermediate database that had external contracts performed. Of these 603, there were only 26 that had known dates and known costs associated with the work. This means that 565 of the 2425 had to be removed from the database resulting in a final eligible database of 1860 bridges. Table 7 presents the database number of bridges for each category.

Table 7: Intermediate Database that Meets External Contract Criteria

Bridge Type	Number of Bridges with Valid Maintenance and Initial Costs	Number of Bridges Removed due to Missing External Contract Information	Number of Bridges with Valid Maintenance, Initial Costs, and Contracts
Steel I Beam	166	81	85
Steel I Girder	456	192	264
P/S Box - Adjacent	487	63	424
P/S Box - Spread	768	149	619
P/S I Beam	548	80	468
Total	2425	565	1860

The impact of the removal of bridges with documented contracts, but not valid dates and costs, would be similar to the impact from bridges with invalid department maintenance. Also, the same rule that any future contracts that may be performed on a bridge is not considered. With department maintenance, as discussed above, the discounted future costs are usually small compared to the initial costs. For external contracts that involve major rehabilitation, this is not as prevalent and the discounted future rehabilitation costs may be significant. This would result in the average Life Cycle Costs would increase since many of these bridges have been removed from the database. However, there is no manner to predict major rehabilitation dates or costs for the database bridges. Therefore, it is assumed that the different types of bridges would be impacted similarly.

3.2.4 Initial Cost Limitation Criterion

There are bridges built that have unrealistic initial costs due to project specific characteristics. A bridge may have unreasonably high costs due to extremely complicated site characteristics or lower than normal costs due to existing abutments or other atypical beneficial characteristics. To consider typical bridges of the different types, it was decided to remove bridges from the database that had initial costs exceeding $500/ft^2 and those with costs less than $100/ft^2. The limits were selected in consultation with the PennDOT Bridge Engineer where the remaining bridges were considered "typical" in his estimation. The criteria removed 155 bridges from the database

3.3 Final LCC Bridge Database

Table 8 presents the final LCC database that will be used for the Life Cycle Cost analyses and the percentage compared to the total number of bridges built from 1960 to 2010 from Table 2.

Table 8: Final LCC Database that Meets All Criteria

Bridge Type	Number of Bridges that Meet All criteria	Percentage of 1960 – 2010 database
Steel I Beam	82	14.9%
Steel I Girder	230	22.6%
P/S Box - Adjacent	400	27.8%
P/S Box - Spread	581	26.5%
P/S I Beam	412	29.8%
Total	1705	25.9%

There were 6587 Precast Box Beam – Spread, Precast Box Beam – Adjacent, Precast I Beam, Steel I Beam – Rolled Shape, and Steel I Welded Girder – Plate Girder eligible bridges identified as being built between 1960 and 2010. Of those, 1705 were found to meet the criteria for the final LCC database. This represents 25.9% of the eligible bridges, a decent percentage of the total. However, the database must be considered only a snapshot of the total PennDOT bridge inventory for the bridge types. The criteria removed nearly 75% of the eligible bridges built between 1960 and 2010, mostly due to incomplete initial cost, maintenance records and external contract records. If these records were complete, the database would be much larger and the resulting Life Cycle Cost analyses would more accurately represent the PennDOT bridge inventory.

3.4 End Of Life Prediction

In the Life Cycle Cost Analyses, the end of life of the bridge (when the bridge needs replacement) defines the life cycle of the bridge. Since the bridges in the final LCC database are all currently in service, it was necessary to estimate an end of life date for each bridge. This was accomplished through the use of average deterioration rates based on the Condition Ratings of the superstructure. This study is interested in the Life Cycle Costs of the superstructure only, so the condition ratings of the deck and substructure were not considered.

3.4.1 Deterioration Rates

To model the deterioration rate, it was assumed that the condition rating decreased linearly over time and the bridge is assumed to be replaced when the condition rating reached 3.0. Also it is assumed that the condition rating is 9.0 when the structure was built. Thus, for a given bridge in the year 2014, the deterioration rate is:

$$Deterioration\ Rate = \frac{(2014\ Condition\ Rating) - 9}{2014 - (Year\ Built)}$$

This has many drawbacks such as deterioration rates are not necessarily linear, rehabilitations tend to raise condition ratings, there is no consideration of average daily traffic, and preservation (maintenance) efforts are not represented.

All 6587 of the bridges built between 1960 and 2010 were used to determine the average deterioration rates for the different types of bridges. Table 9 presents the average deterioration rates and the coefficient of variation of the data within each bridge type.

Table 9: Average Deterioration Rates

Bridge Type	Number of Bridges 1960 - 2010	Deterioration Rate (Condition Rating Loss/Year)	Coefficient of Variation (Mean/St. Deviation)
Steel I Beam	550	-0.07114	54.7%
Steel I Girder	1017	-0.08144	57.4%
P/S Box - Adjacent	1440	-0.08125	50.9%
P/S Box - Spread	2196	-0.07988	70.9%
P/S I Beam	1384	-0.08383	63.3%

It is clear that the variation of the deterioration rate is very high. This is somewhat expected given the variation of bridge characteristics and environments. Other models were considered for deterioration rates. PennDOT assumes certain remaining life based on a non-linear deterioration rate and a Business Plan Network. These were considered for this study, but were found to be difficult to apply and draw conclusions given the limited database of bridges. However, a side-study (not shown here) showed that the differences were small for the averages in Table 9 and the PennDOT method for the bridges in a Business Plan Network of 1. Therefore, given little alternative, the average deterioration rates in Table 9 were used to estimate the remaining life of each bridge in the final LCC database.

3.4.2 Remaining Life and Bridge Life

To estimate the remaining life for each bridge, it is assumed that the bridge will be replaced when the superstructure condition rating reaches 3.0 for the deterioration rates from Table 9:

$$Remaining\ Life = \frac{3 - \ (2014\ Condition\ Rating)}{(Average\ Deterioration\ Rate)}$$

The bridge life becomes:

$$Bridge\ Life = 2014 - (Year\ Built) + Remaining\ Life$$

Table 10 presents the average year built and the average bridge life for the different bridge types in the final LCC database.

Table 10: Final LCC Database that Meets All Criteria

Bridge Type	Number of Bridges in Final LCC Database	Average Year Built	Average Bridge Life (years)
Steel I Beam	82	1981	81.3
Steel I Girder	230	1977	79.2
P/S Box - Adjacent	400	1985	74.0
P/S Box - Spread	581	1984	79.9
P/S I Beam	412	1984	74.5

3.4.3 End of Life Year

The life cycle starts at the year the bridge is built and goes through the year it is replaced (end of life year). The Life Cycle Cost Analyses for each bridge in the final LCC database requires discounting future costs to current value. This means that the year for the bridge replacement (end of life) is necessary for the analyses. Given the remaining life, the end of life year becomes:

$$End\ of\ Life\ Year = 2014 + Remaining\ Life$$

3.5 Summary

Table 11 presents a summary of the final LCC bridge database to be used in Life Cycle Costs studies in the next chapter.

Table 11: Final LCC Bridge Database Summary

Bridge Type	Number of Bridges in Final LCC Database	Percentage of 1960 – 2010 database	Average Year Built	Average Bridge Life (years)
Steel I Beam	82	14.9%	1981	81.3
Steel I Girder	230	22.6%	1977	79.2
P/S Box - Adjacent	400	27.8%	1985	74.0
P/S Box - Spread	581	26.5%	1984	79.9
P/S I Beam	412	29.8%	1984	74.5
Total	1705	25.9%		

Appendix A lists the bridges in the database used for the Life Cycle Cost Analyses. Not all of the 1705 bridges in Table 11 were included in the LCC database as explained in the next section. In the appendix, there are three tables for each type of bridge type. The first lists the general information for each bridge. For the steel bridges, the first table also lists the rebar, geometry, and material characteristics since this study examined variations within steel bridge types. The second table lists the initial cost for the bridge, maintenance costs, year from year built, and type of maintenance, and external contract work. All costs are reduced to dollars/ft^2 of surface deck area. The monetary values are all in constant 2014 dollars as will be explained in the next chapter. The third table presents the Life Cycle Cost results for each bridge. It presents the Perpetual Life Cycle costs, initial costs, maintenance plus external contract costs, along with the basic bridge characteristics. The third table also presents the averages and standard deviations for the bridge data.

4 - PennDOT Database Life Cycle Cost Analyses

4.1 Database Life Cycle Costs

The final LCC bridge database is analyzed for Life Cycle Costs according to the procedures previously demonstrated in Chapter 2. However, the Chapter 2 example was generic with all costs associated with the bridge known. The bridge database, of course, is missing some of the variables used in the example. For instance, there was no data on demolition costs or salvage costs. Also, there is no attempt to add routine maintenance and inspection costs. The database includes the initial cost for the structure, valid maintenance costs, and valid external contract costs. These costs are listed in the second table in Appendix A for each bridge type in constant 2014 dollars. The Life Cycle Cost analyses conducted in this study use constant 2014 dollars.

4.2 Constant 2014 Dollars

The database presented in Appendix A was developed from the criteria previously discussed. The valid initial costs, maintenance costs and external contract costs collected were actual dollars spent at the time of the cost. Therefore, they must be inflated to an equivalent amount in 2014. The dollars at the time expended are transformed into constant 2014 dollars using the Construction Cost Indices (CCI) provided by Engineering News Record publications. Given an expenditure in a past year 19XX, the equivalent 2014 dollars can be determined by:

$$2014\ Dollars = \frac{CCI\ 2014}{CCI\ 19XX} 19XX\ Dollars$$

Table 12 Shows the Historical Construction Cost Indices from 1960 to 2014.

As an example, if a bridge's initial cost is $330,000 and it is built in 1994, the equivalent 2014 initial cost for the bridge is:

$$2014\ Bridge\ Initial\ Cost = \frac{9806}{5408} \$330{,}000 = 1.813(330{,}000) = \$598{,}370$$

In terms of inflation, this means a bridge built in 2014 costs 81.3% more than a bridge built in 1994.

The cost data for all the bridges in Appendix A are in constant 2014 dollars. Therefore, the study assumes that all of the bridges are built in 2014 for the Life Cycle Cost analyses. The constant 2014 dollars is necessary to (1) account for inflation to transform past built bridges to 2014 using the Construction Cost Index and (2) the discount rate for all future costs considers future inflation and discounting future costs with the discount rate is applied to constant 2014 dollars.

Table 12: Historical Construction Cost Indices from 1960 to 2014 (Engineering News Record)

Year	CCI	Year	CCI	Year	CCI
2014	9806	1995	5471	1976	2401
2013	9547	1994	5408	1975	2212
2012	9308	1993	5210	1974	2020
2011	9070	1992	4985	1973	1895
2010	8799	1991	4835	1972	1753
2009	8570	1990	4732	1971	1581
2008	8310	1989	4615	1970	1381
2007	7966	1988	4519	1969	1269
2006	7751	1987	4406	1968	1155
2005	7446	1986	4295	1967	1074
2004	7115	1985	4195	1966	1019
2003	6694	1984	4146	1965	971
2002	6538	1983	4066	1964	936
2001	6343	1982	3825	1963	901
2000	6221	1981	3535	1962	872
1999	6059	1980	3237	1961	847
1998	5920	1979	3003	1960	824
1997	5826	1978	2776		
1996	5620	1977	2576		

4.3 Life Cycle Cost Example PennDOT Bridge 30570

The Life Cycle Cost analysis will be demonstrated using Precast Box Beam – Spread PennDOT Bridge 30570. The results are shown in Appendix A.

BrKey:	30570
Bridge Type:	P/S, Box Beam (Spread)
County:	Shuylkill
Location:	0.75 mi. N of Exit 107(33)
Year Built:	1969
Spans:	3
Length:	176 ft
Deck Area:	7621 ft^2
Super Cond Rating:	5

Using the average Precast Box Beam – Spread bridge deterioration rate of -0.07988 from Table 9, with a superstructure condition rating of 5, the remaining life is:

$$Remaining\ Life = \frac{(3-5)}{-0.07988} = 25\ years$$

The bridge life is estimated to be:

$$Bridge\ Life = 2014 + 25 - 1969 = 70\ years$$

There were two incidents of department maintenance and one external contract. For this example, total costs and costs/ft^2 of deck area are shown. The remainder of this report will use costs/ft^2 for direct comparisons. The costs at the time of the work and year of the work are:

Initial Cost:	Year = 1969	Cost = \$141475 (\$18.56/ft^2)	Work: Bridge Construction
External Contract:	Year = 1988	Cost = \$58401 (\$7.66/ft^2)	Work: Latex Overlay
Maintenance 1:	Year = 2009	Cost = \$1891 (\$0.25/ft^2)	Work: Repair Concrete Deck
Maintenance 2:	Year = 2013	Cost = \$2510 (\$0.33/ft^2)	Work: Repair Concrete Deck

To transform the costs to constant 2014 dollars, the Construction Cost Indices are applied. To set the time frame for the Life Cycle Cost analysis, the date of maintenance from the built date is determined. The inputs for the LCC analysis are:

Initial Cost:	Year = 0	Cost = \$18.56/ft^2(9806/1269)	= \$143.45/ft^2
External Contract:	Year = 19	Cost = \$7.66/ft^2(9806/4519)	= \$ 16.63/ft^2
Maintenance 1:	Year = 40	Cost = \$0.25/ft^2(9806/8570)	= \$ 0.28/ft^2
Maintenance 2:	Year = 44	Cost = \$0.33/ft^2(9806/9547)	= \$ 0.34/ft^2

The bridge life timeline is shown in Figure 8.

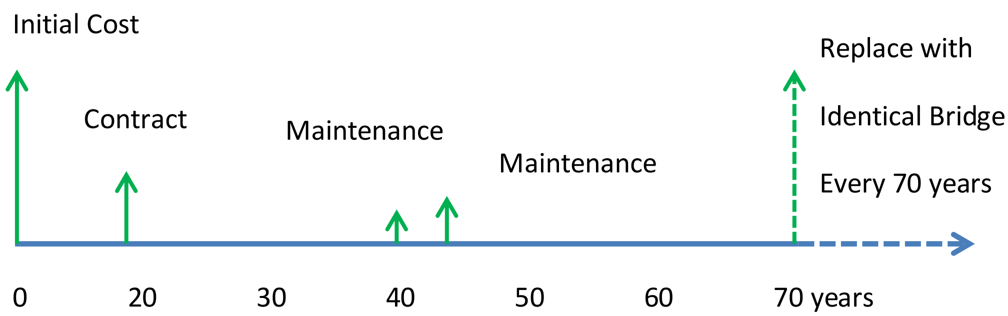


Figure 8: PennDOT Bridge 30750 Life Cycle Cost Timeline

To determine the Present Value Cost, the future costs are discounted to year 0 with a discount rate of 2.3% and added to the initial cost:

$$PVC = \$143.45 + \$16.63(1.023)^{-19} + \$0.28(1.023)^{-40} + \$0.34(1.023)^{-44} = \$154.49/ft^2$$

The Present Value Cost of only the future costs (maintenance and contracts) is:

$$Maintenance\ PVC = 16.63(1.023)^{-19} + 0.28(1.023)^{-40} + 0.34(1.023)^{-44} = \ \$11.04/ft^2$$

Finally, to compare this bridge with others in the PennDOT database, the Perpetual Present Value Cost for Bridge 30570 is:

$$PPVC = \$154.49\left[\frac{(1+0.023)^{70}}{(1+0.023)^{70}-1}\right] = 1.256(\$154.49) = \$193.97/ft^2$$

4.4 Removal of Non-Typical Bridges

There are 1705 bridges in Table 11 that met the database selection criteria. However, there are only 1186 that are used for the Life Cycle Cost comparisons. For the Life Cycle Cost analyses, bridges were removed based on Perpetual Present Value Costs that were considered non-typical. The idea is to compare typical bridges based on the bridge type averages. Therefore, working with the PennDOT Bridge Engineer, a removal criterion was set to be bridges that have a Perpetual Present Value Costs exceeding plus or minus one standard deviation from the mean of the entire bridge type group. This removes bridges that have either unreasonably high or low PPVC due to complicated or simple projects and keeps what is considered typical bridges. Table 13 shows the original number of bridges in the Table 11 database and the number of bridges used for the Life Cycle Cost study.

Table 13: Final Life Cycle Cost Database

Bridge Type	Number of Bridges in Table 11 Database	Number of Bridges in LCC Study Database	Percentage Removed with "Typical Bridge" Criterion
Steel I Beam	82	54	34%
Steel I Girder	230	144	37%
P/S Box - Adjacent	400	282	30%
P/S Box - Spread	581	397	32%
P/S I Beam	412	309	25%
	1705	1186	30%

From Table 13, the percentage of bridges removed with the "Typical Bridge" criterion is fairly consistent over the bridge types. The opinion is that the final Life Cycle Cost database represents typical bridges for the different bridge types and that the averages can be used for comparison. Appendix A contains the 1186 individual bridge results for each bridge type for the final Life Cycle Cost database.

4.5 Life Cycle Cost Results

For each bridge type, the third table in Appendix A lists the PPVC, Initial and present value of all future maintenance costs. Each bridge can be compared to any other within a bridge type or over different bridge types using the PPVC. The third table also lists year built, bridge life, length and number of spans. At the top of the third table are averages and standard deviations for all of these quantities.

Table 14 presents the results of the Life Cycle Cost study for the averages over the database. The PPVC is the quantity to equally compare over different bridge types. The least expensive alternative is the P/S I Beam, followed by the Steel I Beam. Another important consideration for bridge owners is bridge life. Both of the steel bridge types (rolled and girder) have the longest average bridge life. However, since the standard deviations, average length, average number of spans, and average life all vary considerably between the bridge types, it is worth studying these variables a little closer.

Table 14: Life Cycle Cost Results Using Total Database

	# Bridges	PPVC	Initial Cost	Future Cost	Avg Length	Avg # Spans	Avg Year Built	Avg Life
Steel I Beam	54	$232.78	$194.78	$0.42	166	2.19	1980	82
Steel I Girder	144	$273.71	$226.10	$0.21	406	4.07	1976	80
P/S Box - Adjacent	282	$278.30	$223.74	$0.96	89	1.31	1987	74
P/S Box - Spread	397	$256.11	$210.65	$2.06	89	1.56	1986	79
P/S I Beam	309	$217.50	$174.10	$0.20	212	2.43	1985	73

4.5.1 Variability in Perpetual Present Value Cost

Table 15 repeats the averages for PPVC for the different bridge types, but it also presents the standard deviation in the PPVC.

Table 15: Statistical Characteristics of Perpetual Present Value Cost

	Mean	St. Dev	Pr(PPVC<$300)
Steel I Beam	$232.78	$57.51	87.9%
Steel I Girder	$273.71	$65.60	65.6%
P/S Box - Adjacent	$278.30	$48.02	67.4%
P/S Box - Spread	$256.11	$53.51	79.4%
P/S I Beam	$217.50	$54.85	93.4%

Assuming that the behavior follows a Normal distribution, Figure 9 demonstrates the Probability Density Function (PDF) PPVC behavior of the different bridge types. The PDF shows the mean and the standard deviation characteristics. All of the bridge types are similar in both mean and standard deviation. There is no one type of bridge that is clearly less expensive or more uncertain in the cost than another. This is especially true given the limited database that is used in the Life Cycle Cost study.

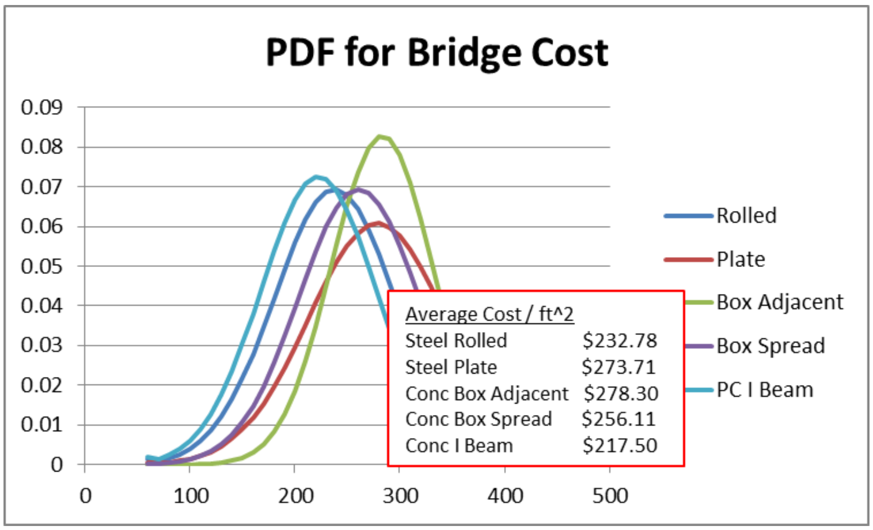


Figure 9: Probability Density Function for Perpetual Present Value Cost

A useful way to use such data is to ask the question, what is the probability that the PPVC is less than $\$300/ft^2$ for the different bridge types? Still assuming the probability distribution is Normal, any statistics textbook can determine that the probability (shown in Table 15) is:

$$Probability(PPVC < \$300/ft^2) = \Phi\left(\frac{300 - Mean}{St.Deviation}\right)$$

This analysis is demonstrated in Figure 10 where the Cumulative Density Function (CDF) is plotted for the different bridge types. There is a 93% probability (confidence for bridge owners) that a Precast I Beam bridge, and an 88% probability that a Steel I Shape Beam bridge, will have a Perpetual Present Value Cost less than $\$300/ft^2$. The probabilities decrease for the other types of bridges.

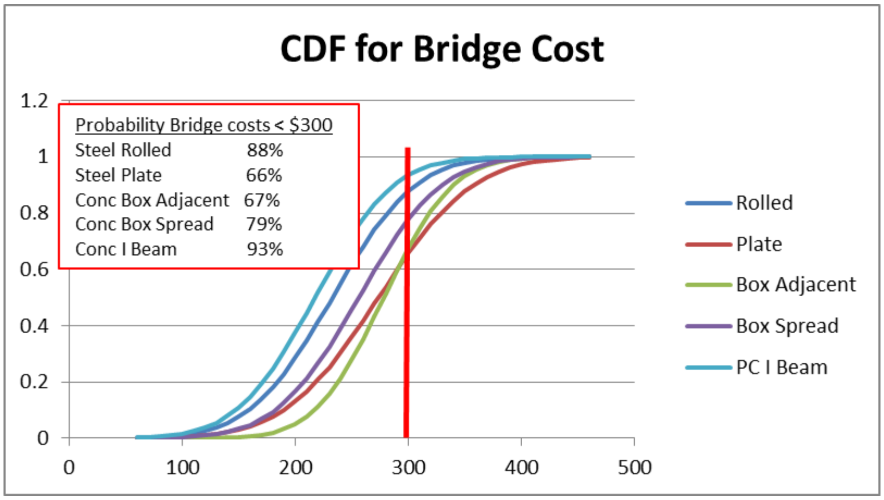


Figure 10: Cumulative Density Function for Perpetual Present Value Cost

4.5.2 Variability in Bridge Life

A similar analysis can be conducted for bridge life. Table 16 repeats the averages for bridge life for the different bridge types, but it also presents the standard deviation in the bridge life.

Table 16: Statistical Characteristics of Bridge Life

	Mean	St. Dev.	Pr(Life>75yrs)
Steel I Beam	82	10.83	73.0%
Steel I Girder	80	15.40	62.7%
P/S Box - Adjacent	74	10.47	45.6%
P/S Box - Spread	79	11.15	65.6%
P/S I Beam	73	11.91	44.3%

Assuming that the behavior follows a Normal distribution, Figure 11 demonstrates the Probability Density Function (PDF) bridge life behavior of the different bridge types. The PDF shows the mean and the standard deviation characteristics. All of the bridge types are similar in mean bridge life and standard deviation (with some differences). There is no one type of bridge that clearly has a significantly longer bridge life (except there is a difference between steel and concrete as a whole) or more uncertain bridge life than another.

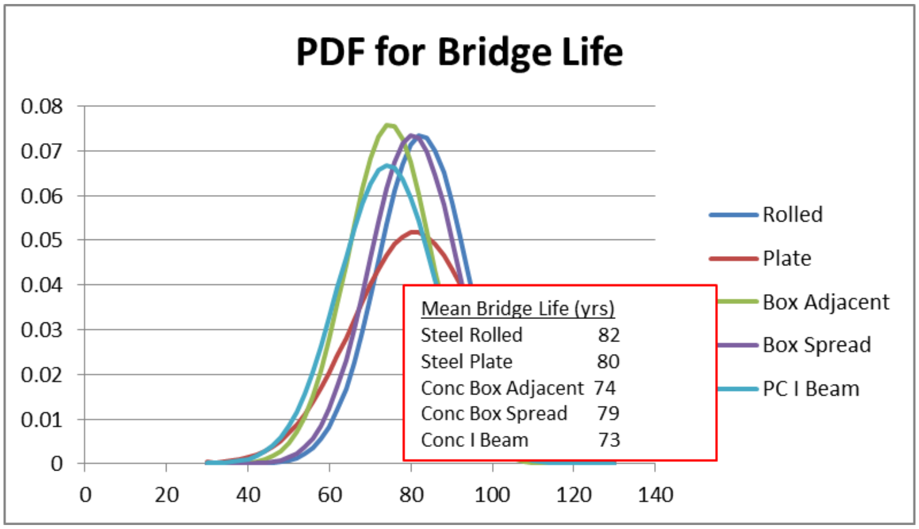


Figure 11: Probability Density Function for Bridge Life

Again, a useful way to use such data is to ask the question, what is the probability that the Bridge Life exceeds 75 years for the different bridge types? Still assuming the probability distribution is Normal, any statistics textbook can determine that the probability (shown in Table 16) is:

$$Probability(Life > 75\ years) = 1 - \Phi\left(\frac{75 - Mean}{St.Deviation}\right)$$

This analysis (assuming Normal distribution) is demonstrated in Figure 12 where the Cumulative Density Function (CDF) is plotted for the different bridge types.

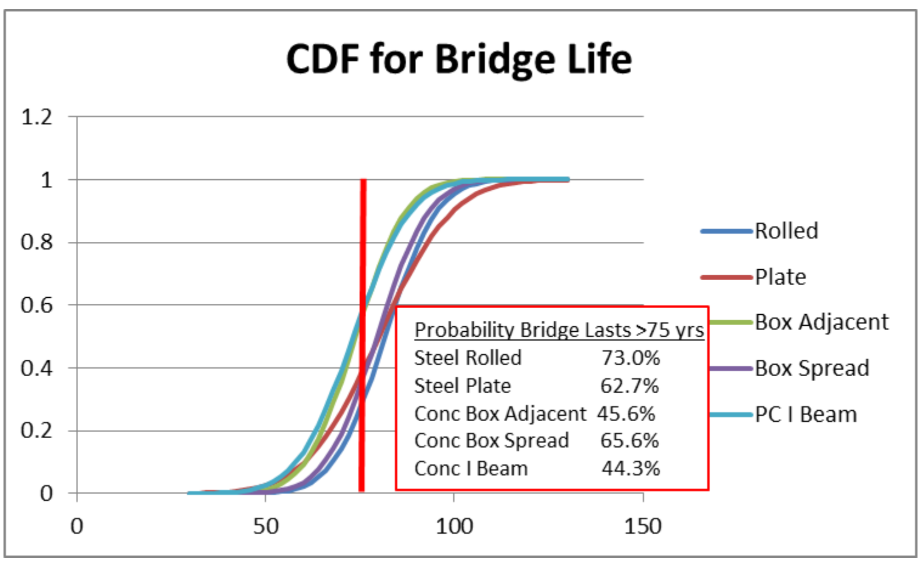


Figure 12: Cumulative Density Function for Bridge Life

There is a 73% probability (confidence for bridge owners) that a Steel I Shape Beam bridge, but only a 44% probability that a Precast I Beam bridge, will have a Bridge Life that exceeds 75 years. The probabilities are between the two for the other types of bridges.

4.5.3 Variability in Average Number of Spans

There is a significant difference in average number of spans between the bridge types. The following examines sub-groups of the bridge types for various numbers of spans. Table 17 shows the results for simple-span bridges. There are 608 simple span bridges that meet the criteria and the re-application of the "Typical Bridge" PPVC criterion.

Table 17: Life Cycle Cost Results for Simple Span Bridges

	# Bridges	PPVC	Initial Cost	Future Cost	Avg Length	Avg # Spans	Avg Year Built	Avg Life
Steel I Beam	22	$302.38	$253.90	$0.13	90	1.00	1981	84
Steel I Girder	21	$318.73	$263.02	$0.25	128	1.00	1979	81
P/S Box - Adjacent	215	$300.74	$241.81	$1.00	65	1.00	1987	74
P/S Box - Spread	245	$294.67	$245.40	$1.06	54	1.00	1988	81
P/S I Beam	105	$287.24	$234.67	$0.04	108	1.00	1989	76

For all the bridge types, the PPVC increases compared to the entire database results. This is expected since most of the time simple-span bridges have higher cost per ft^2. The ranking also changes some with the three concrete bridge types being the least expensive. However, all the bridge types are fairly competitive as they were for the entire database.

Table 18 presents the results for 2-span bridges. There are 184 two-span bridges that meet the criteria and the re-application of the "Typical Bridge" PPVC criterion. For 2-span bridges, some of the PPVC increase and some decrease compared to the overall results. Steel I Girder bridges have the least PPVC, followed by Precast Box Beam – Spread bridges. However, like in previous examples, all of the bridge types are competitive.

Table 18: Life Cycle Cost Results for 2-Span Bridges

	# Bridges	PPVC	Initial Cost	Future Cost	Avg Length	Avg # Spans	Avg Year Built	Avg Life
Steel I Beam	16	$234.04	$193.99	$0.05	198	2.00	1988	81
Steel I Girder	24	$210.49	$175.04	$0.24	243	2.00	1976	81
P/S Box - Adjacent	32	$242.74	$191.74	$1.53	155	2.00	1987	72
P/S Box - Spread	59	$226.78	$183.55	$0.08	127	2.00	1989	74
P/S I Beam	53	$230.78	$183.02	$0.18	209	2.00	1985	71

To consider any bridge that exceeds a simple span, Table 19 has the results for all the bridges that have a number of spans that exceed one (all multi-span bridges). There are 614 multi-span bridges that meet the criteria and the re-application of the "Typical Bridge" PPVC criterion.

Table 19: Life Cycle Cost Results for All Multi-Span Bridges (Number of Spans > 1)

	# Bridges	PPVC	Initial Cost	Future Cost	Avg Length	Avg # Spans	Avg Year Built	Avg Life
Steel I Beam	35	$213.82	$177.00	$0.62	213	2.80	1980	80
Steel I Girder	123	$262.12	$217.78	$0.19	460	4.66	1976	80
P/S Box - Adjacent	70	$214.90	$170.96	$1.21	181	2.63	1983	73
P/S Box - Spread	170	$190.13	$152.34	$3.29	158	2.82	1980	77
P/S I Beam	216	$193.38	$153.66	$0.21	260	3.15	1983	73

All of the different bridge type average PPVC decreases compared to the overall database for multi-span bridges. Here Precast Box Beam – Spread bridges have the least PPVC, but, again, all of the bridge types are competitive with Steel I Girder (high average number of spans) bridges on the high end of PPVC.

4.5.4 Variability in Average Bridge Length

The Steel Marketing Development Institute, through the Short Span Steel Bridge Alliance, defines short span bridges as those with a length of 140 ft or less. To consider short span bridge behavior, Table 20 presents the results for all bridges that have a maximum span of 140 ft. There are 708 multi-span bridges (most of them precast concrete boxes) that meet the criteria and the re-application of the "Typical Bridge" PPVC criterion. Here the Steel I Beam bridges are the least expensive with Precast Box Beam – Spread next. All of the average PPVC are greater than those of the entire database.

Table 20: Life Cycle Cost Results for Bridge Length Maximum = 140 ft

	# Bridges	PPVC	Initial Cost	Future Cost	Avg Length	Avg # Spans	Avg Year Built	Avg Life
Steel I Beam	27	$266.24	$222.08	$0.16	84	1.26	1978	82
Steel I Girder	18	$311.26	$257.19	$0.29	119	1.00	1977	81
P/S Box - Adjacent	240	$292.38	$235.03	$0.95	69	1.09	1987	74
P/S Box - Spread	325	$272.20	$225.14	$2.16	64	1.23	1986	81
P/S I Beam	98	$281.64	$231.20	$0.05	104	1.08	1987	77

For bridges that have bridge length greater than 140 ft, Table 21 presents the results. There are 479 multi-span bridges (most of them precast concrete boxes) that meet the criteria and the re-application of the "Typical Bridge" PPVC criterion. The three concrete bridge types have the least average PPVC.

Table 21: Life Cycle Cost Results for Bridge Length > 140 ft

	# Bridges	PPVC	Initial Cost	Future Cost	Avg Length	Avg # Spans	Avg Year Built	Avg Life
Steel I Beam	28	$216.25	$180.08	$0.69	234	2.86	1982	80
Steel I Girder	96	$256.79	$213.34	$0.19	281	3.02	1975	80
P/S Box - Adjacent	48	$214.14	$170.45	$1.41	213	2.77	1983	73
P/S Box - Spread	75	$191.14	$153.59	$0.90	206	3.16	1981	74
P/S I Beam	232	$195.38	$154.71	$0.25	258	3.05	1984	72

4.5.5 Summary of PPVC Comparisons

Drawing absolute Life Cycle Cost conclusions between different bridge types is difficult given the PennDOT database used in the analyses. The database comprises bridges that met all of the criteria, including known dates and costs for all maintenance performed, known dates and costs for all external contracts performed, and known initial costs. There were many bridges that had maintenance and external contracts, but without known dates or costs. These bridges were removed from the database. There were many bridges with most of the information known, but one item missing. These bridges were removed from the database. Therefore, the database is biased towards bridges that did not have maintenance or external contracts since these would not have been removed as long as they had initial costs. The results do not include a large number of bridges that have maintenance. So, consideration of the specific numbers must be taken in context that the numbers represent the bridges that made it into the database, and the database is not as comprehensive as one would like.

However, a conclusion that can be drawn is that all the types of bridges are fairly competitive in both Initial Costs and Perpetual Present Value Costs. With the dispersion of costs (standard deviation) any of the bridge types may be least expensive for a given project.

4.5.6 Future Costs

The benefit in considering Life Cycle Costs in bridge project decisions is that a LCC analysis considers future costs and bridge life. Both are important aspects for bridge management. Bridge life was addressed above with the steel bridge types having a slight advantage over the concrete types. One indicator of how much future maintenance costs and bridge life impact Life Cycle Costs would be the ratio of PPVC and Initial Cost. The ratio would contain an influence from bridge life since the PPVC assumes the bridge is replaced into perpetuity. Table 22 presents the average PPVC, Initial Cost, the present value cost of all future maintenance costs, bridge life, and the ratio of PPVC and Initial Cost. The average Future Cost is the sum of all maintenance and external contract work for each bridge type divided by the number of bridges for that bridge type.

Table 22: Life Cycle Costs and PPVC/Initial Cost for Total Database

	# Bridges	PPVC	Initial Cost	Future Cost	Avg Life	PPVC/Initial Cost
Steel I Beam	54	$232.78	$194.78	$0.42	82	1.20
Steel I Girder	144	$273.71	$226.10	$0.21	80	1.21
P/S Box - Adjacent	282	$278.30	$223.74	$0.96	74	1.24
P/S Box - Spread	397	$256.11	$210.65	$2.06	79	1.22
P/S I Beam	309	$217.50	$174.10	$0.20	73	1.25

For instance, for Steel I Beam bridges, the result indicates that, for this database, on average it takes 20% more than the initial cost to take care of all future maintenance costs and replace the bridge into perpetuity. The reason that the above statement states “for this database” is that the database is biased towards bridges with no maintenance costs.

When comparing the bridge types, the steel type bridges have a lower future cost component (1.20 and 1.21 vs. 1.22 – 1.25). This is a combination of future maintenance costs and bridge life. Precast I beam bridges have the lowest Future Cost of $0.20, but an average bridge life of only 73 years, whereas Steel I Beam bridges have a higher Future Cost of $0.42, but the average bridge life is 82 years. The combination of the two variables results in Steel I Beam bridges having a lower PPVC/Initial Cost of 1.20 while the Precast I Beam bridges have a ratio 0f 1.25.

4.5.7 Maintenance and External Contracts

The second table in Appendix A lists the maintenance and external contracts that were performed on each bridge for each bride type in the database. Table 23 lists the types of maintenance that are included in the database.

Table 23: Maintenance Definitions for the Database

Group	PennDOT Designation	Description
1 - Concrete Deck	6-D744303-RPR.CONC.DECK	Concrete Deck (Repair)
2 - Deck Joints	20-D744102-RPR.STL.EXP.DAM	Steel Dams (Repair/Rehab)
	2-A743301-RESEAL DK.JOINT	Reseal Deck Joint
	33-B744102-RPR/RPLCOMPR.SEAL	Compression Seal (Repair/Rehab)
	4-A744101-REPAIR DK.JOINT	Repair/Reseal Deck Joint
3 - Structure Framing	25-A744602-RPR/RPL.STEEL BEAM	Stringer (Repair/Replace) - Steel
	54-D744602-RPR/RPLSTLDIAPHRAM	Diaphragm/Lateral Bracing (Repair/Replace) - Steel
	49-C744602-RPR.STEELGIRDER	Girder (Repair) - Steel
	42-A744603-RPR/RPL.CONC.BEAM	Stringer (Repair/Replace) - Concrete
	69-B744603-RPR/RPLCONC DIAPHRAM	Diaphragm (Repair/Replace) - Concrete
	45-D744503-RPL.BRGPED/SEAT	Pedestal Seat (Reconstruct)
	EXTERNAL CONTRACT WORK	Various Superstructure Work
4 - Painting	57-A743201-SPOT PAINT SUPERSTR	Superstucture Spot Painting
	65-C743201-PAINT SUPERSTRUCTURE	Superstructure Full Painting
5 - Protection	80-A743401-PROT.CTG.TO SUPERSTR	Superstructure Protective Coating

The maintenance work is divided into five groups: Concrete Deck, Deck Joints, Structure Framing, Painting and Protection. Noting that the database has concerns in terms of completeness of information, Tables 24 through 26 present maintenance characteristics for the Concrete Deck, Deck Joints and Structure Framing groups.

Table 24: Maintenance Characteristics for Concrete Deck Repair

	# Bridges	# Occurrences	Avg Age to Repair	Average Cost per ($/ft^2)	% of Bridges Repaired	Avg Cost over all Bridges
Steel Rolled	54	12	42	$0.29	22.22%	$0.06
Steel Plate	144	22	39	$0.89	15.28%	$0.14
Concrete Box Adjacent	282	32	35	$6.95	11.35%	$0.79
Concrete Box Spread	397	82	37	$1.15	20.65%	$0.24
Concrete I-beam	309	78	40	$0.46	25.24%	$0.12

Table 25: Maintenance Characteristics for Deck Joints

	# Bridges	# Occurrences	Avg Age to Repair	Average Cost per ($/ft^2)	% of Bridges Repaired	Avg Cost over all Bridges
Steel Rolled	54	16	37	$0.32	29.63%	$0.09
Steel Plate	144	42	36	$0.64	29.17%	$0.19
Concrete Box Adjacent	282	25	32	$3.43	8.87%	$0.30
Concrete Box Spread	397	51	33	$0.91	12.85%	$0.12
Concrete I-beam	309	51	35	$0.94	16.50%	$0.16

Table 26: Maintenance Characteristics for Structure Framing

	# Bridges	# Occurrences	Avg Age to Repair	Average Cost per ($/ft^2)	% of Bridges Repaired	Avg Cost over all Bridges
Steel Rolled	54	4	38	$9.87	7.41%	$0.73
Steel Plate	144	19	38	$1.08	13.19%	$0.14
Concrete Box Adjacent	282	2	27	$63.81	0.71%	$0.45
Concrete Box Spread	397	18	25	$44.04	4.53%	$2.00
Concrete I-beam	309	6	39	$0.51	1.94%	$0.01

The number of occurrences is the total number of maintenance events that were performed for that bridge type. The average cost per event is the total cost of all occurrences divided by the number of occurrences. The percentage of bridges repaired is the number of occurrences divided by the number of bridges. However, this may have some inaccuracy since the same repair may have been applied to a bridge more than once. The same inaccuracy may be present in the average cost over all bridges in that the average cost of each repair times the number of occurrences is divided by the number of bridges in the database for each bridge type.

The results shown are for the database as developed and the number of maintenance occurrences is fairly low. With the limited number of bridges in the database that have valid maintenance records, it is difficult to draw meaningful conclusions. However, the Concrete Box type bridges, when maintenance is required, have high maintenance costs for deck repair and structure framing. Concrete Box type bridges are configured to where the deck is part of the structure framing, so there is a cross-over when trying to separate the deck from the box.

So, again, consideration of the specific numbers must be taken with the context that the numbers represent the bridges that made it into the database, and the database is not as comprehensive as one would like. However, if the database was comprehensive, such a study could be very beneficial to bridge owners and managers.

4.5.8 PennDOT Steel Bridge Database

Within the steel type bridge database, additional characteristics were examined. For instance, curved steel bridge construction is more complicated than straight bridges. Fracture-critical bridges, having additional scrutiny over non-fracture-critical bridges, may result in additional initial and future costs. Also, coating systems can have an influence on initial and future costs. Table 27 examines these variables. The following discusses the results within the limited steel bridge PennDOT database.

Table 27: Steel I Beam and Steel I Girder Bridges

	# Bridges	PPVC	Initial Cost	Future Cost	Avg Length	Avg # Spans	Avg Year Built	Avg Life
Steel Rolled - All	54	$232.78	$194.78	$0.42	166	2.19	1980	82
Steel Rolled - Straight	46	$229.94	$193.19	$0.48	160	2.22	1979	82
Steel Rolled - Weathering	15	$242.75	$203.95	$0.07	164	1.47	1983	83
Steel Girder - All	144	$273.71	$226.10	$0.21	406	4.07	1976	80
Steel Girder - Straight	100	$273.54	$225.58	$0.21	330	3.18	1976	80
Steel Girder - Weathering	11	$254.04	$215.76	$0.03	263	2.45	1974	83
Steel Girder - Non Fract. Crit.	132	$272.53	$225.11	$0.23	359	3.50	1976	80

4.5.8.1 Curved vs. Straight Steel Bridges

When comparing the results for straight bridges and the results for all of the bridges, for both the Steel I Beam and Steel I Girder bridges in the database, there is little difference between curved and straight bridges for PPVC, Initial Costs, Future Costs, or Bridge Life. Although there are not that many curved bridges in the database (8 I beam (15%) and 44 I Girder (30%)), the additional costs associated with curved bridges does not increase the all bridge data significantly (($232.78-$229.94)/$229.94 = 1.2% for I Beam and nearly nothing for I Girder).

4.5.8.2 Fracture-Critical Steel Bridges

There were 12 fracture-critical bridges in the Steel I Girder database. The PPVC for the fracture-critical bridges is actually lower than the PPVC for all I Girder bridges. From this database analysis, it does not appear that fracture-critical designation has a significant impact on Life Cycle Costs.

4.5.8.3 Painted vs. Weathering Steel

The database includes 15 I Beam and 11 I Girder bridges that used weathering steel. The remainder of the bridges are assumed to be painted. When comparing the painted to the weathering steel bridges, the results are mixed. For PPVC, the weathering steel I Beam bridges have a higher (4.3%) PPVC than the overall PPVC, but the I Girder weathering steel bridges have a lower (0.4%) PPVC. However, what is consistent is that future costs are significantly less for weathering steel bridges than for painted bridges. Also, the bridge life increased slightly.

4.5.8.4 Galvanizing

There were no galvanized bridges that made it into the Life Cycle Cost database. This is unfortunate because protective coating systems is an important aspect of steel bridges and galvanizing has become an economical and effective protection system. Recent information shows that Hot Dipped Galvanizing initial costs are approximately equal to or even less than a quality 3-coat paint system. Of course paint systems need maintenance over the bridge life, whereas galvanizing usually does not, or it may require a zinc-rich spot painting at about 60 years. Group 4 in Table 23 shows the painting maintenance for the steel bridges. Table 28 lists the number of paint maintenance events where there were 4 I Beam and 11 I Girder paint maintenance records. The present value of the average future painting costs for these bridges are \$1.44/ft^2 and \$0.21/ft^2, respectively. If galvanizing was an option, these future costs would be eliminated. However, since there were no galvanized bridges in the database, no direct comparisons can be made in this study.

Table 28: Painted Steel I Beam and Steel I Girder Bridges

	# Bridges	# Occurrences	Avg Age to Repair	Average Cost per (\$/ft^2)
Steel Rolled	54	4	34	\$1.44
Steel Plate	144	11	39	\$0.21

4.5.8.5 Summary of PennDOT Steel Bridge Database

The discussion on characteristics of steel bridges, whether it is curved vs. straight, fracture-critical, or painted vs. weathering steel vs. galvanizing, is based on the limited PennDOT database developed herein. Hard conclusions are difficult to discern due to the limitations within the database. However, with a more comprehensive database, these types of studies would be beneficial to bridge owners and managers.

4.6 Summary

This chapter determined the Life Cycle Costs for the Life Cycle Cost bridge database. The initial costs, Life Cycle Costs, and future costs of the 1186 bridges in the database are examined with respect to variability in bridge type, bridge length, number of spans, and bridge life. The steel bridges in the database are also examined with respect to protective coating systems. Drawing hard conclusions from the results is difficult knowing that the database is limited with respect to the PennDOT bridge inventory. Chapter 5 presents a summary of the study and conclusions from the results.

5 - Summary and Conclusions

5.1 Review of Objectives and Life Cycle Cost Database

The objective of this study was to examine historical Life Cycle Costs of typical steel and concrete bridges across the United States. This requires collecting the life histories of bridges, including initial costs, maintenance, rehabilitation and bridge life. Unfortunately, except for the Pennsylvania Department of Transportation, the select number of states and counties contacted for this study were not able to provide the required data on their bridges due to the large amount of time and resources required to collect this data. Therefore the Life Cycle Cost study contained in this report is limited to state bridges in the PennDOT inventory. Even within the PennDOT inventory, only 18% (1186 bridges out of a possible 6587) of the bridges built between 1960 and 2010 had complete historical records and are included in the Life Cycle Cost analyses. The database must be considered only a snapshot of the total PennDOT bridge inventory. The criteria applied removed 82% of the eligible bridges, mostly due to incomplete initial cost, maintenance records and external contract records. If these records were complete, the database would be much larger and the resulting Life Cycle Cost analyses would more accurately represent the PennDOT bridge inventory.

5.2 Interpreting Results and Conclusions

The report examines the initial costs, Life Cycle Costs, and future costs of the bridges in the database with respect to variability in bridge type, bridge length, number of spans, and bridge life. The types of bridges in the database include steel rolled shape beam, steel plate girder, precast box, and precast beam bridges. The steel bridges in the database are also examined with respect to protective coating systems.

Therefore, given the nature of the database used, interpreting the tables and figures showing comparisons of initial costs, Perpetual Present Value Costs, maintenance and future costs, and bridge life is left to the reader. Consideration of the specific numbers and any conclusions must be taken in the context that the results represent the bridges that made it into the database, and the database is not as comprehensive as desirable for drawing conclusions.

A conclusion that can be drawn, however, is that all the types of bridges are fairly competitive in both Initial Costs and Perpetual Present Value Costs. The average initial costs vary from $174/ft^2 to $226/ft^2 and the average Perpetual Present Value Costs vary between $218/ft^2 (Pretressed I Beam) and $278/ft^2 (Prestressed Adjacent Box). For bridge life, the lowest average life was 73 years (Pretressed I Beam) and the longest was 82 years (Steel I Beam).

The coefficient of variation (standard deviation / mean) of the PPVC was approximately 20%, which is considerably high. With the relatively small differences in the PPVC averages, given the dispersion of the PPVC costs (standard deviation), any of the bridge types may have the least Perpetual Present Value Cost for a given project.

5.3 Future Work

Even though this research was limited to only a subset of PennDOT bridges, the analyses demonstrate the potential benefits of LCC analysis for bridge construction and management. A study of a more comprehensive database of bridges on the initial costs, Life Cycle Costs and future costs of different types of bridges over a diverse set of circumstances would be very useful for bridge owners and managers. With a more comprehensive database, not only would there be a more accurate comparison of bridge types, an accurate comparison of design details, such as jointless decks, rebar coatings, steel protection systems, and other construction details could be completed. The author worked with several states and many counties to try to develop a broad database of bridges across the country. However, these particular states and local owners could not provide the necessary historical data. Although extending this work would take considerable effort, other states and counties could be contacted in an effort to obtain a comprehensive bridge database.

Appendix A - PennDOT Bridge Database

The PennDOT Bridge Database is Divided by Bridge Type:

- **Steel I-Beam**
- **Steel I Welded Girder**
- **Precast Box Beam – Adjacent**
- **Precast Box Beam – Spread**
- **Precast I Beam**

For Each Bridge Type, the Data is Presented as:

- **General Information**
- **Initial Cost, Maintenance and External Contracts**
- **Life Cycle Cost Results**

2015

LIFE-CYCLE COST ANALYSIS OF REINFORCED CONCRETE BRIDGES REHABILITATED WITH CFRP

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Jeffrey L. Smith, Student

Dr. Issam Harik, Major Professor

Dr. Y.T. Wang, Director of Graduate Studies

LIFE-CYCLE COST ANALYSIS OF REINFORCED CONCRETE BRIDGES REHABILITATED WITH CFRP

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Engineering
at the University of Kentucky

By
Jeffrey L. Smith

Lexington, Kentucky

Director: Dr. Issam Harik, Professor of Civil Engineering

Lexington, Kentucky

2015

ABSTRACT OF DISSERTATION

LIFE-CYCLE COST ANALYSIS OF REINFORCED CONCRETE BRIDGES REHABILITATED WITH CFRP

The deterioration of highway bridges and structures and the cost of repairing, rehabilitating, or replacing deteriorated structures is a major issue for bridge owners. An aging infrastructure as well as the need to upgrade structural capacity for heavier trucks adds to problem. Life-cycle cost analysis (LCCA) is a useful tool for determining when the deployment of fiber-reinforced polymer (FRP) composite components is an economically viable alternative for rehabilitating deteriorated concrete bridges.

The use of LCCA in bridge design and rehabilitation has been limited. The use of LCCA for bridges on a project level basis has often been limited to the non-routine design of major bridges where the life-cycle cost model is customized.

LCCA has historically been deterministic. The deterministic analysis uses discrete values for inputs and is fairly simple and easy to do. It does not give any indication of risk, i.e. the probability that the input values used in the analysis and the resulting life-cycle cost will actually occur.

Probabilistic analysis accounts for uncertainty and variability in input variables. It requires more effort than a deterministic analysis because probability distribution functions are required, random sampling is used, and a large number of iterations of the life-cycle cost calculations are carried out. The data needed is often not available.

The significance of this study lies in its identification of the parameters that had the most influence on life-cycle costs of concrete bridge and how those parameters interacted. The parameters are: (1) Time to construct the new bridge; (2) traffic volume under bridge (when applicable); (3) value of time for cars; and (4) delay time under the bridge during new bridge construction (when applicable). Using these parameters the analyst can now "simulate" a probabilistic analysis by using the deterministic approach and reducing the number of iterations. This study also extended the use of LCCA to bridge rehabilitations and to bridges with low traffic volumes. A large number of bridges in the United States have low traffic volumes. For the highway bridge considered in the parametric study, rehabilitation using FRP had a lower life-cycle cost when compared to the new bridge alternative.

KEYWORDS: life-cycle cost analysis, bridge rehabilitation, reinforced concrete t-beam bridges, fiber-reinforced polymer

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REHABILITATED WITH CFRP

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CHAPTER ONE: INTRODUCTION

The deterioration of highway bridges and structures is a major problem worldwide. In 2010 about 25.9 percent of the 604,493 bridges in the United States are deficient (USDOT 2013a). This includes both structurally deficient and functionally obsolete bridges. About 11.7 percent of the bridges are structurally deficient.

There are various reasons to replace or rehabilitate deficient bridges (Seible et al. 1991; Arduini and Nanni 1997; Weissmann and Harrison 1998; Lees et al. 2002; Aidoo et al. 2004; Nezamian and Setunge 2007; Choi et al. 2008; Kim and Harries 2013). The reasons may be design, construction, or operation related. Design related reasons include design errors, changes in design specifications, and deficiencies in design specifications. Construction related reasons include construction errors and deficiencies in construction specifications. Operation related reasons include element deterioration, increases in traffic volumes, truck collisions, earthquakes, and increases in legal loads (commercial vehicle sizes and weights) and permit loads.

There are three alternatives for dealing with deficient bridges (Klaiber et al. 1988; Alkhrdaji et al. 2000; Deniaud and Cheng 2003; Flowers et. al. 2010). One alternative is to do nothing. This often leads to load posting the bridge for weight restrictions. Load posting imposes financial hardships on those who then must detour around the posted bridge and can increase congestion on the alternate routes. Another alternative is to rehabilitate the bridge to increase the live load capacity. A third alternative is to replace the bridge.

Bridge Strengthening

There are some advantages to bridge strengthening in lieu of replacement or load posting (Klaiber et al. 1988; Reed et al. 2002; Tavakkolizadeh and Saadatmanesh 2003; Jones et al. 2004; Flowers et. al. 2010; Okeil et al. 2013). Bridge rehabilitation extends the service life of existing bridges. It can cost less to strengthen a bridge than to replace it. The reduced construction time can minimize construction-related impacts such as an increase in traffic delay and congestion, the disruption to local businesses, and environmental impacts (i.e. noise and air quality).

There are several traditional methods to increase the live load capacity of existing bridges (Berger and Gorgon 1978; Klaiber et al. 1988; Nezamian and Setunge 2007). One method is to add supplemental supports or members. Another is to strengthen critical members by increasing their cross section or replacing them. Live load capacity can be increased by reducing dead load, usually by replacing the normal weight concrete deck with a lightweight concrete one. Another is to change the behavior of the structural system by making simple spans continuous or making non-composite beams composite. Most of these methods require closing the bridge or limiting traffic. This has an economic impact on the travelling public (Carolin et al. 2005; Hoult and Lees 2009). One alternative that can minimize these impacts is the addition of external reinforcement.

One traditional method for adding external reinforcement is externally bonded steel plates (Klaiber et al. 1988; Reed et al. 2002; Petrou et al. 2008). It can be accomplished with minimal disruption to traffic (Carolin et al. 2005). However, problems with using steel have led to the search for alternate materials (Bakis et al. 2002; Deniaud and Cheng 2003; Petrou et al. 2008). The two primary issues with using steel plates are corrosion of the steel and the heavy weight of the plates. Fiber-reinforced polymer (FRP) plates can be used in place of steel (Arduini and Nanni 1997; Chaallal et al. 1998; Malek and Patel 2002; Monti and Santini 2002; Alagusundaramoorthy et al. 2003; Choi et al. 2008; Petrou et al. 2008; Hoult and Lees 2009).

Fiber-reinforced Polymers

Fiber-reinforced polymers (FRPs) are being used to strengthen concrete bridges (Alkhrdaji et al. 2000; Shekar et al. 2003; Ekenel et al. 2005; Catbas et al. 2006; Täljsten et al. 2007). The benefits and advantages of FRP composites are widely reported in the published literature (Spadea et al. 1998; Bakis et al. 2002; Alagusundaramoorthy et al. 2003; Deniaud and Cheng 2003; Tavakkolizadeh and Saadatmanesh 2003; Aidoo et al. 2004; Shahrooz and Boy 2004; El Maaddawy and Soudki 2005; Kim et al. 2008; Allen and Atadero 2012; Kim and Harries 2013; Wang et al. 2013). They include a high strength-to-weight ratio, a high tensile strength, superior fatigue resistance, excellent corrosion resistance, strong chemical resistance, advantageous electromagnetic properties, and versatility of use.

The FRP strengthening technique has several advantages (Shahawy et al. 2000; Malek and Patel 2002; Deniaud and Cheng 2003; Wang et al. 2004; Nezamian and Setunge 2007; Soudki et al. 2007; Kim et al. 2008; Allen and Atadero 2012; Kim and Harries 2013; Wang et al. 2013). One of the primary advantages is its lightweight. As a result it is easy to install, requires a minimum amount of equipment to support, and can be installed quickly. This simplifies construction and reduces the amount of time required for installation which can lower the cost. FRP systems can be installed without disrupting traffic on the bridge which decreases the impact on the travelling public. They can increase the ductility, shear resistance, and flexural strength of bridge members. The system can be designed to provide strength where needed. It may be possible to bond FRPs to surfaces that are curved and wrap them to match member geometry. Some other advantages include reduced maintenance costs, minimal reduction in clearances, and minimal changes in member dimensions.

Life-cycle Cost Analysis

The cost of repairing, rehabilitating, or replacing deteriorated structures is a major issue for State Departments of Transportation (DOT). The National Bridge Investment Analysis System model estimates a backlog of bridge investments in 2010 of $106.4 billion (USDOT 2013a). It is estimated that $20.5 billion annually is needed to eliminate the backlog of deficient bridges by the year 2028, which is a 60 percent increase over the $12.8 billion currently being spent (ASCE 2013). An aging infrastructure as well as the need to upgrade structural capacity for heavier live loads (trucks) adds to the backlog. FRP can be used to repair and rehabilitate existing concrete bridges (Bae et al. 2013). Life-cycle cost analysis (LCCA) is a useful tool for determining when FRP is an economically viable method for rehabilitating deteriorated concrete bridges.

The Federal Highway Administration (FHWA) defines Life-Cycle Cost Analysis as “an engineering economic analysis tool useful in comparing the relative merit of competing project implementation alternatives” (FHWA 2002). All costs are considered, both agency and user. The effects of agency activities such as construction on user costs are accounted for. The alternative with the lowest life-cycle cost is identified.

LCCA has historically been deterministic (FHWA 2002, Pittenger et al. 2012). The deterministic analysis uses discrete values for inputs and is fairly simple and easy to do. Published tables of discount factors simplified computational effort required. Since a deterministic analysis gives only a single life-cycle cost it does not give any indication of risk, i.e. the probability that the input values used in the analysis and the resulting life-cycle cost will actually occur (FHWA 2002). Costs and timings do however vary and this variability can affect the choice of alternative.

Probabilistic analysis accounts for uncertainty and variability in input variables (FHWA 2002, Reigle and Zaniewski 2002, Smith et al. 2005). It allows for simultaneous variations in more than one input parameter. A probabilistic analysis requires more effort than a deterministic analysis because probability distribution functions are required, random sampling is used, and a large number of iterations of the life-cycle cost calculations are carried out. In addition the results are tracked and stored for further statistical analysis.

A deterministic sensitivity analysis can be done to partially address the uncertainty and variability of input parameters. However the analysis only varies one parameter at a time and the "compounding" effect of changes in multiple inputs is not addressed. Some changes when individually applied increase life-cycle costs and others decrease life-cycle costs. When taken together the changes may additive or subtractive.

Dissertation Objective and Tasks

The objective of this study is to determine when rehabilitating a reinforced concrete bridge with externally applied fiber reinforced polymer composites had a lower life-cycle cost than bridge replacement.

In order to achieve the objective of this study, the following tasks are carried out:

1) Conduct a literature search to identify the current state-of -the-art in life cycle cost analysis for highway bridges to identify areas needing further research (Chapters 2 and 3);
2) Comparison of the life-cycle cost of reinforced concrete bridges rehabilitated using externally applied FRP composites with a new replacement bridge (Chapter 4);
3) Conduct a sensitivity analysis to identify the variables that primarily influence the life-cycle costs (Chapter 5); and
4) Determine the probability when rehabilitation has the lower life-cycle cost (Chapter 6);

Tasks 2, 3, and 4 were accomplished by applying the methodology to a reinforced concrete T-beam bridge.

Dissertation Significance

The significance of this study lies in its identification of the parameters that had the most influence on life-cycle costs of concrete bridge and how those parameters interacted. The identification of those parameters with the most influence can allow analysts to “simulate” a probabilistic analysis by using the deterministic approach but with a reduced number of iterations. The study extended the use of LCCA to bridge rehabilitations and to bridges with low traffic volumes. A large number of bridges in the United States have low traffic volumes. The study introduced the use of time declining discount rates for longer analysis periods.

Parametric studies included a bridge over a highway, a bridge over a highway with modified construction time and cost, a bridge over a highway with a limited number of random variables, a bridge over a waterway, and a bridge over a waterway with modified construction time and cost. The bridge included in the studies was a reinforced concrete bridge that was either rehabilitated with fiber reinforced polymer composites or replaced with a new bridge.

The methodology can be easily programmed in a spreadsheet. Bridge owners can then perform these analyses to assist with the decision making process as it relates to rehabilitating or replacing a concrete bridge. The methodology can easily be applied to other bridge types.

CHAPTER TWO: LITERATURE REVIEW

A historical background on life-cycle cost analysis (LCCA) is presented by Ozbay et al. (2004). The use of economic analysis in highway engineering was first introduced in the 19th century. In 1847 Gillespie published the *Manual of the Principles and Practices of Road Making*. In this manual the cheapest road is not necessarily the one that costs the least but the one with the greatest return on investment. In 1960 the American Association of State Highway Officials (AASHO) Redbook introduced LCCA to transportation. In 1969 the engineering economist Winfrey published *Economic Analysis for Highways*. During this time research began on user and vehicle operating costs. The American Association of State Highway and Transportation Officials (AASHTO) pavement design guides, 1983 and 1993, included LCCA for economic analysis. Sections 1024 and 1025 of the Intermodal Surface Transportation Efficiency Act of 1992 contain provisions for life cycle costs of bridges, tunnels, and pavements. Federal Executive Order 12893 was issued in 1994 and stated that "Benefits and costs should be measured and appropriately discounted over the full life cycle of each project." The National Highway System (NHS) Designation Act of 1995 required the use of LCCA on NHS projects that cost $25 million or more. The FHWA issued its policy on LCCA in 1996. To assist in the implementation of LCCA for pavements FHWA Demonstration Project 115, "Life-Cycle Cost Analysis in Pavement Design," was made available in 1998. In conjunction with this workshop a technical bulletin (Walls III and Smith 1998) and a spreadsheet based program were developed. National Cooperative Highway Research

Program Report 483 (Hawk 2003) provides a methodology and guidance manual for the LCCA of individual bridges in a project level analysis.

A three-stage survey on LCCA usage was conducted in 2001 and 2002. It obtained information from 39 state DOTs (Ozbay et al. 2004). The results were reported by offices or divisions using LCCA and by the types of projects on which LCCA is used. Of the respondents 68 percent of the design and research offices, 37.5 percent of the materials and pavement offices, and 12.5 percent of bridges offices reported using LCCA. All of the respondents reported using LCCA for pavement projects and only 25 percent reported using LCCA for bridge projects.

Life-cycle Cost Analysis for Pavements

As shown by the results of the LCCA survey most of the usage has been for pavements. It has been used to evaluate design alternatives on a project-level basis (Kulkarni 1984; Beg et al. 2000; Safronetz and Sparks 2003; Lee et al. 2011). The California Department of Transportation (Caltrans) has mandated the use of LCCA to evaluate pavement design alternatives (Lee et. al. 2011). It has been used to evaluate rehabilitation, preventive maintenance, preservation alternatives, and construction techniques (Reigle and Zaniewski 2002; Smith et al. 2005; Gerbrandt and Berthelot 2007; Praticò et al. 2011; Pittenger et al. 2011 and 2012; Pour and Jeong 2012). LCCA has been used to optimize the timing and location of road infrastructure (pavements and bridges) maintenance projects (Evdorides et al. 2002), optimize resource allocation (Gerbrandt and Berthelot 2007), and to estimate annualized life-cycle costs of constructing and maintaining representative road segments that included pavements, bridges, and other road infrastructure components (Swan et al. 2007). Katz (2004) used LCCA to compare FRP reinforced concrete pavement to steel reinforced concrete pavement.

Life-cycle Cost Analysis for Bridges

Many bridge management systems (BMS) use some form of life-cycle cost analysis on a network level (Safi et al. 2012). A BMS typically includes deterioration, life-cycle cost, and budget optimization procedures (Saito and Sinha 1987; Al-Subhi et al. 1990; Shirole et al. 1991; James et al. 1991; Frangopol et al. 2000; Patidar et al. 2007). Chen and Johnston (1990) reported on using economic analysis of alternatives to optimize bridge management decisions (time and cost) for maintenance, rehabilitation, and replacement. Elbehairy et al. (2009) reported on a bridge management system that uses decisions made on the project-level and network-level to optimize bridge repairs. Johnson et al. (1998) reported on using economic analysis to make a preliminary selection of a rehabilitation option, compare the cost and benefits of various rehabilitation alternatives to the no rehabilitation alternative, and establish priorities. Cady (1985) reported on using minimum life-cycle costs for bridge deck protection, repair, rehabilitation, and replacement strategies for the Pennsylvania Department of Transportation. LCCA was used to optimize maintenance of a reinforced concrete bridge deck (Mullard and Stewart 2012) and a reinforced concrete girder bridge (Zhu and Liu 2013).

The use of LCCA in bridge design and rehabilitation has been limited. Fagen and Phares (2000) used LCCA to evaluate a bridge-replacement alternative for low-volume county roads. Okasha et al. (2012) used LCCA to compare steel bridges fabricated with a new maintenance-free steel and conventional painted carbon steel. Ehlen and Marshall (1996) used LCCA to compare concrete beams reinforced with FRP to beams reinforced with conventional steel. Ehlen (1997, 1999) used LCCA to compare FRP bridge decks to reinforced concrete decks. Grace et al. (2012) used LCCA to compare bridge decks reinforced with carbon fiber-reinforced polymer (CFRP) to bridge decks reinforced with conventional steel. The use of LCCA for bridges on a project level basis has been limited to the non-routine design of major bridges where the life-cycle cost model is customized (Thompson, 2004). Meiarashi et al. (2002) compared the life-cycle costs of a CFRP suspension bridge and a steel bridge.

Life-cycle Cost Analysis for Bridge Rehabilitation

LCCA tools for evaluating and comparing bridge rehabilitation strategies, especially fiber reinforced polymers, on a project level are needed. Klaiber et al. (1987) recommended using a life-cycle cost analysis to compare strengthening and replacement options on a project level. Limited information on life-cycle costs and the lack of simple LCCA tools have kept FRP from being used more (Hastak and Halpin 2000; Thompson 2004; Trejo and Reinschmidt 2007a). Cosenza and Manfredi (2002) and Porter and Harries (2007) identified and reported on the need for life-cycle analysis tools for FRP. These tools would allow designers to justify the use of high performance materials such as FRP even though initial costs are higher (Trejo and Reinschmidt 2007b).

The rehabilitation of reinforced concrete bridges with FRP extends the service life of the bridge which postpones the need for replacement. Since FRP can be installed without major impact on traffic it can reduce the user costs due to the repair or rehabilitation. When it increases the live load capacity of a bridge it also reduces user costs for those vehicles that no longer need to detour around the bridge. LCCA tools would allow designers to justify the use of high performance materials such as FRP even though initial costs are higher (Trejo and Reinschmidt 2007b).

CHAPTER THREE: LIFE-CYCLE COST ANALYSIS

In a life-cycle cost analysis future costs are discounted to their present value. Costs (initial and future) can be either nominal or real (constant) dollars. While nominal dollars directly include the effect of inflation real dollars do not. Although either can be used in a LCCA they should not be combined in the same analysis and the use of real dollars is recommended (FHWA 2002). Three types of analyses were used in the study: deterministic, sensitivity, and probabilistic.

Discount Factors

Discount factors are used to calculate the present value of future costs (Blank and Tarquin 1998). The discount factor for a single amount (P/F) depends on the discount rate, *i*, and the time that the cost occurs, *n*:

$$(P/F, i, n) = \frac{1}{(1+i)^n} \tag{3.1}$$

The discount factor for a uniform series (P/A) depends on the discount rate and the time over which the costs occur, *n*:

$$(P/A, i, n) = \frac{(1+i)^n - 1}{i(1+i)^n} \tag{3.2}$$

In order to conduct the LCCA an appropriate discount rate must be selected. This allows future and present costs to be combined (James et al. 1991). For analysis periods longer than 50 years the use of a time declining discount rate is recommended (Boardman et al. 2011). A discount rate of 3.5 percent was used for costs occurring 50 or less years in the future and 2.5 percent for costs occurring more than 50 years in the future (Boardman et al. 2011).

Bridge Alternatives

The bridge used in the study is based on an existing bridge located in Woodford County in Central Kentucky. It is a four span continuous reinforced concrete T-beam structure that carries Huntertown Road over the Bluegrass Parkway. There are two lanes on the bridge and four lanes, two in each direction, under the bridge. The maximum span length is 60 feet (18.3 m) and the total bridge length is 204.1 feet (62.2 m). The typical cross section of the existing bridge is shown in Figure 3.1a.

Two alternatives were considered, rehabilitation and replacement. Since the alternatives need to achieve the same level of service or utility, comparable benefits and no externalities, the rehabilitation alternative included deck restoration and safety work. Otherwise LCCA is not appropriate for comparing alternatives and a Benefit-Cost Analysis should be done instead (FHWA 2002). The first alternative was to rehabilitate the existing bridge. The rehabilitation consisted of externally applied CFRP to strengthen it for shear, latex modified concrete (LMC) overlay to improve the deck condition, and retrofitting the existing bridge rail with thrie beam for safety. The second alternative was to replace the existing bridge with a two span prestressed concrete I-beam bridge. The total length of the new bridge is 204 feet (62.2 m). The typical cross section of the replacement bridge is shown in Figure 3.1b. A typical installation of thrie beam retrofit is shown in Figure 3.2.

The analysis period is the time interval used to evaluate all future costs. The length of the analysis period was selected to include at least one major rehabilitation activity after any initial construction (FHWA 2002) and was the same for both alternatives in order to fairly compare results. The analysis period for this study was 75 years which is the designated service life for new bridges designed using the AASHTO Load and Resistance Factor Design specifications (AASHTO 2010a).

Remaining Service Life

The remaining service life (RSL) is the amount of service life remaining for an alternative at the end of the analysis period. In this study this occurs only for the rehabilitation alternative. The RSL is to account for remaining service life of the new bridge constructed at the end of the service life of the bridge rehabilitation. RSL is not the same as salvage value. With RSL the bridge remains in service while with a salvage value the bridge is demolished and materials reused.

The value of any remaining service life depends on when the activity occurs relative to the end of the analysis period. The value of the RSL was determined using activity cost and the amount of service life remaining past the end of the analysis period (Walls III and Smith 1998). The value was assumed to linearly decrease from the full value at the time of its construction to zero at the end of its service life. An RSL was calculated when the construction of an activity occurred before the end of the analysis period but the end of its service life occurred after. When timing of an activity was greater than or equal to the analysis period the RSL and the cost of the activity are equal and there was no net change in life-cycle cost.

In the probabilistic analysis the service lives of the replacement bridge, deck overly, and deck replacement varied. As a result the activity timings also varied and more than one deck overlay and deck replacement may occur in an analysis period. In addition any activity that would possibly occur five years or closer to the end of the bridge replacement service life was assumed to not have occurred since replacement would most likely be planned. Expressions were developed to calculate the RSL value for the possible timings of deck overlays and replacements and 21 test examples were used to verify the expressions.

Deck overlay number 1

$$RSL = \left(\frac{T_{DR1} - SL_{BR}}{T_{DR1} - T_{OV1}}\right)(C_{OV}) = \left(\frac{T_{DR1} - SL_{BR}}{SL_{OV}}\right)(C_{OV}) \tag{3.3}$$

Deck replacement number 1

If $T_{DR2} < T_{BR} + SL_{BR}$

$$RSL = \left(\frac{T_{DR2} - SL_{BR}}{T_{DR2} - T_{DR1}}\right)(C_{DR}) \tag{3.4}$$

If $T_{DR2} \geq T_{BR} + SL_{BR}$

$$RSL = \left(\frac{T_{BR} + SL_{BR} - SL_{BR}}{T_{BR} + SL_{BR} - T_{DR1}}\right)(C_{DR}) = \left(\frac{T_{BR}}{T_{BR} + SL_{BR} - T_{DR1}}\right)(C_{DR}) \tag{3.5}$$

Deck overlay number 2

If $T_{DR2} < T_{BR} + SL_{BR}$

$$RSL = \left(\frac{T_{DR2} - SL_{BR}}{T_{DR2} - T_{OV2}}\right)(C_{OV}) = \left(\frac{T_{DR2} - SL_{BR}}{SL_{OV}}\right)(C_{OV}) \tag{3.6}$$

If $T_{DR2} \geq T_{BR} + SL_{BR}$

$$RSL = \left(\frac{T_{BR} + SL_{BR} - SL_{BR}}{T_{BR} + SL_{BR} - T_{OV2}}\right)(C_{OV}) = \left(\frac{T_{BR}}{T_{BR} + SL_{BR} - T_{OV2}}\right)(C_{OV}) \tag{3.7}$$

Deck replacement number 2

$$RSL = \left(\frac{T_{BR}}{T_{BR} + SL_{BR} - T_{DR2}}\right)(C_{DR}) \tag{3.8}$$

Deck overlay number 3

$$RSL = \left(\frac{T_{BR}}{T_{BR} + SL_{BR} - T_{OV3}}\right)(C_{OV}) \tag{3.9}$$

where:

T_{BR} = timing of bridge replacement (years)

T_{DR1} = timing of deck replacement number 1 (years)

T_{DR2} = timing of deck replacement number 2 (years)

T_{OV1} = timing of deck overlay number 1 (years)

T_{OV2} = timing of deck overlay number 2 (years)

T_{OV3} = timing of deck overlay number 3 (years)

SL_{BR} = service life of bridge replacement (years)

SL_{OV} = service life of deck overlay (years)

C_{DR} = cost of bridge deck replacement ($)

C_{OV} = cost of deck overlay ($)

RSL test examples used included:

1. 75-year Bridge Service Life (Mean), T_{BR} = 20 years, T_{OV1} = 40 years, T_{DR1} = 60 years, T_{OV2} = 80 years, T_{DR2} = 100 years (Mean Activity Timings)
2. 70-year Bridge Service Life (Minimum), T_{BR} = 20 years, T_{OV1} = 40 years, T_{DR1} = 60 years, T_{OV2} = 80 years, T_{DR2} = 100 years (Mean Activity Timings)
3. 90-year Bridge Service Life (Maximum), T_{BR} = 20 years, T_{OV1} = 40 years, T_{DR1} = 60 years, T_{OV2} = 80 years, T_{DR2} = 100 years, T_{OV3} = 120 years (Mean Activity Timings)
4. 70-year Bridge Service Life (Minimum), T_{BR} = 10 years, T_{OV1} = 25 years, T_{DR1} = 40 years, T_{OV2} = 55 years, T_{DR2} = 70 years, T_{OV3} = 85 years (Minimum Activity Timings)

5. 90-year Bridge Service Life (Maximum), T_{BR} = 10 years, T_{OV1} = 25 years, T_{DR1} = 40 years, T_{OV2} = 55 years, T_{DR2} = 70 years, T_{OV3} = 85 years (Minimum Activity Timings)

6. 70-year Bridge Service Life (Minimum), T_{BR} = 25 years, T_{OV1} = 50 years, T_{DR1} = 75 years, T_{OV2} = 100 years (Maximum Activity Timings)

7. 90-year Bridge Service Life (Maximum), T_{BR} = 25 years, T_{OV1} = 50 years, T_{DR1} = 75 years, T_{OV2} = 100 years, T_{DR2} = 125 years (Maximum Activity Timings)

8. 80-year Bridge Service Life, T_{BR} = 20 years, T_{OV1} = 40 years, T_{DR1} = 60 years, T_{OV2} = 80 years, T_{DR2} = 100 years, T_{OV3} = 120 years (Mean Activity Timings)

9. 75-year Bridge Service Life, T_{BR} = 10 years, T_{OV1} = 25 years, T_{DR1} = 40 years, T_{OV2} = 55 years, T_{DR2} = 70 years, T_{OV3} = 85 years (Minimum Activity Timings)

10. 85-year Bridge Service Life, T_{BR} = 20 years, T_{OV1} = 40 years, T_{DR1} = 60 years, T_{OV2} = 80 years, T_{DR2} = 100 years, T_{OV3} = 120 years (Mean Activity Timings)

11. 75-year Bridge Service Life, T_{BR} = 20 years, T_{OV1} = 45 years, T_{DR1} = 70 years, T_{OV2} = 95 years, T_{DR2} = 120 years

12. 90-year Bridge Service Life, T_{BR} = 25 years, T_{OV1} = 45 years, T_{DR1} = 70 years, T_{OV2} = 90 years, T_{DR2} = 115 years

13. 75-year Bridge Service Life, T_{BR} = 15 years, T_{OV1} = 35 years, T_{DR1} = 55 years, T_{OV2} = 75 years, T_{DR2} = 95 years

14. 80-year Bridge Service Life, T_{BR} = 15 years, T_{OV1} = 35 years, T_{DR1} = 55 years, T_{OV2} = 75 years, T_{DR2} = 95 years

15. 80-year Bridge Service Life, T_{BR} = 10 years, T_{OV1} = 30 years, T_{DR1} = 50 years, T_{OV2} = 70 years, T_{DR2} = 90 years

16. 90-year Bridge Service Life, T_{BR} = 10 years, T_{OV1} = 30 years, T_{DR1} = 50 years, T_{OV2} = 70 years, T_{DR2} = 90 years, T_{OV3} = 110 years

17. 75-year Bridge Service Life, T_{BR} = 15 years, T_{OV1} = 30 years, T_{DR1} = 45 years, T_{OV2} = 60 years, T_{DR2} = 75 years, T_{OV3} = 90 years

18. 85-year Bridge Service Life, T_{BR} = 15 years, T_{OV1} = 35 years, T_{DR1} = 50 years, T_{OV2} = 70 years, T_{DR2} = 85 years, T_{OV3} = 105 years

19. 90-year Bridge Service Life, T_{BR} = 20 years, T_{OV1} = 45 years, T_{DR1} = 65 years, T_{OV2} = 90 years, T_{DR2} = 110 years

20. 85-year Bridge Service Life, T_{BR} = 15 years, T_{OV1} = 30 years, T_{DR1} = 50 years, T_{OV2} = 65 years, T_{DR2} = 85 years, T_{OV3} = 100 years

21. 75-year Bridge Service Life, T_{BR} = 15 years, T_{OV1} = 35 years, T_{DR1} = 60 years, T_{OV2} = 80 years, T_{DR2} = 105 years

Bridge Activities and Costs

All activities associated with each alternative (initial construction, rehabilitation, and routine maintenance) are identified. The number of activities can be different for each alternative. Activities include routine maintenance (on an annual basis unless detailed data is available), preventive maintenance (preservation), repair, and rehabilitation. A schedule of activity timing includes the performance period or service life of each activity, when work zones and detours will be used, how long work zones will be in place, and the length of detours. The activity timings used in this study are summarized in Table 3.1.

Expenditure stream diagrams show all activities, costs associated with those activities, and activity and cost timing in a single graphic. This can be a visual aid for the analyst and when presenting the LCCA results. Any remaining service life for the rehabilitation alternative is shown at the end of the analysis period as a negative cost. Example expenditure stream diagrams for the replacement and rehabilitation alternatives are shown in Figure 3.

The estimated time to construct the bridge replacement and deck restoration are based on an analysis of contract completion dates included in Kentucky Transportation Cabinet (KYTC) bridge and deck restoration projects let from January 2013 to October 2014. A listing of the projects used is contained in Appendix A. Details of the time analysis are contained in Appendix B.

There are two general categories of costs, agency and user costs (Zimmerman et al. 2000, Beg et al. 2000, FHWA 2002). Costs that were similar for both alternatives were eliminated from the analysis. These are typically user costs during normal operations, i.e. no maintenance or construction activities that require a work zone with traffic restrictions.

Agency Costs

Agency costs include the costs of new construction, repair, rehabilitation, and maintenance of bridges and bridge components. Other agency costs include the cost of design, condition assessment of existing structures, right-of-way acquisition, utility adjustments, and any salvage value. Some costs can be estimated on a unit cost basis, i.e. bridge replacement, deck replacement, repairs, and routine annual maintenance.

However, some of these costs are only for the actual construction. The cost of preliminary engineering (PE), construction engineering (CE), maintenance of traffic (MOT), and any demolition are added to the cost of actual construction. The agency cost parameters used are summarized in Table 3.2.

Agency cost data was obtained from bridge replacement, deck restoration, and guardrail projects constructed in Kentucky and published data. The bid data analysis herein is from the Kentucky Transportation Cabinet (KYTC) projects let from January 2013 to October 2014. The bid data analysis determined unit costs for prestressed concrete girder bridges, deck replacement, bridge removal, deck removal, latex modified concrete (LMC) overlays, bridge overlay approach pavement, bridge rail retrofit, and maintenance of traffic. Details of the analyses are contained in Appendix C for unit construction costs and Appendix D for maintenance of traffic costs.

Bridge replacement projects and roadway projects that included new and replacement bridges were used to determine the unit costs for prestressed concrete girder bridges, deck replacement, and the percentage of the contract price for maintenance of traffic during bridge replacement. The analysis used the bid data (116 bidders) for 30 prestressed concrete I-beam bridges to determine the cost of bridge and deck replacement and the bid data (93 bidders) for 27 bridge projects to determine the percentage of contract price for maintenance of traffic costs. The bridge removal cost was determined using the bid data (23 bidders) for the removal of 10 continuous reinforced concrete T-beam bridges. The deck removal cost used the bid data (three bidders) for two bridges.

Bridge deck restoration projects were used to determine the unit costs for LMC overlays, bridge overlay approach pavement, and the percentage of the contract price for maintenance of traffic costs during bridge rehabilitation. The analysis used the bid data (595 bidders) for 108 bridges.

Guardrail projects were used to determine the unit cost for bridge rail retrofit with thrie beam. The analysis used the bid data (six bidders) for two bridges.

The unit cost for carbon fiber-reinforced polymer (CFRP) wrap was based on published cost data (e.g. O'Conner et al. 1999). O'Connor et al. (1999) reported costs of CFRP used to strengthen a reinforced concrete pier cap of a bridge in New York. Hag-Elsafi et al. (2001) reported costs of CFRP used to strengthen a reinforced concrete T-beam bridge in New York. Wipf et al. (2004) reported costs of CFRP used to repair impact damaged prestressed concrete beams in Iowa.

A survey by the Washington State Department of Transportation (DOT) in 2002 collected engineering cost data from 25 states. The average cost of PE was 10.3 percent and for CE was 11.2 percent. These values tend to be higher for more complex urban projects than for rural projects (Alam et al. 2005).

Annual routine bridge maintenance costs are the sum of annual maintenance costs for the various bridge components. Wipf et al. (1987) reported annual maintenance costs using data provided by some states. The average annual cost for reinforced concrete deck girders (old bridge) and prestressed concrete beams (new bridge) were converted to 2013 dollars using gross domestic product (GDP) deflators (U.S. Department of Commerce).

Bridge Replacement Cost

The total cost to replace the existing bridge included the costs for PE, CE, removing the existing bridge, constructing the new bridge and approaches, and maintaining traffic during the construction. The cost of bridge removal and construction were estimated using unit costs and estimated bridge areas. The cost of approach roadway construction was estimated as a percent of the bridge construction cost. The cost of maintenance of traffic was estimated as a percent of the cost of bridge removal, bridge construction, and approach roadway construction. The cost of PE was estimated as a percentage of bridge and approach roadway construction costs. The cost of CE was estimated as a percentage of bridge removal, bridge construction, and approach roadway construction costs.

Bridge Deck Replacement Cost

The total cost to replace the existing bridge deck included the costs for PE, CE, removing the existing reinforced concrete bridge deck and rails, constructing the new reinforced concrete bridge deck and rails, and maintaining traffic during the construction. The cost of bridge deck removal and construction were estimated using unit costs and estimated bridge areas. The cost of maintenance of traffic was estimated as a percent of the cost of bridge deck removal and bridge deck construction. The bridge deck construction unit cost was developed using a subset of bridge construction bid items, those items used to construct the reinforced concrete deck and rails. The cost of PE was estimated as a percentage of bridge deck construction cost. The cost of CE was estimated as a percentage of bridge deck removal and construction costs.

Bridge Deck Restoration Cost

The total cost to construct the bridge deck restoration included the costs for PE, CE, constructing the deck overlay, construct the overlay approach pavement, and maintaining traffic during construction. The costs for PE and CE were estimated as a percentage of deck overlay and overlay approach pavement costs. The quantity of deck overlay for the existing bridge was estimated to be 5,100 ft^2 (474 m^2) and for the replacement bridge to be 5,712 ft^2 (531 m^2). The quantity of overlay approach pavement for the existing bridge was estimated to be 278 yd^2 (232 m^2) and for the replacement bridge to be 355 yd^2 (297 m^2).

Bridge Rehabilitation Cost

The total cost to rehabilitate the existing bridge included the costs for PE, CE, applying the CFRP, restoring the bridge deck, retrofiting the existing bridge rail with thrie beam rail, and maintaining traffic during construction. The cost of CFRP application, bridge deck restoration, and bridge deck approach pavement construction were estimated using unit costs and estimated areas or lengths as appropriate. The cost of maintenance of traffic was estimated as a percent of the cost of bridge rehabilitation construction. The costs of PE and CE were estimated as a percentage of CFRP, deck restoration, and bridge rail retrofit costs. The quantity of CFRP wrap was estimated assuming the girder stems are wrapped with two plies on the bottom and both faces of each stem from the supports to the quarter points in the adjacent spans. An additional ply is added longitudinally near the top of both stem faces for anchorage of the wrapped plies. This resulted in an estimated quantity of single ply CFRP of 5,700 ft^2 (530 m^2).

User Costs

User costs include the costs of time delays (value of time), vehicle operation, and crashes (FHWA 2002, AASHTO 2010b, Watts et al. 2012). Crash costs include costs for property damage only, injury, and fatality crashes. The user cost parameters used are summarized in Table 3.3.

Long term user costs are those costs due to load limits, height restrictions, narrow widths, and poor horizontal alignment. Load limits and height restrictions cause some vehicles to detour around a bridge. Detours lead to an increase in travel lime, vehicle operating costs, and accident rates. Narrow bridge widths lead to an increase in travel time due to reduced operating speeds and crashes (Son and Sinha 1997). Deck condition, functional classification, bridge width, and approach roadway alignment can influence accident risks (Thompson et al. 2000). A very badly spalled deck increases user costs as drivers tend to slow down which increases travel time as well as vehicle operating costs (Markow et al. 1993).

Short term user costs are those costs due to work zones for bridge maintenance, repair, rehabilitation, or replacement. When a bridge is closed all traffic must detour around the bridge. When one or more lanes are closed there are increases in travel time and crash rates. Sufficient data to determine any increase in crash rates may not be available. Drivers may also opt to detour around a work zone, where possible, to avoid work zone congestion.

Vehicle operating costs can be broken down by vehicle class, passenger cars and heavy trucks as a minimum, and could also include busses and utility trucks (dos Santos et al. 2011). In order to use a variety of vehicle types the number of each vehicle type needs to be known. Since this is typically not known, this study used an average value for automobiles, pickups, vans, and sport utility vehicles and another value for commercial trucks (Barnes and Langworthy 2004). The “baseline” case is based on a fuel price of $1.50 per gallon ($0.40 per liter) and costs for maintenance/repair, tires, and depreciation in 2003 dollars. This study adjusted the fuel cost using $3.25 per gallon ($0.86 per liter) and converted the other costs to 2013 dollars using GDP deflators. The average cost to operate personal vehicles is then 27.25 cents per mile (16.9 cents per kilometer) and the cost to operate commercial trucks is 73.4 cents per mile (45.6 cents per kilometer). The baseline costs and the adjusted costs are summarized in Table 3.4.

The value of time can be broken down by personal and business travel (USDOT 2012). The values are per person-hour. Two weighted averages for automobiles are given: one for local travel and one for intercity travel. The weighted averages were determined using distributions of travel by trip purpose on various modes. This study assumed an equal distribution and used the average of the two.

Crash costs depend on traffic volumes, crash rates, crash distribution by severity level, and the cost associated with each level. This study used the Abbreviated Injury Scale (AIS), National Highway Traffic Safety Administration guidance for the distribution of injuries to the different injury levels, the value of property damage only crashes (AIS 0), and the Value of a Statistical Life (VSL) to calculate the cost of a non-fatal crash, Table 3.5 (USDOT 2012, USDOT 2013b).

User Cost Calculations

In order to calculate user costs it is necessary to estimate traffic volumes, travel delays, additional travel distance, crash rate, and fatality rate. The value of time (VOT), traffic volumes, and vehicle operating costs (VOC) were then used with the estimated amount of delay and vehicle occupancy rates to calculate additional user costs. The vehicle occupancy rates used are from AASHTO (2010b). Traffic volumes, additional travel distance, and crash and fatality rates were used to calculate crash costs. The nine combinations of initial traffic volumes on and under the bridge, average daily traffic (ADT) cases, are shown in Table 3.6. The rates for total crashes and fatalities are from the Kentucky Strategic Highway Safety Plan, 2011-2014 (KYTC 2011). The rates used are for the year 2011 which was the latest year for which rates were given.

This study used the following assumptions in calculating user costs:

- User costs under normal operating conditions are the same for existing and replacement bridges, no delays or additional travel distance
- User costs for identical activities under work zone conditions may be the same (lane closures, delays, or detours, additional travel time and distance) but generally occur at different times
- Crash and fatality rates under normal operating conditions are the same for existing and replacement bridges
- Crash and fatality rates in work zones are the statewide rates due to lack of work zone specific data

The vehicle operating costs (VOC) were calculated using:

$$C_{VOC} = [(ADT)(VOC_C) + (ADTT)(VOC_T)](\Delta D) \quad (3.10)$$

where:

C_{VOC} = total vehicle operating cost per day, \$

VOC_C = vehicle operating cost for cars, \$/vehicle

VOC_T = vehicle operating cost for trucks, \$/vehicle

ADT = average daily traffic, vehicles per day

ADTT = average daily truck traffic, vehicles per day

ΔD = additional distance travelled, mi (km)

The value of time (VOT) costs were calculated using:

$$C_{VOT} = [(ADT)(VOT_C) + (ADTT)(VOT_T)](\Delta T) \quad (3.11)$$

where:

C_{VOC} = total value of time cost per day, \$

VOT_C = value of time for cars, \$/hr

VOT_T = value of time for trucks, \$/hr

ADT = average daily traffic, vehicles per day

ADTT = average daily truck traffic, vehicles per day

ΔT = time delay per vehicle

The crash costs were calculated using:

$$C_{crash} = [(CR)(cost/crash) + (FR)(cost/fatality)](ADT)(D)/1{,}000{,}000 \quad (3.12)$$

where:

C_{crash} = total crash cost per day, \$

CR = crash rate, number of crashes per million vehicle-miles (crashes per million vehicle-kilometers)

FR = fatality rate, number of fatalities per million vehicle-miles (crashes per million vehicle-kilometers)

ADT = average daily traffic, vehicles per day

D = distance travelled, mi (km)

Table 3.1-Bridge activity timing

Activity	Timing (year)	Duration (days)	Detour
Replacement Alternative			
Construct new bridge	0	240	Yes
Place deck overlay	20	30	No
Replace deck	40	45	Yes
Place deck overlay	60	30	No
End service life	75	--	--
Rehabilitation Alternative			
Apply FRP, place deck overlay, retrofit bridge rail	0	30	No
Construct new bridge	20	240	Yes
Place deck overlay	40	30	No
Replace deck	60	45	Yes
Remaining service life new bridge	75	--	--

Table 3.2-Agency cost parameters

Parameter	Value
Prestressed concrete girder bridge, $/ft^2 ($/m^2)	107.52 (1,157.33)
Deck overlay-new bridge, $/ft^2 ($/m^2)	16.54 (178.03)
Deck overlay-old bridge, $/ft^2 ($/m^2)	16.54 (178.03)
Bridge overlay approach pavement-new bridge, $/yd^2 ($/m^2)	40.01 (47.85)
Bridge overlay approach pavement-old bridge, $/yd^2 ($/m^2)	54.83 (65.58)
Deck replacement, $/ft^2 ($/m^2)	38.17 (410.86)
CFRP wrap (one layer), $/ft^2 ($/m^2)	54.39 (585.45)
Bridge rail retrofit with thrie beam, $/ft ($/m)	76.99 (252.59)
Bridge removal, $/ft^2 ($/m^2)	14.13 (152.09)
Deck removal, $/ft^2 ($/m^2)	4.87 (52.42)
Bridge annual maintenance-new bridge, $/ft^2 ($/m^2)	0.10 (1.08)
Bridge annual maintenance-old bridge, $/ft^2 ($/m^2)	0.15 (1.61)
Maintenance of traffic-replacement, percent	3.41
Maintenance of traffic-rehabilitation, percent	15.12
Preliminary Engineering, percent	10
Construction Engineering, percent	11

Table 3.3-User cost parameters

Parameter	Value
Length of detour, miles (km)	2 (3.2)
Duration of bridge work, days	30 to 240
Average daily traffic on bridge-initial, vehicles/day	100 to 5,000
Truck traffic on bridge, percent	5
Average daily traffic under bridge-initial, vehicles/day	5,000 to 25,000
Truck traffic under bridge, percent	12
Annual traffic growth rate on bridge, percent	1
Annual traffic growth rate under bridge, percent	2
Value of time-cars, $/hour	16.28
Value of time-trucks, $/hour	25.30
Vehicle operating cost-cars, $/mile ($/km)	0.27 (0.17)
Vehicle operating cost-trucks	0.74 (0.46)
Vehicle occupancy rate-cars, persons/vehicle	1.5
Vehicle occupancy rate-trucks, persons/vehicle	1.05
Estimated travel delay per vehicle on bridge	
Bridge replacement, minutes	10
Bridge rehabilitation, minutes	5
Deck overlay, minutes	5
Deck replacement, minutes	10
Estimated travel delay per vehicle under bridge	
Bridge replacement, minutes	5
Bridge rehabilitation, minutes	5
Deck overlay, minutes	0
Deck replacement, minutes	0
Cost per non-fatal accident, $	126,870
Cost per fatal accident, $	9,100,000
Non-fatal crash rate per million vehicle miles	2.65
Fatality rate per million vehicle miles	0.015

Table 3.4-Baseline vehicle operating costs

Cost Category	Automobile		Pickup/Van/SUV		Commercial Truck	
	$2003	$2013	$2003	$2013	$2003	$2013
Total Marginal Costs cents/mi (cents/km)	15.3 (9.5)	23.6 (14.7)	19.2 (11.9)	30.9 (19.2)	43.4 (27.0)	73.4 (15.6)
Fuel cents/mi (cents/km)	5.1 (3.2)	11.1 (6.9)	7.8 (4.8)	16.9 (10.5)	21.4 (13.3)	46.4 (28.8)
Maintenance/Repair cents/mi (cents/km)	3.1 (1.9)	3.8 (2.4)	3.7 (2.3)	4.6 (2.9)	10.5 (6.5)	12.9 (8.0)
Tires cents/mi (cents/km)	0.9 (0.6)	1.1 (0.7)	1.0 (0.6)	1.2 (0.7)	3.5 (2.2)	4.3 (2.7)
Depreciation cents/mi (cents/km)	6.2 (3.9)	7.6 (4.7)	6.7 (4.2)	8.2 (5.1)	8.0 (5.0)	9.8 (6.1)

Table 3.5-Cost for a non-fatal crash

Fraction Crashes		Fraction VSL	Unit Value	Estimated cost per non-fatal crash
AIS 0	0.43676		$3,465	$1,513.37
AIS 1	0.41739	0.003	$9,100,000	$11,394.75
AIS 2	0.08872	0.047	$9,100,000	$37,945.54
AIS 3	0.04817	0.105	$9,100,000	$46,026.44
AIS 4	0.00617	0.266	$9,100,000	$14,935.10
AIS 5	0.00279	0.593	$9,100,000	$15,055.68
	1.00000	1.000		$126,870.88

AIS = Abbreviated Injury Scale

Table 3.6-Initial average daily traffic, ADT, volume

Case	ADT on bridge, vehicles per day		ADT under bridge, vehicles per day	
1	100	Low	5,000	Low
2	100	Low	10,000	Medium
3	100	Low	25,000	High
4	1,000	Medium	5,000	Low
5	1,000	Medium	10,000	Medium
6	1,000	Medium	25,000	High
7	5,000	High	5,000	Low
8	5,000	High	10,000	Medium
9	5,000	High	25,000	High

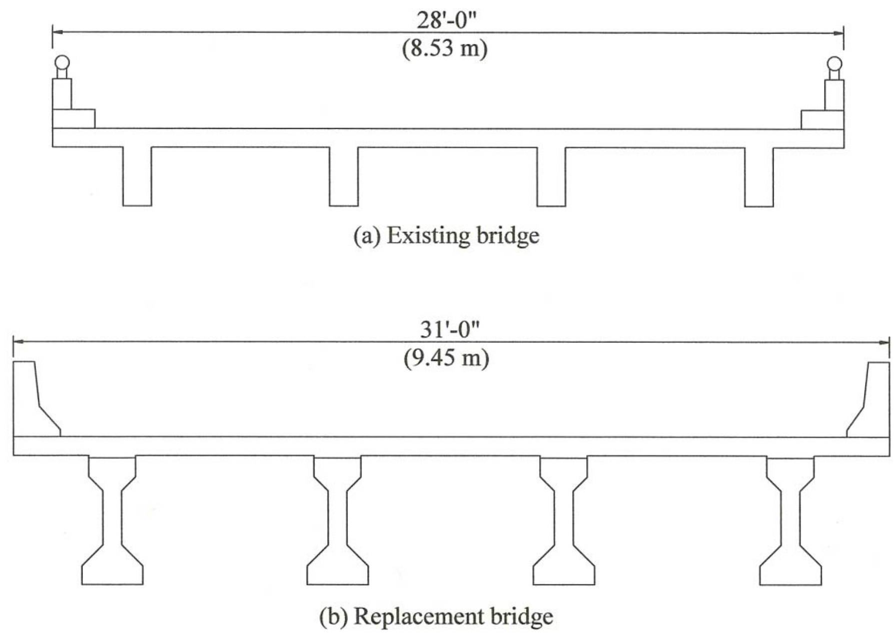
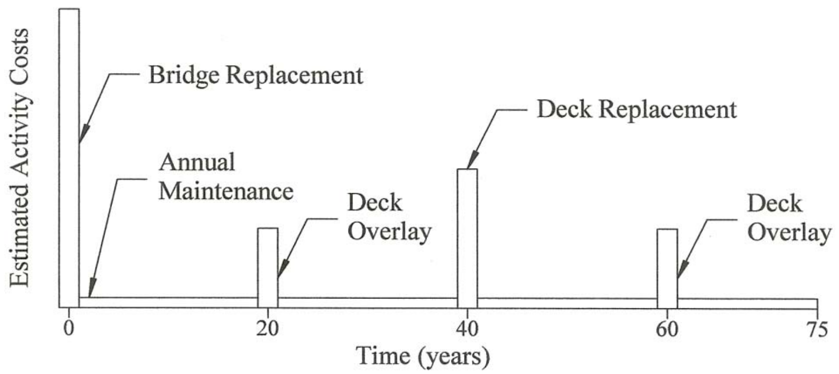
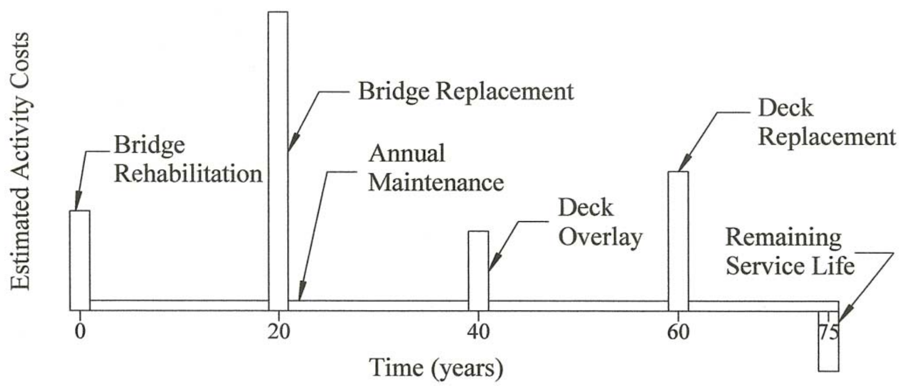


Figure 3.1-Typical sections

Figure 3.2-Bridge rail retrofit with thrie beam



(a) Bridge Replacement Alternative



(b) Bridge Rehabilitation Alternative

Figure 3.3-Expenditure stream diagrams

CHAPTER FOUR: DETERMINISTIC ANALYSIS

In this study deterministic analyses were carried out to determine the life-cycle costs of the replacement and rehabilitation alternatives and which had the lower life-cycle cost. Analyses were carried out for 1) a bridge over a highway, 2) a bridge over a highway with modified bridge construction time and cost, 3) a bridge over a waterway, and 4) a bridge over a waterway with modified bridge construction time and cost. Each analysis used the agency and user cost parameters shown in Table 3.1, Table 3.2 and Table 3.3. Each analysis used a range of initial traffic volumes, both on and under the bridge.

Bridge over Highway

Deterministic analyses were carried out for each of the nine ADT cases (Table 3.6). The agency, user, and total life-cycle costs for the replacement and rehabilitation alternatives of the bridge over a highway are summarized in Table 4.1.

In all the traffic cases the rehabilitation alternative had the lower life-cycle cost. Although the agency costs for both alternatives were almost equal the user costs were not. For this example the agency cost for the replacement alternative is only 1.6 percent more than the rehabilitation. Since agency costs do not depend on traffic volumes they were the same for all traffic cases and the increases in life-cycle costs were primarily due to user costs. The user costs for lower traffic volumes were relatively close and the difference dramatically increased as the traffic volumes increased. The impact of traffic volume on user costs was especially significant for traffic under the bridge for the estimated delays, i.e. ADT cases 3, 6, and 9 (Table 3.6).

As the traffic volume increased, both on and under the bridge, the difference in total life-cycle cost between the alternatives also increased. The differences in total life-cycle costs are summarized in Table 4.2. The smallest difference was for case 1, 100 vehicles per day (vpd) on the bridge and 5,000 vpd under the bridge. The second smallest difference was for case 2, 100 vpd on the bridge and 10,000 vpd under the bridge. This is followed by cases 4 and 5 with 1,000 vpd on the bridge and 5,000 to 10,000 vpd under the bridge. These are followed by cases 3 and 6 with 25,000 vpd under the bridge and 100 to 1,000 vpd on the bridge. The next two are cases 7 and 8 with 5,000 vpd on the bridge and 5,000 to 10,000 vpd under the bridge. The largest difference was for case 9, 5,000 vpd on the bridge and 25,000 vpd under the bridge.

Agency, user, and total life-cycle costs for all the activities and for each traffic case are summarized in Table 4.3 for the replacement alternative and Table 4.4 for the rehabilitation alternative. Agency costs for the replacement alternative are the same for each of the traffic cases. Agency costs for the rehabilitation alternative are the same for each of the traffic cases.

User life-cycle costs for the replacement alternative is summarized in Table 4.5 and for the rehabilitation alternative is summarized in Table 4.6. Two activities had no impact on traffic under the bridge: deck replacement and deck overlay. For these activities the user costs are the same for those traffic cases where traffic on the bridge is the same. For the remaining activities, user costs increase as traffic on and under the bridge increases.

Bridge over Highway with Modified Bridge Construction Time and Cost

The deterministic analysis of the bridge over a highway showed that user costs were frequently high and also a significant portion of the life-cycle costs, Table 4.7. The percentage of life-cycle costs that were due to user costs for the two alternatives did not differ by much, about three percent or less. For low traffic volumes the user costs ranged from 68.7 to 91.3 percent of total life-cycle costs for the replacement alternative and from 65.8 to 90.3 percent of total life-cycle costs for the rehabilitation alternative. For medium traffic volumes the user costs ranged from 76.9 to 92.1 percent of total life-cycle costs for the replacement alternative and from 73.0 to 90.9 percent of total life-cycle costs for the rehabilitation alternative. For high traffic volumes the user costs ranged from 89.4 to 94.3 percent of total life-cycle costs for the replacement alternative and from 86.0 to 93.1 percent of total life-cycle costs for the rehabilitation alternative. The percentage of life-cycle costs due to user costs increased as traffic volumes increased.

The sensitivity analysis showed that the time to construct the new bridge was one of the four parameters that had the most influence on life-cycle costs. Therefore, two modifications to the bridge construction time were investigated. In the first modification the most likely time to construct the bridge was decreased by 25 percent. In the second modification it was decreased by 50 percent. The times used are summarized in Table 4.8.

Since decreases in construction time would most likely increase the cost three cost variations were used with each time modification. For the first time modification the unit cost to construct the bridge was increased by zero, five, and ten percent. For the second time modification they were increased by zero, ten, and twenty percent. The unit costs used are summarized in Table 4.9.

The combinations of modified times and costs used are summarized in Table 4.10. Even though no increase in cost is likely to occur it was included as a base line or limiting value.

Six additional deterministic analyses using the modified bridge construction times and costs were carried out for each of the nine traffic cases. The agency, user, and total life-cycle costs for the six modifications are summarized in Tables 4.11 to 4.16. Although the decrease in construction time reduced the difference in life-cycle costs between the replacement and rehabilitation alternative, the rehabilitation alternative still had the lower life-cycle cost. The decrease in construction time had the larger influence on life-cycle costs than subsequent increases in unit costs.

Bridge over Waterway

Since a large number of bridges cross waterways the effect of no vehicular traffic under the bridge was investigated. This reduced the number of traffic cases to just three: low (100 vpd), medium (1,000 vpd), and high (5,000 vpd) traffic volumes on the bridge.

Three additional deterministic analyses were carried out. The agency, user, and total life-cycle costs for the three cases are summarized in Table 4.17. The rehabilitation alternative still had the lower life-cycle cost. However the difference for the low traffic case was only 5.3 percent. This cost difference maybe small enough for some decision makers to choose the replacement alternative. Although the difference in total life-cycle costs between the alternatives decreased, there was a significant decrease for some traffic cases.

Bridge over Waterway with Modified Bridge Construction Time and Cost

The effect of reducing bridge construction time on bridge with no vehicular traffic under the bridge was investigated. Six additional deterministic analyses were carried out for each three traffic volume cases. The agency, user, and total life-cycle costs for the six modifications are summarized in Tables 4.18 to 4.23.

Although the decrease in construction time reduced the difference in life-cycle costs between the replacement and rehabilitation alternative, the rehabilitation alternative still had the lower life-cycle cost. For the lower traffic cases the difference is small enough for one to consider using accelerated bridge technologies for bridge construction as long as any increases in construction costs are minimal. A five percent increase in the bridge construction unit cost, however, resulted in an increase in the difference. The reduced construction time had an adverse effect on the difference.

Deterministic Analysis Summary

Deterministic analyses were carried out for a highway bridge, a highway bridge with modified bridge construction time and cost, a waterway bridge, and a waterway bridge with modified bridge construction time and cost. The percent difference in total life-cycle costs from all the analyses are summarized in Table 4.24.

The rehabilitation alternative had the lower life-cycle cost in all analyses. However there were instances where the difference in life-cycle cost has been reduced enough for a decision maker to consider accelerated bridge construction technologies for low and medium traffic volumes. If it were possible to obtain a 50 percent decrease in bridge construction time without any increase in cost the life-cycle costs are almost the same, 0.8 percent difference.

When the bridge is over a waterway the differences in life-cycle costs are all reduced. For 100 vpd the difference was 5.3 percent or less. When combined with accelerated bridge construction technologies a further decrease in the difference was possible. For the low traffic volumes the difference was less than five percent for some combinations of decreased construction time and increased cost. However, increases in bridge construction cost negated any decrease in the difference and in some cases increased the difference.

Table 4.1-Summary of life-cycle costs for highway bridge

ADT Case[1]	Life-cycle Costs, Dollars						Percent Difference[2]
	Replacement Alternative			Rehabilitation Alternative			
	Agency	User	Total	Agency	User	Total	
1	1,191,515	2,618,430	3,809,944	1,172,788	2,252,939	3,425,727	11.1
2	1,191,515	5,086,170	6,277,684	1,172,788	4,404,281	5,577,069	12.5
3	1,191,515	12,489,390	13,680,904	1,172,788	10,858,308	12,031,096	13.7
4	1,191,515	3,974,636	5,166,151	1,172,788	3,167,309	4,340,097	19.1
5	1,191,515	6,442,376	7,633,891	1,172,788	5,318,651	6,491,439	17.6
6	1,191,515	13,845,596	15,037,111	1,172,788	11,772,678	12,945,466	16.1
7	1,191,515	10,002,220	11,193,735	1,172,788	7,231,176	8,403,964	33.2
8	1,191,515	12,469,960	13,661,475	1,172,788	9,382,519	10,555,307	29.4
9	1,191,515	19,873,180	21,064,695	1,172,788	15,836,546	17,009,334	23.8

[1]Refer to Table 3.6 for ADT cases

[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.2-Comparison of total life-cycle costs for highway bridge

ADT Case[1]	Life-cycle Costs, Dollars		
	Replacement Alternative	Rehabilitation Alternative	Difference
1	3,809,944	3,425,727	384,217
2	6,277,684	5,577,069	700,615
4	5,166,151	4,340,097	826,054
5	7,633,891	6,491,439	1,142,452
3	13,680,904	12,031,096	1,649,808
6	15,037,111	12,945,466	2,091,645
7	11,193,735	8,403,964	2,789,771
8	13,661,475	10,555,307	3,106,168
9	21,064,695	17,009,334	4,055,361

[1]Refer to Table 3.6 for ADT cases

Table 4.3-Life-cycle costs replacement alternative highway bridge

ADT Case[1]	Life-Cycle Cost, Dollars						
	Category	Bridge Replacement	Deck Overlay	Deck Replacement	Deck Overlay	Annual Routine Maintenance	Total
1	Agency	980,572	74,347	84,750	33,623	18,223	1,191,515
	User	2,602,627	3,760	9,511	2,532		2,618,430
	Total	3,583,198	78,107	94,260	36,155	18,223	3,809,944
2	Agency	980,572	74,347	84,750	33,623	18,223	1,191,515
	User	5,070,367	3,760	9,511	2,532		5,086,170
	Total	6,050,938	78,107	94,260	36,155	18,223	6,277,684
3	Agency	980,572	74,347	84,750	33,623	18,223	1,191,515
	User	12,473,587	3,760	9,511	2,532		12,489,390
	Total	13,454,158	78,107	94,260	36,155	18,223	13,680,904
4	Agency	980,572	74,347	84,750	33,623	18,223	1,191,515
	User	3,816,609	37,602	95,107	25,319		3,974,636
	Total	4,797,180	111,949	179,856	58,942	18,223	5,166,151
5	Agency	980,572	74,347	84,750	33,623	18,223	1,191,515
	User	6,284,349	37,602	95,107	25,319		6,442,376
	Total	7,264,920	111,949	179,856	58,942	18,223	7,633,891
6	Agency	980,572	74,347	84,750	33,623	18,223	1,191,515
	User	13,687,569	37,602	95,107	25,319		13,845,596
	Total	14,668,140	111,949	179,856	58,942	18,223	15,037,111
7	Agency	980,572	74,347	84,750	33,623	18,223	1,191,515
	User	9,212,083	188,009	475,534	126,593		10,002,220
	Total	10,192,655	262,357	560,284	160,216	18,223	11,193,735
8	Agency	980,572	74,347	84,750	33,623	18,223	1,191,515
	User	11,679,823	188,009	475,534	126,593		12,469,960
	Total	12,660,395	262,357	560,284	160,216	18,223	13,661,475
9	Agency	980,572	74,347	84,750	33,623	18,223	1,191,515
	User	19,083,043	188,009	475,534	126,593		19,873,180
	Total	20,063,615	262,357	560,284	160,216	18,223	21,064,695

[1]Refer to Table 3.6 for ADT cases

Table 4.4-Life-cycle costs rehabilitation alternative highway bridge

ADT Case[1]	Life-Cycle Cost, Dollars							
	Category	Bridge Rehabilitation	Bridge Replacement	Deck Overlay	Deck Replacement	Remaining Service Life	Annual Routine Maintenance	Total
1	Agency	602,952	492,802	37,364	76,264	-57,083	20,489	1,172,788
	User	314,599	1,925,591	2,306	10,443			2,252,939
	Total	917,552	2,418,393	39,670	86,707	-57,083	20,489	3,425,727
2	Agency	602,952	492,802	37,364	76,264	-57,083	20,489	1,172,788
	User	623,067	3,768,466	2,306	10,443			4,404,281
	Total	1,226,019	4,261,268	39,670	86,707	-57,083	20,489	5,577,069
3	Agency	602,952	492,802	37,364	76,264	-57,083	20,489	1,172,788
	User	1,548,469	9,297,090	2,306	10,443			10,858,308
	Total	2,151,422	9,789,892	39,670	86,707	-57,083	20,489	12,031,096
4	Agency	602,952	492,802	37,364	76,264	-57,083	20,489	1,172,788
	User	369,786	2,670,036	23,058	104,429			3,167,309
	Total	972,738	3,162,838	60,423	180,693	-57,083	20,489	4,340,097
5	Agency	602,952	492,802	37,364	76,264	-57,083	20,489	1,172,788
	User	678,253	4,512,911	23,058	104,429			5,318,651
	Total	1,281,205	5,005,713	60,423	180,693	-57,083	20,489	6,491,439
6	Agency	602,952	492,802	37,364	76,264	-57,083	20,489	1,172,788
	User	1,603,656	10,041,535	23,058	104,429			11,772,678
	Total	2,206,608	10,534,337	60,423	180,693	-57,083	20,489	12,945,466
7	Agency	602,952	492,802	37,364	76,264	-57,083	20,489	1,172,788
	User	615,058	5,978,681	115,292	522,145			7,231,176
	Total	1,218,010	,471,482	152,657	598,409	-57,083	20,489	8,403,964
8	Agency	602,952	492,802	37,364	76,264	-57,083	20,489	1,172,788
	User	923,526	7,821,556	115,292	522,145			9,382,519
	Total	1,526,478	8,314,357	152,657	598,409	-57,083	20,489	10,555,307
9	Agency	602,952	492,802	37,364	76,264	-57,083	20,489	1,172,788
	User	1,848,928	13,350,180	115,292	522,145			15,836,546
	Total	2,451,880	13,842,982	152,657	598,409	-57,083	20,489	17,009,334

[1]Refer to Table 3.6 for ADT cases

Table 4.5-User life-cycle cost summary highway bridge replacement alternative

ADT Case[1]	Life-cycle Cost, Dollars				
	Bridge replacement	Deck overlay	Deck replacement	Deck overlay	Total
1	2,602,627	3,760	9,511	2,532	2,618,430
2	5,070,367	3,760	9,511	2,532	5,086,170
3	12,473,587	3,760	9,511	2,532	12,489,390
4	3,816,609	37,602	95,107	25,319	3,974,636
5	6,284,349	37,602	95,107	25,319	6,442,376
6	13,687,569	37,602	95,107	25,319	13,845,596
7	9,212,083	188,009	475,534	126,593	10,002,220
8	11,679,823	188,009	475,534	126,593	12,469,960
9	19,083,043	188,009	475,534	126,593	19,873,180

[1]Refer to Table 3.6 for ADT cases

Table 4.6-User life-cycle cost summary highway bridge rehabilitation alternative

ADT Case[1]	Life-cycle Cost, Dollars				
	Bridge rehabilitation	Bridge replacement	Deck overlay	Deck replacement	Total
1	314,599	1,925,591	2,306	10,443	2,252,939
2	623,067	3,768,466	2,306	10,443	4,404,281
3	1,548,469	9,297,090	2,306	10,443	10,858,308
4	369,786	2,670,036	23,058	104,429	3,167,309
5	678,253	4,512,911	23,058	104,429	5,318,651
6	1,603,656	10,041,535	23,058	104,429	11,772,678
7	615,058	5,978,681	115,292	522,145	7,231,176
8	923,526	7,821,556	115,292	522,145	9,382,519
9	1,848,928	13,350,180	115,292	522,145	15,836,546

[1]Refer to Table 3.6 for ADT cases

Table 4.7-Percent user costs for highway bridge

ADT Case[1]	Replacement Alternative			Rehabilitation Alternative		
	User Costs	Total Costs	Percent User	User Costs	Total Costs	Percent User
1	2,618,430	3,809,944	68.7	2,252,939	3,425,727	65.8
2	5,086,170	6,277,684	81.0	4,404,281	5,577,069	79.0
3	12,489,390	13,680,904	91.3	10,858,308	12,031,096	90.3
4	3,974,636	5,166,151	76.9	3,167,309	4,340,097	73.0
5	6,442,376	7,633,891	84.4	5,318,651	6,491,439	81.9
6	13,845,596	15,037,111	92.1	11,772,678	12,945,466	90.9
7	10,002,220	11,193,735	89.4	7,231,176	8,403,964	86.0
8	12,469,960	13,661,475	91.3	9,382,519	10,555,307	88.9
9	19,873,180	21,064,695	94.3	15,836,546	17,009,334	93.1

[1]Refer to Table 3.6 for ADT cases

Table 4.8-Bridge construction times

	Most Likely, days
Initial	240
Initial minus 25%	180
Initial minus 50%	120

Table 4.9-Bridge construction unit costs

	Mean, $\$/ft^2$ ($\$/m^2$)
Initial	107.52 (1,157.33)
Initial plus 5%	112.90 (1,215.20)
Initial plus 10%	118.27 (1,273.04)
Initial plus 20%	129.02 (1,388.75)

Table 4.10-Modified bridge construction time and cost

Modification	Decrease in Time	Increase in Costs
1a	25%	0%
1b	25%	5%
1c	25%	10%
2a	50%	0%
2b	50%	10%
2c	50%	20%

Table 4.11-Summary of life-cycle costs for highway bridge with modification 1a

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1	1,191,515	1,967,773	3,159,288	1,172,788	1,771,541	2,944,329	7.3
2	1,191,515	3,818,578	5,010,093	1,172,788	3,462,165	4,634,953	8.1
3	1,191,515	9,370,993	10,562,508	1,172,788	8,534,036	9,706,824	8.8
4	1,191,515	3,020,484	4,211,999	1,172,788	2,499,800	3,672,588	14.7
5	1,191,515	4,871,289	6,062,804	1,172,788	4,190,424	5,363,212	13.0
6	1,191,515	10,423,704	11,615,219	1,172,788	9,262,295	10,435,082	11.3
7	1,191,515	7,699,199	8,890,714	1,172,788	5,736,506	6,909,294	28.7
8	1,191,515	9,550,004	10,741,519	1,172,788	7,427,130	8,599,918	24.9
9	1,191,515	15,102,419	16,293,934	1,172,788	12,499,001	13,671,789	19.2

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.12-Summary of life-cycle costs for highway bridge with modification 1b

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1	1,235,959	1,967,773	3,203,732	1,193,264	1,771,541	2,964,805	8.1
2	1,235,959	3,818,578	5,054,537	1,193,264	3,462,165	4,655,429	8.6
3	1,235,959	9,370,993	10,606,952	1,193,264	8,534,036	9,727,300	9.0
4	1,235,959	3,020,484	4,256,443	1,193,264	2,499,800	3,693,064	15.3
5	1,235,959	4,871,289	6,107,248	1,193,264	4,190,424	5,383,688	13.4
6	1,235,959	10,423,704	11,659,663	1,193,264	9,262,295	10,455,559	11.5
7	1,235,959	7,699,199	8,935,158	1,193,264	5,736,506	6,929,770	28.9
8	1,235,959	9,550,004	10,785,963	1,193,264	7,427,130	8,620,394	25.1
9	1,235,959	15,102,419	16,338,378	1,193,264	12,499,001	13,692,265	19.3

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.13-Summary of life-cycle costs for highway bridge with modification 1c

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1	1,280,321	1,967,773	3,248,094	1,213,703	1,771,541	2,985,244	8.8
2	1,280,321	3,818,578	5,098,899	1,213,703	3,462,165	4,675,867	9.1
3	1,280,321	9,370,993	10,651,314	1,213,703	8,534,036	9,747,738	9.3
4	1,280,321	3,020,484	4,300,805	1,213,703	2,499,800	3,713,503	15.8
5	1,280,321	4,871,289	6,151,610	1,213,703	4,190,424	5,404,126	13.8
6	1,280,321	10,423,704	11,704,025	1,213,703	9,262,295	10,475,997	11.7
7	1,280,321	7,699,199	8,979,520	1,213,703	5,736,506	6,950,209	29.2
8	1,280,321	9,550,004	10,830,325	1,213,703	7,427,130	8,640,832	25.3
9	1,280,321	15,102,419	16,382,740	1,213,703	12,499,001	13,712,703	19.5

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.14-Summary of life-cycle costs for highway bridge with modification 2a

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1	1,191,515	1,317,116	2,508,631	1,172,788	1,290,144	2,462,931	1.9
2	1,191,515	2,550,986	3,742,501	1,172,788	2,520,048	3,692,836	1.3
3	1,191,515	6,252,596	7,444,111	1,172,788	6,209,763	7,382,551	0.8
4	1,191,515	2,066,332	3,257,846	1,172,788	1,832,291	3,005,079	8.4
5	1,191,515	3,300,202	4,491,716	1,172,788	3,062,196	4,234,984	6.1
6	1,191,515	7,001,812	8,193,326	1,172,788	6,751,911	7,924,699	3.4
7	1,191,515	5,396,178	6,587,693	1,172,788	4,241,836	5,414,624	21.7
8	1,191,515	6,630,048	7,821,563	1,172,788	5,471,741	6,644,529	17.7
9	1,191,515	10,331,658	11,523,173	1,172,788	9,161,456	10,334,244	11.5

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.15-Summary of life-cycle costs for highway bridge with modification 2b

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1	1,280,321	1,317,116	2,597,437	1,213,703	1,290,144	2,503,846	3.7
2	1,280,321	2,550,986	3,831,307	1,213,703	2,520,048	3,733,751	2.6
3	1,280,321	6,252,596	7,532,917	1,213,703	6,209,763	7,423,466	1.5
4	1,280,321	2,066,332	3,346,653	1,213,703	1,832,291	3,045,994	9.9
5	1,280,321	3,300,202	4,580,523	1,213,703	3,062,196	4,275,899	7.1
6	1,280,321	7,001,812	8,282,133	1,213,703	6,751,911	7,965,613	4.0
7	1,280,321	5,396,178	6,676,499	1,213,703	4,241,836	5,455,539	22.4
8	1,280,321	6,630,048	7,910,369	1,213,703	5,471,741	6,685,443	18.3
9	1,280,321	10,331,658	11,611,979	1,213,703	9,161,456	10,375,158	11.9

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.16-Summary of life-cycle costs for highway bridge with modification 2c

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1	1,369,128	1,317,116	2,686,244	1,254,617	1,290,144	2,544,761	5.6
2	1,369,128	2,550,986	3,920,114	1,254,617	2,520,048	3,774,666	3.9
3	1,369,128	6,252,596	7,621,724	1,254,617	6,209,763	7,464,380	2.1
4	1,369,128	2,066,332	3,435,459	1,254,617	1,832,291	3,086,908	11.3
5	1,369,128	3,300,202	4,669,329	1,254,617	3,062,196	4,316,813	8.2
6	1,369,128	7,001,812	8,370,939	1,254,617	6,751,911	8,006,528	4.6
7	1,369,128	5,396,178	6,765,306	1,254,617	4,241,836	5,496,453	23.1
8	1,369,128	6,630,048	7,999,176	1,254,617	5,471,741	6,726,358	18.9
9	1,369,128	10,331,658	11,700,786	1,254,617	9,161,456	10,416,073	12.3

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.17-Summary of life-cycle costs for waterway bridge

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1,2,3	1,191,515	150,690	1,342,204	1,172,788	101,597	1,274,384	5.3
4,5,6	1,191,515	1,506,896	2,698,411	1,172,788	1,015,967	2,188,755	23.3
7,8,9	1,191,515	7,534,480	8,725,995	1,172,788	5,079,834	6,252,622	39.6

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.18-Summary of life-cycle costs for waterway bridge with modification 1a

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1,2,3	1,191,515	116,968	1,308,483	1,172,788	80,918	1,253,705	4.4
4,5,6	1,191,515	1,169,679	2,361,194	1,172,788	809,177	1,981,964	19.1
7,8,9	1,191,515	5,848,394	7,039,909	1,172,788	4,045,883	5,218,670	34.9

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.19-Summary of life-cycle costs for waterway bridge with modification 1b

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1,2,3	1,235,959	116,968	1,352,927	1,193,264	80,918	1,274,182	6.2
4,5,6	1,235,959	1,169,679	2,405,638	1,193,264	809,177	2,002,441	20.1
7,8,9	1,235,959	5,848,394	7,084,353	1,193,264	4,045,883	5,239,147	35.2

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.20-Summary of life-cycle costs for waterway bridge with modification 1c

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1,2,3	1,280,321	116,968	1,397,289	1,213,703	80,918	1,294,620	7.9
4,5,6	1,280,321	1,169,679	2,450,000	1,213,703	809,177	2,022,879	21.1
7,8,9	1,280,321	5,848,394	7,128,715	1,213,703	4,045,883	5,259,585	35.5

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.21-Summary of life-cycle costs for waterway bridge with modification 2a

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1,2,3	1,191,515	83,246	1,274,761	1,172,788	60,239	1,233,026	3.4
4,5,6	1,191,515	832,462	2,023,976	1,172,788	602,386	1,775,174	14.0
7,8,9	1,191,515	4,162,308	5,353,823	1,172,788	3,011,931	4,184,719	27.9

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.22-Summary of life-cycle costs for waterway bridge with modification 2b

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1,2,3	1,280,321	83,246	1,363,567	1,213,703	60,239	1,273,941	7.0
4,5,6	1,280,321	832,462	2,112,783	1,213,703	602,386	1,816,089	16.3
7,8,9	1,280,321	4,162,308	5,442,629	1,213,703	3,011,931	4,225,634	28.8

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.23-Summary of life-cycle costs for waterway bridge with modification 2c

ADT Case[1]	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars			Percent Difference[2]
	Agency	User	Total	Agency	User	Total	
1,2,3	1,369,128	83,246	1,452,374	1,254,617	60,239	1,314,856	10.5
4,5,6	1,369,128	832,462	2,201,589	1,254,617	602,386	1,857,003	18.6
7,8,9	1,369,128	4,162,308	5,531,436	1,254,617	3,011,931	4,266,548	29.6

[1]Refer to Table 3.6 for ADT cases
[2]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation

Table 4.24-Summary of difference in total life-cycle costs for all bridges

Analysis	Percent Difference[1]								
	ADT Case 1[2]	ADT Case 2[2]	ADT Case 3[2]	ADT Case 4[2]	ADT Case 5[2]	ADT Case 6[2]	ADT Case 7[2]	ADT Case 8[2]	ADT Case 9[2]
Highway	11.1	12.5	13.7	19.1	17.6	16.1	33.2	29.4	23.8
Highway + Mod 1a	7.3	8.1	8.8	14.7	13.0	11.3	28.7	24.9	19.2
Highway + Mod 1b	8.1	8.6	9.0	15.3	13.4	11.5	28.9	25.1	19.3
Highway + Mod 1c	8.8	9.1	9.3	15.8	13.8	11.7	29.2	25.3	19.5
Highway + Mod 2a	1.9	1.3	0.8	8.4	6.1	3.4	21.7	17.7	11.5
Highway + Mod 2b	3.7	2.6	1.5	9.9	7.1	4.0	22.4	18.3	11.9
Highway + Mod 2c	5.6	3.9	2.1	11.3	8.2	4.6	23.1	18.9	12.3
Waterway	5.3	5.3	5.3	23.3	23.3	23.3	39.6	39.6	39.6
Water + Mod 1a	4.4	4.4	4.4	19.1	19.1	19.1	34.9	34.9	34.9
Water + Mod 1b	6.2	6.2	6.2	20.1	20.1	20.1	35.5	35.5	35.5
Water + Mod 1c	7.9	7.9	7.9	21.1	21.1	21.1	35.5	35.5	35.5
Water + Mod 2a	3.4	3.4	3.4	14.0	14.0	14.0	27.9	27.9	27.9
Water + Mod 2b	7.0	7.0	7.0	16.3	16.3	16.3	28.8	28.8	28.8
Water + Mod 2c	10.5	10.5	10.5	18.6	18.6	18.6	29.6	29.6	29.6

[1]Percent difference = (Total Replacement - Total Rehabilitation)/Total Rehabilitation
[2]Refer to Table 3.6 for ADT cases

CHAPTER FIVE: SENSITIVITY ANALYSIS

A sensitivity analysis can be used to improve the results of a deterministic analysis (FHWA 2002) by providing a limited measure of the effects of input parameter variability on life-cycle costs. The sensitivity analysis is used to determine which input parameters the life-cycle costs are the most sensitive to. This can assist decision-makers in understanding any variability in the analysis results of the design alternatives. It can also be used to identify which input values need a more refined estimate and which do not. Changes in only one input parameter are made while all the others are held constant. The life-cycle cost is sensitive to an input parameter when a small change in that parameter results in a relatively large change in the life-cycle cost (Trejo and Reinschmidt 2007a). However, since only one input parameter is changed at a time the analysis cannot measure the impact of simultaneous changes in more than one parameter. It also does not give any indication of risk (Pittenger et al. 2012).

The sensitivity analysis in this study used the 26 parameters presented in Table 5.1. Each parameter was changed by plus and minus ten percent from the mean input values. An analysis was done for each of the nine ADT cases. Changes in life-cycle costs were converted to a percentage of the mean life-cycle cost for each ADT case. Except for changes in the service life of the CFRP rehabilitation, both plus and minus changes in parameter mean values of ten percent resulted in the same magnitude, but different sign, of change in life-cycle costs. All parameters had changes less than ten percent.

Although the ranking of parameters varied depending on the alternative and the ADT case, the same four parameters had the most impact on life-cycle cost, user costs in particular, for both alternatives. They were bridge replacement duration, ADT under bridge, VOT cars, and delay time under the bridge during bridge replacement.

Three summaries of the analysis results are presented. The first one is for the replacement alternative, the second one is for the rehabilitation alternative, and the third one is for both alternatives combined.

The degree of sensitivity depended on the initial traffic volume. Some parameters had changes greater than one percent for all ADT cases. For other parameters some ADT cases had changes less than one percent and other ADT cases had changes greater than one percent. Four categories of changes in life-cycle cost, as a function of initial ADT, were found. Categories A, B, C, and D are described as follows:

- Category A: percent change in life-cycle cost increased as ADT on bridge increased (ADT under bridge constant) and as ADT under bridge increased (ADT on bridge constant)
- Category B: percent change in life-cycle cost decreased as ADT on bridge increased (ADT under bridge constant) and increased as ADT under bridge increased (ADT on bridge constant)
- Category C: percent change in life-cycle cost increased as ADT on bridge increased (ADT under bridge constant) and decreased as ADT under bridge increased (ADT on bridge constant)
- Category D: percent change in life-cycle cost decreased as ADT on bridge increased (ADT under bridge constant) and as ADT under bridge increased (ADT on bridge constant)

The categories of each input parameter for the replacement and rehabilitation alternatives are summarized in Table 5.2

Replacement Alternative

The results of the sensitivity analysis for the replacement alternative are summarized in Table 5.3.

Nine parameters had changes greater than one percent for at least two ADT cases. Four of these had changes greater than one percent for all nine ADT cases: bridge replacement duration (Category A), ADT under bridge (Category B), delay time under the bridge during bridge replacement (Category B), and VOT cars (Category A). Two of these had the same impact on life-cycle cost: ADT under bridge and delay time under the bridge during bridge replacement. The remaining five parameters had changes greater than one percent for the number of ADT cases shown. Category B included one parameter: VOT trucks (3 cases). Category C included three parameters: ADT on bridge (6 cases), delay time on the bridge during bridge replacement (5 cases), and detour length during replacement (2 cases). Category D included one parameter: bridge replacement cost (4 cases).

The remaining 17 parameters had changes less than one percent for all nine ADT cases. Two parameters had the same impact on life-cycle cost: deck overlay duration and delay time on the bridge during deck overlay. Category C included six parameters: VOC cars, deck replacement duration, delay time on the bridge during deck replacement, deck overlay duration, delay time on the bridge during deck overlay, and VOC trucks. Category D included four parameters: deck overlay cost for the new bridge, deck replacement cost, MOT during replacement, and MOT during rehabilitation. The seven rehabilitation specific parameters had no impact on the life-cycle cost of the replacement alternative.

Rehabilitation Alternative

The results of the sensitivity analysis for the rehabilitation alternative are summarized in Table 5.4.

Fifteen parameters had changes greater than one percent for at least one ADT case. Five of these had changes greater than one percent for all nine ADT cases: ADT under bridge (Category B), VOT cars (Category A), bridge replacement duration (Category A), delay time under the bridge during bridge replacement (Category B) and service life of the CFRP rehabilitation (Category C). The remaining ten parameters had changes greater than one percent for the number of ADT cases shown. Category B included four parameters: deck overlay duration (5 cases), bridge rehabilitation duration (5 cases), delay time under the bridge during bridge rehabilitation (3 cases), and VOT trucks (3 cases). Category C included three parameters: ADT on bridge (5 cases), delay time on the bridge during bridge replacement (4 cases), and detour length during replacement (2 cases). Category D included three parameters: Bridge replacement cost (1 case), FRP strengthening cost (1 case), and quantity of CFRP (1 case). Two parameters had the same impact on LCC: FRP strengthening cost and the quantity of CFRP.

The remaining 11 parameters had changes less than one percent for all nine ADT cases. Category C included six parameters: deck replacement duration, VOC cars, delay time on the bridge during deck replacement, delay time on the bridge during bridge rehabilitation, delay time on the bridge during deck overlay, and VOC trucks. Category D included five parameters: deck overlay cost for the old bridge, MOT during rehabilitation, deck replacement cost, deck overlay cost for the new bridge, and MOT during replacement.

Replacement and Rehabilitation Alternatives

A comparison of the sensitivity analysis results for both alternatives show some similarities in which parameters have the most influence on the life-cycle cost for each of the nine ADT cases. The same four parameters had the most impact on life-cycle cost, user costs in particular. They were bridge replacement duration, ADT under bridge, VOT cars, and delay time under bridge-bridge replacement. In addition, two of these parameters had changes in life-cycle cost greater than five percent for all nine ADT cases: bridge replacement duration and VOT cars. The other two parameters had changes greater than five percent in six of the nine ADT cases. The ADT on bridge parameter also had changes greater than five percent but only for two ADT cases with the replacement alternative and only one ADT case with the rehabilitation alternative.

The 11 parameters that had changes less than one percent for all ADT cases for the rehabilitation alternative also had changes less than one percent for all ADT cases for the replacement alternative. The deck overlay duration parameter had changes less than one percent for all ADT cases for the replacement alternative but not for the rehabilitation alternative.

The five parameters that had changes greater than one percent for some ADT cases for the replacement alternative also had changes greater than one percent for some

ADT cases for the rehabilitation alternative. Four other parameters had changes greater than one percent for some ADT cases for only the rehabilitation alternative: bridge rehabilitation duration, delay time under bridge-bridge rehabilitation, FRP strengthening cost, and quantity of CFRP. The service life of the CFRP rehabilitation had changes greater than one percent for all ADT cases for the rehabilitation alternative.

Sensitivity Analysis Summary

Although only one parameter at a time is varied in a sensitivity analysis multiple parameters can vary simultaneously in a probabilistic analysis. Individually some parameters had a positive effect on life-cycle costs, an increase in the value of the parameter resulted in an increase in life-cycle costs. Other parameters had a negative effect, an increase in the value of the parameter resulted in a decrease in life-cycle costs. When the individual changes are combined and applied simultaneously the overall effect may be positive, negative, or about neutral.

Four parameters had the most influence on life-cycle costs: bridge replacement duration, ADT under the bridge, VOT cars, and delay time under the bridge during bridge replacement. Two of these were Category A: bridge replacement duration and VOT cars. The other two were Category B: ADT under the bridge and delay time under the bridge during bridge replacement. For increases in traffic volume on the bridge the two categories had the opposite effect on the percent change in life-cycle costs. For increases in traffic volume under the bridge they had the same effect.

For the high traffic volume on the bridge cases the influence was similar to the four parameters that had the most influence, i.e. for high traffic volumes there were five parameters with the most influence on life-cycle costs. It was a Category C parameter:

ADT on the bridge. Increases in traffic volume on the bridge increased the percent change in life-cycle costs and increases in traffic volume under the bridge decreased the percent change in life-cycle costs. Traffic volume under the bridge had the opposite effect. When combined the influence of one of the parameters offset the influence of the other, especially for high traffic volumes.

Table 5.1-Sensitivity analysis parameters

No.	Parameter	No.	Parameter
1	Bridge replacement cost	14	Initial ADT on bridge
2	Deck replacement cost	15	Initial ADT under bridge
3	FRP strengthening cost	16	VOT cars
4	Deck overlay cost-new bridge	17	VOT trucks
5	Deck overlay cost-old bridge	18	VOC cars
6	Bridge replacement duration	19	VOC trucks
7	Bridge rehabilitation duration	20	Delay time on bridge-bridge replacement
8	Deck overlay duration	21	Delay time under bridge-bridge replacement
9	Deck replacement duration	22	Delay time on bridge-bridge rehabilitation
10	Quantity of CFRP	23	Delay time under bridge-bridge rehabilitation
11	MOT-replacement	24	Delay time on bridge-deck overlay
12	MOT-rehabilitation	25	Delay time on bridge-deck replacement
13	Detour length-replacement	26	Service life CFRP rehabilitation

Table 5.2-Sensitivity analysis categories

No.	Parameter	Replacement Category	Rehabilitation Category
1	Bridge replacement cost	D	D
2	Deck replacement cost	D	D
3	FRP strengthening cost	NA	D
4	Deck overlay cost-new bridge	D	D
5	Deck overlay cost-old bridge	NA	D
6	Bridge replacement duration	A	A
7	Bridge rehabilitation duration	NA	B
8	Deck overlay duration	C	B
9	Deck replacement duration	C	C
10	Quantity of CFRP	NA	D
11	MOT-replacement	D	D
12	MOT-rehabilitation	D	D
13	Detour length-replacement	C	C
14	Initial ADT on bridge	C	C
15	Initial ADT under bridge	B	B
16	VOT cars	A	A
17	VOT trucks	B	B
18	VOC cars	C	C
19	VOC trucks	C	C
20	Delay time on bridge-bridge replacement	C	C
21	Delay time under bridge-bridge replacement	B	B
22	Delay time on bridge-bridge rehabilitation	NA	C
23	Delay time under bridge-bridge rehabilitation	NA	B
24	Delay time on bridge-deck overlay	C	C
25	Delay time on bridge-deck replacement	C	C
26	Service life CFRP rehabilitation	NA	C

NA=not applicable

Table 5.3-Sensitivity analysis summary highway bridge replacement alternative

No.	Percent Change Life-cycle Costs								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
1	2.331	1.415	0.649	1.719	1.163	0.591	0.793	0.650	0.422
2	0.199	0.121	0.055	0.147	0.099	0.050	0.068	0.056	0.036
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.283	0.172	0.079	0.209	0.141	0.072	0.096	0.079	0.051
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	6.831	8.077	9.118	7.388	8.232	9.103	8.230	8.549	9.059
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.017	0.010	0.005	0.122	0.082	0.042	0.281	0.230	0.149
9	0.025	0.015	0.007	0.184	0.125	0.063	0.425	0.348	0.226
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.077	0.047	0.021	0.057	0.038	0.020	0.026	0.021	0.014
12	0.031	0.019	0.009	0.023	0.016	0.008	0.011	0.009	0.006
13	0.103	0.063	0.029	0.762	0.516	0.262	1.759	1.441	0.935
14	0.396	0.240	0.110	2.917	1.974	1.002	6.731	5.515	3.577
15	6.477	7.862	9.019	4.777	6.465	8.205	2.205	3.613	5.858
16	5.924	7.023	7.941	6.205	7.018	7.855	6.631	7.008	7.609
17	0.853	1.025	1.169	0.734	0.914	1.100	0.554	0.687	0.900
18	0.038	0.023	0.011	0.283	0.192	0.097	0.654	0.536	0.348
19	0.005	0.003	0.001	0.035	0.024	0.012	0.080	0.066	0.043
20	0.258	0.156	0.072	1.899	1.285	0.652	4.382	3.591	2.329
21	6.477	7.862	9.019	4.777	6.465	8.205	2.205	3.613	5.858
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.017	0.010	0.005	0.122	0.082	0.042	0.281	0.230	0.149
25	0.018	0.011	0.005	0.134	0.091	0.046	0.309	0.253	0.164
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

[1]Refer to Table 3.6 for ADT cases

Table 5.4-Sensitivity analysis summary highway bridge rehabilitation alternative

No.	Percent Change Life-cycle Costs								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
1	1.194	0.734	0.340	0.943	0.630	0.316	0.487	0.388	0.241
2	0.157	0.097	0.045	0.124	0.083	0.042	0.064	0.051	0.032
3	1.232	0.757	0.351	0.973	0.650	0.326	0.502	0.400	0.248
4	0.109	0.067	0.031	0.086	0.057	0.029	0.044	0.035	0.022
5	0.395	0.243	0.112	0.312	0.208	0.105	0.161	0.128	0.080
6	5.621	6.757	7.728	6.152	6.952	7.757	7.114	7.410	7.849
7	0.918	1.117	1.287	0.852	1.045	1.239	0.732	0.875	1.087
8	0.925	1.121	1.289	0.905	1.080	1.257	0.869	0.984	1.155
9	0.030	0.019	0.009	0.241	0.161	0.081	0.621	0.495	0.307
10	1.232	0.757	0.351	0.972	0.650	0.326	0.502	0.400	0.248
11	0.041	0.025	0.012	0.033	0.022	0.011	0.017	0.013	0.008
12	0.207	0.127	0.059	0.164	0.109	0.055	0.085	0.067	0.042
13	0.074	0.046	0.021	0.585	0.391	0.196	1.511	1.203	0.747
14	0.297	0.182	0.084	2.341	1.565	0.785	6.045	4.813	2.986
15	6.280	7.715	8.941	4.957	6.628	8.309	2.560	4.076	6.324
16	5.686	6.856	7.855	5.984	6.891	7.802	6.525	6.972	7.635
17	0.823	1.004	1.158	0.735	0.920	1.105	0.576	0.722	0.938
18	0.028	0.017	0.008	0.218	0.146	0.073	0.562	0.448	0.278
19	0.003	0.002	0.001	0.027	0.018	0.009	0.069	0.055	0.034
20	0.176	0.108	0.050	1.386	0.927	0.465	3.579	2.850	1.769
21	5.380	6.609	7.659	4.246	5.678	7.118	2.193	3.492	5.417
22	0.018	0.011	0.005	0.141	0.094	0.047	0.365	0.290	0.180
23	0.900	1.106	1.282	0.711	0.950	1.191	0.367	0.584	0.907
24	0.007	0.004	0.002	0.053	0.036	0.018	0.137	0.109	0.068
25	0.022	0.014	0.006	0.175	0.117	0.059	0.452	0.360	0.223
26a[2]	2.838	2.722	2.623	3.100	2.914	2.726	3.574	3.363	3.050
26b[3]	-2.716	-2.619	-2.536	-2.962	-2.797	-2.632	-3.409	-3.216	-2.931

[1]Refer to Table 3.6 for ADT cases
[2]CFRP service life minus 10%
[3]CFRP service life plus 10%

CHAPTER SIX: PROBABILISTIC ANALYSIS

In a probabilistic analysis multiple parameters are varied at the same time to account for variability and uncertainty. The Monte Carlo simulation is commonly used to perform the probabilistic analysis. The two main parameters with uncertainties are related to costs and service life (Pittenger et al. 2012). Probability distribution functions and random sampling were used to select a discrete value for inputs that varied. The process was repeated and a range of life-cycle costs was generated for each alternative. A statistical analysis of the results was performed to determine the cumulative probability of the life-cycle costs for each alternative (Reigle and Zaniewski 2002).

Two common probability distributions were used in this study to represent the variability of some input parameters (Walls III and Smith 1998, Pittenger et al. 2012). Agency unit costs represented by a normal distribution with mean and standard deviation values are summarized in Table 6.1. In order to avoid the possibility of low or negative unit costs minimum values were included. Parameters represented by a triangular distribution with minimum, most likely, and maximum values, are summarized in Table 6.2. Minimum traffic volumes were assumed to be 80% of the most likely traffic volume and maximum traffic volumes were 110% of the most likely traffic volume. The Palisades @Risk software (Palisades Corporation) was used within spreadsheets to calculate life-cycle costs using the ranges and distributions of input values.

Each life-cycle cost analysis consisted of 100,000 iterations of the life-cycle cost model. Latin Hypercube sampling was used when generating random number as it has quicker convergence (Walls III and Smith, 1998). Each analysis used the same initial seed number for each ADT case in order to be able to compare the impact of traffic volume on the results.

The risk profile basic statistics from each probabilistic analysis included the minimum life-cycle cost, maximum life-cycle cost, mean life-cycle cost, median life-cycle cost, standard deviation of the life-cycle costs, and distribution of life-cycle costs by percentile. Cumulative probability curves for each alternative were then developed using the distribution of life-cycle costs. The decision-maker can use this information to select an alternative based on the level of risk that they are most comfortable with and not rely only on mean life-cycle costs (FHWA 2002).

In this study probabilistic analyses were carried out to determine the probability when rehabilitation had the lower life-cycle cost. Analyses were carried out for 1) a bridge over a highway, 2) a bridge over a highway with limited random variables, 3) a bridge over a highway with modified bridge construction time and cost, 4) a bridge over a waterway, and 5) a bridge over a waterway with modified bridge construction time and cost. Each analysis used the agency and user cost parameters shown in Table 3.1, Table 3.2 and Table 3.3. Each analysis used a different initial traffic volume, both on and under the bridge.

Bridge over Highway

Nine probabilistic analyses were carried out. The risk profile statistics from the probabilistic analyses and the cumulative probability curves are contained in Appendix E for each of the nine ADT cases.

The typical results of a simulation, ADT case 1, presented as ascending cumulative probability curves for each alternative are shown in Figure 6.1. Each curve shows the cumulative probability of life-cycle cost, i.e. the probability that the life-cycle cost is less than or equal to any given value. Although the curves for the other ADT cases are similar there are two main differences. The first one is the range of life-cycle costs. The second is the point where the two curves intersect, when they do intersect. This is the point at which the alternative with the lower life-cycle cost changes from replacement to rehabilitation.

The minimum, maximum, and range of life-cycle costs are summarized in Table 6.3. As the traffic volumes increased the minimum life-cycle cost, maximum life-cycle cost, and the range in life-cycle costs all increased. For a fixed traffic volume on the bridge the increases in maximum values was larger than the increases in minimum values. For a fixed traffic volume under the bridge the increases in minimum values was larger than the increases in maximum values. This holds for both the replacement and rehabilitation alternatives.

Changes in traffic volumes for the replacement alternative resulted in different percent changes in the minimum and maximum life-cycle costs. Two analyses were done. In the first one the traffic on the bridge was held constant and traffic under the bridge was increased, Table 6.4. For 100 vpd on the bridge, traffic under the bridge was increased first from 5,000 to 10,000 vpd and then from 10,000 to 25,000 vpd. Increasing traffic under the bridge from 5,000 to 10,000 vpd increased the minimum value 8.74 percent and the maximum value 82.70 percent. Increasing traffic under bridge from 10,000 to 25,000 vpd increased the minimum value 11.73 percent and the maximum value 135.79 percent.

For 1,000 vpd on the bridge, traffic under the bridge was also increased first from 5,000 to 10,000 vpd and then from 10,000 to 25,000 vpd. Increasing traffic under bridge from 5,000 to 10,000 vpd increased the minimum value 6.83 percent and the maximum value 62.39 percent. Increasing traffic under bridge from 10,000 to 25,000 vpd increased the minimum value 4.75 percent and the maximum value 115.26 percent. For 5,000 vpd on the bridge, traffic under the bridge was also increased first from 5,000 to 10,000 vpd and then from 10,000 to 25,000 vpd. Increasing traffic under bridge from 5,000 to 10,000 vpd increased the minimum value 3.07 percent and the maximum value 22.97 percent. Increasing traffic under bridge from 10,000 to 25,000 vpd increased the minimum value 8.92 percent and the maximum value 68.94 percent.

In the second analysis for the replacement alternative the traffic under the bridge was held constant and traffic on the bridge was increased, Table 6.5. For 5,000 vpd under the bridge increasing traffic on bridge from 100 to 1,000 vpd increased the minimum value 72.85 percent and the maximum value 32.54 percent. Increasing traffic on the bridge from 1,000 to 5,000 vpd increased the minimum value 131.73 percent and the maximum value 120.79 percent. For 10,000 vpd under the bridge increasing traffic on the bridge from 100 to 1,000 vpd increased the minimum value 69.81 percent and the maximum value 17.81 percent. Increasing traffic on the bridge from 1,000 to 5,000 vpd increased the minimum value 123.57 percent and the maximum value 67.19 percent. For 25,000 vpd under the bridge, increasing traffic on the bridge from 100 to 1,000 vpd increased the minimum value 59.21 percent and the maximum value 7.55 percent. Increasing traffic on the bridge from 1,000 to 5,000 vpd increased the minimum value 132.47 percent and the maximum value 31.21 percent.

Changes in traffic volumes for the rehabilitation alternative also resulted in different percent changes in the minimum and maximum life-cycle costs. Two same two analyses were done. In the first analysis the traffic on the bridge was held constant and traffic under the bridge was increased, Table 6.4. For 100 vpd on the bridge increasing traffic under the bridge from 5,000 to 10,000 vpd increased the minimum value 24.11 percent and the maximum value 81.43 percent. Increasing traffic under the bridge from 10,000 to 25,000 vpd increased the minimum value 52.35 percent and the maximum value 134.65 percent. For 1,000 vpd on the bridge increasing traffic under the bridge from 5,000 to 10,000 vpd increased the minimum value 22.41 percent and the maximum value 66.70 percent. Increasing traffic under the bridge from 10,000 to 25,000 vpd increased the minimum value 39.36 percent and the maximum value 120.04 percent. For 5,000 vpd on the bridge increasing traffic under the bridge from 5,000 to 10,000 vpd increased the minimum value 9.09 to 23.65 percent. Increasing traffic under the bridge from 10,000 to 25,000 vpd increased the minimum value 23.19 percent and the maximum value 71.80 percent.

In the second analysis for the rehabilitation alternative the traffic under the bridge was held constant and traffic on the bridge was increased, Table 6.5. For low traffic under the bridge increasing traffic on the bridge from 100 to 1,000 vpd increased the minimum value 37.47 percent and the maximum value 22.09 percent. Increasing traffic on the bridge from 1,000 to 5,000 vpd increased the minimum value 100.07 percent and the maximum value 110.51 percent. For 10,000 vpd under the bridge increasing traffic on the bridge from 100 to 1,000 vpd increased the minimum value 35.59 percent and the maximum value 12.17 percent. Increasing traffic on the bridge from 1,000 to 5,000 vpd increased the minimum value 78.30 percent and the maximum value 56.15 percent. For 25,000 vpd under the bridge increasing traffic on the bridge from 100 to 1,000 vpd increased the minimum value 24.03 percent and the maximum value 5.19 percent. Increasing traffic on the bridge from 1,000 to 5,000 vpd increased the minimum value 57.61 percent and the maximum value 21.92 percent.

The point where the cumulative probability curves intersect indicates the life-cycle cost and probability at which the alternative with the lower life-cycle cost changes from one alternative to the other. At this point the probabilities that either replacement or rehabilitation will have the lower life-cycle cost are the same. For the highway bridge and life-cycle costs less than this value there is a higher probability that replacement will have the lower life-cycle cost. For life-cycle costs greater than this value there is a higher probability that rehabilitation will have the lower life-cycle cost. The life-cycle costs and probabilities where the curves intersect were estimated using the risk profile statistics and straight line interpolation.

The point where the two curves intersect varied depending on the traffic volume. For ADT case 1 (Table 3.6) this point is at 17.02 percent and 2.54 million dollars. For ADT case 2 (Table 3.6) this point is at 17.85 percent and 3.80 million dollars. For ADT case 3 (Table 3.6) this point is at 17.99 percent and 7.52 million dollars. For ADT case 4 (Table 3.6) this point is at 0.23 percent and 2.00 million dollars. For ADT case 5 (Table 3.6) this point is at 2.52 percent and 3.37 million dollars. For ADT case 6 (Table 3.6) this point is at 9.34 percent and 7.07 million dollars. For ADT case 9 (Table 3.6) this point is at 0.30 percent and 5.86 million dollars. For ADT cases 7 and 8 (Table 3.6) the curves did not intersect. For these ranges of traffic there is a zero percent probability that the replacement life-cycle cost is lower.

The agency, user, and total life-cycle costs from the deterministic analysis and the mean and median values from the probabilistic analyses are compared in Table 6.6. Some values are close to the deterministic values but never equal. This shows that deterministic life-cycle costs are mean values. In some cases the deterministic values are lower and in the others they are higher. The deterministic values tended to be higher with low traffic volumes and lower with increased traffic volume. For the replacement alternative the deterministic values ranged from 7.2 percent lower to 5.3 percent higher than mean values and from 5.2 percent lower to 9.9 percent higher than the median values. For the rehabilitation alternative the deterministic values ranged from 8.8 percent lower to 2.4 percent higher than mean values and from 6.7 percent lower to 5.3 percent higher than the median values.

The results of the probabilistic analysis show some trends with respect to increases in traffic volumes. As the traffic volumes on the bridge increased, with traffic volume under the bridge constant, the probability that replacement has the lower life-cycle cost decreased. As the traffic volume under bridge increased, with traffic volume on the bridge constant, the probability that replacement has the lower life-cycle cost increased. This increase in probability became more significant with increases in traffic volumes on the bridge. These opposing trends can make it difficult to predict the effect of different combinations of traffic volume on and under the bridge.

Bridge over Highway with Limited Random Variables

The probabilistic analyses for the highway bridge used either normal distributions or triangular distributions of more variables that what the sensitivity analysis indicated are necessary. The sensitivity analysis showed that four variables had the most influence on life-cycle costs: bridge replacement duration, traffic under the bridge, VOT cars, and delay time under the bridge during bridge replacement. Therefore, nine probabilistic analyses were carried out using probability distributions for only these four variables. The risk profile statistics and cumulative probability curves for the highway bridge with limited random variables are contained in Appendix E. The estimated probabilities at which replacement has the lower life-cycle cost are compared with the highway bridge analysis that used more random variables in Table 6.7. The associated estimated life-cycle costs are compared in Table 6.8.

The effect of using the limited random variables on probabilities depended on traffic volumes. For the low traffic volumes on the bridge the probabilities that replacement had the lower life-cycle cost all decreased. The decrease was more significant for ADT case 1 (Table 3.6). For the medium traffic volumes the effect was mixed. ADT cases 4 and 5 (Table 3.6) showed a slight increase in probability while ADT case 6 (Table 3.6) showed a slight decrease. For the high traffic volumes the results were also mixed. For ADT cases 7 and 8 (Table 3.6) there was no change. For ADT case 9 (Table 3.6) there was a slight increase. Although the other random variables individually had a small influence on life-cycle costs collectively they had more influence.

The effect of using the limited random variables on the associated life-cycle cost also depended on traffic volumes. For the low traffic volumes on the bridge the life-cycle costs all decreased. For the medium traffic volumes the effect was mixed. ADT cases 4 and 6 (Table 3.6) showed an increase while ADT case 5 (Table 3.6) showed a decrease. For the high traffic volumes the results were also mixed. For ADT cases 7 and 8 (Table 3.6) there was no change. For ADT case 9 (Table 3.6) there was an increase.

These changes in probabilities and costs mostly likely would not change which alternative is selected. If the decision maker was not going to select the replacement alternative at 17 to 18 percent probability, for low traffic volume on the bridge, they would most likely not select the replacement alternative at lower probability.

Bridge over Highway with Modified Bridge Construction Time and Cost

As done in the deterministic analysis two modifications to the bridge construction time were investigated. In the first modification the initial value of the most likely time to construct the bridge was decreased by 25 percent. In the second modification it was decreased by 50 percent. The maximum times were adjusted by about the same percentages. Since minimum times would most likely not decrease as much as the other two times a nominal decrease of five and ten days was selected. The times used are summarized in Table 6.9.

Three variations of the unit bridge construction cost were used with each modification. For the first time modification the initial mean and minimum values of unit cost to construct the bridge was increased by zero, five, and ten percent. For the second time modification they were increased by zero, ten, and twenty percent. The value of the standard deviation was not changed. The unit costs used are summarized in Table 6.10.

The combinations of modified times and costs are summarized in Table 6.11. Even though no increase in cost is likely to occur it was also included in the probabilistic analyses as a base line or limiting value.

Six additional probabilistic analyses using the modified bridge construction times and costs were done for each of the nine traffic cases. The estimated probabilities at which replacement had the lower life-cycle cost are summarized in Table 6.12. The associated estimated life-cycle costs are summarized in Table 6.13. The risk profile statistics and cumulative probability curves for the highway bridge with modified construction time and costs are contained in Appendix E.

Decreasing the time to construct the new bridge generally increased the probability at which the replacement alternative had the lower life-cycle cost. However, for the higher traffic volumes the decrease in time had no effect, ADT cases 7 and 8 (Table 3.6), or little effect, ADT case 9 (Table 3.6). It also had little effect on ADT case 4 (Table 3.6). Decreasing the construction time without any increase in the unit cost had the most effect. For the low traffic volume on the bridge cases the probability increased to more than 50 percent. Although subsequent increases in unit cost negated most of the increase in probability, the resulting probabilities were still more than those for the corresponding highway bridge. The associated life-cycle costs changed very little.

Bridge over Waterway

Three additional probabilistic analyses using no vehicular traffic under the bridge were carried out. The risk profile statistics and cumulative probability curves for the bridge over waterway are contained in Appendix E. The estimated probabilities at which replacement has the lower life-cycle cost are compared with the highway bridge in Table 6.14. The associated estimated life-cycle costs are compared in Table 6.15.

Changing the traffic volume under the bridge to zero resulted in two significant changes in probabilities. For medium and high traffic volumes there was now a zero percent probability that the replacement alternative had the lower life-cycle cost. For the low traffic volume case the relative positions of the two cumulative probability curves was reversed, Figure 6.2. Below the intersection point of the curves the rehabilitation alternative now had the lower life-cycle cost instead of the replacement alternative. The intersection point also shifted upwards to about 74 percent, i.e. the probability that the rehabilitation alternative had the lower life-cycle cost was about 74 percent. The associated life-cycle cost was also reduced. The amount it decreased was relatively small for ADT case 1 (Table 3.6) but was more significant for ADT case 3 (Table 3.6). This was due to the removal of more traffic from under the bridge in case 3 (Table 3.6) and the subsequent reduction in user costs.

Bridge over Waterway with Modified Bridge Construction Time and Cost

Six additional probabilistic analyses using no vehicular traffic under the bridge together with the modified bridge construction times and costs were carried out for the same three traffic volume cases used for a bridge over a waterway. The risk profile statistics and cumulative probability curves for the bridge over waterway with modified construction time and cost are contained in Appendix E. The estimated probabilities at which replacement has the lower life-cycle cost are compared with the highway bridge and the waterway bridge in Table 6.16. The associated estimated life-cycle costs are compared in Table 6.17.

Modifying the bridge construction time and cost for a bridge over a waterway only had an impact for the low traffic volume case. As with the bridge over water analysis the relative position of the two cumulative probability curves was reversed. It also raised the point where the two cumulative probability curves intersect. The probability that the rehabilitation alternative had the lower life-cycle cost increased to about 81 percent with modification 1b to as much as 96 percent for modification 2c. There was a corresponding increase in the associated life-cycle cost.

This was not the case for modifications 1a and 2a, Figures 6.3 and 6.4. The two curves were close enough for them to intersect in three places. For modification 1a the curves intersected at 0.82, 6.12, and 59.03 percent. The associated life-cycle costs were 0.97, 1.09, and 1.37 million dollars. For modification 2a the curves intersected at 0.59, 18.18, and 32.59 percent. The associated life-cycle costs were 0.92, 1.15, and 1.23 million dollars. The difference in life-cycle costs were generally less than five percent.

Modifying the bridge construction time and cost for a bridge over a waterway made no difference in which alternative had the lower life-cycle cost for the medium and high traffic volume cases. The rehabilitation alternative continued to have the lower life-cycle cost. It did however increase the difference in life-cycle costs for all probabilities, i.e. increased the distance between the two curves.

Probabilistic Analysis Summary

Probabilistic analyses were carried out for a highway bridge, a highway bridge with limited random variables, a highway bridge with modified bridge construction time and cost, a waterway bridge, and a waterway bridge with modified bridge construction time and cost. The estimated probabilities at which replacement has the lower life-cycle cost are compared for all the analyses in Table 6.18. The associated estimated life-cycle costs are compared in Table 6.19.

The rehabilitation alternative generally had the higher probability of having the lower life-cycle cost. However there were instances where the difference between the two alternatives had been reduced enough for a decision maker to consider using accelerated bridge construction technologies. This was for a bridge over a waterway with low traffic volumes. If it were possible to obtain a 50 percent decrease in bridge construction time without any increase in bridge construction cost the life-cycle costs are close. However this may not be likely to occur.

The effect of the different bridge options on life-cycle costs and the difference in life-cycle costs between the two alternatives depended on the traffic volumes. They had the most effect on the low traffic volume cases. For the low traffic volume cases modification of bridge construction time and cost had a wide range of effect on probabilities. Some of these probabilities may be high enough for a decision maker to choose replacement instead of rehabilitation. For bridges over a waterway the results favored the rehabilitation alternative. As the traffic volumes increased the probability that the replacement alternative had the lower life-cycle cost decreased and eventually went to zero.

Table 6.1-Probabilistic analysis input-normal distribution

Parameter	Mean	Std. Dev.	Minimum
Prestressed concrete girder bridge, $/ft^2 ($/m^2)	107.52 (1,157.33)	18.28 (196.76)	72.00 (775.00)
Deck overlay-new bridge, $/ft^2 ($/m^2)	16.54 (178.03)	4.79 (51.56)	7.00 (75.35)
Deck overlay-old bridge, $/ft^2 ($/m^2)	16.54 (178.03)	4.79 (51.56)	7.00 (75.35)
Bridge overlay approach pavement-new bridge, $/yd^2 ($/m^2)	40.01 (47.85)	12.25 (14.65)	20.00 (23.92)
Bridge overlay approach pavement-old bridge, $/yd^2 ($/m^2)	54.83 (65.58)	16.45 (19.67)	20.00 (23.92)
Deck construction, $/ft^2 ($/m^2)	38.17 (410.86)	7.19 (77.39)	24.00 (258.33)
CFRP wrap (one layer), $/ft^2 ($/m^2)	54.39 (585.45)	21.24 (228.62)	39.00 (419.79)
Bridge rail retrofit with thrie beam, $/ft ($/m)	$76.99 (252.59)	14.52 (47.64)	65.00 (213.25)
Bridge removal, $/ft^2 ($/m^2)	14.13 (152.09)	4.03 (43.38)	8.00 (86.11)
Deck removal, $/ft^2 ($/m^2)	4.87 (52.42)	2.61 (28.09)	2.00 (21.53)

Table 6.2-Probabilistic analysis input-triangular distribution

Parameter	Minimum	Most Likely	Maximum
Construct new bridge-duration, days	90	240	370
Service life new bridge, years	70	75	90
Service life bridge deck (time to overlay), years	15	20	25
Service life bridge deck overlay, years	15	20	25
Service life CFRP strengthening, years	10	20	25
Value of time-cars, $/hour	13.34	16.28	19.21
Delay time on bridge-bridge replacement, minutes	8	10	20
Delay time under bridge-bridge replacement, minutes	0	5	10

Table 6.3-Total life-cycle costs for highway bridge

ADT Case[1]	Total Life-cycle Costs, millions of Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Minimum	Maximum	Range	Minimum	Maximum	Range
1	1.05	9.42	8.37	1.34	8.12	6.78
2	1.14	17.20	16.06	1.66	14.73	13.07
3	1.27	40.56	39.29	2.54	34.55	32.01
4	1.81	12.48	10.67	1.84	9.91	8.07
5	1.93	20.27	18.34	2.26	16.52	14.26
6	2.02	43.63	41.61	3.14	36.34	33.20
4	4.19	27.55	23.36	3.69	20.86	17.17
8	4.32	33.88	29.56	4.02	25.79	21.77
9	4.70	57.24	52.54	4.96	44.31	39.35

[1]Refer to Table 3.6 for ADT cases
Range = Maximum - Minimum

Table 6.4-Change in minimum and maximum life-cycle cost (LCC) with constant traffic on bridge

Traffic on, vehicles per day	Change in traffic under, vehicles per day	Replacement		Rehabilitation	
		Minimum	Maximum	Minimum	Maximum
100	From 5,000 to 10,000[1]	8.74%	82.70%	24.11%	81.43%
	From 10,000 to 25,000[2]	11.73%	135.79%	52.35%	134.65%
1,000	From 5,000 to 10,000[1]	6.83%	62.39%	22.41%	66.70%
	From 10,000 to 25,000[2]	4.75%	115.26%	39.36%	120.04%
5,000	From 5,000 to 10,000[1]	3.07%	24.45%	9.09%	23.70%
	From 10,000 to 25,000[2]	8.92%	68.94%	23.19%	71.80%

[1]Percent change = $(LCC_{10000}-LCC_{5000})/LCC_{5000}$
[2]Percent change = $(LCC_{25000}-LCC_{10000})/LCC_{10000}$

Table 6.5-Change in minimum and maximum life-cycle cost (LCC) with constant traffic under bridge

Traffic under, vehicles per day	Changes in traffic on, vehicles per day	Replacement		Rehabilitation	
		Minimum	Maximum	Minimum	Maximum
5,000	From 100 to 1,000[1]	72.85%	32.54%	37.47%	22.09%
	From 1,000 to 5,000[2]	131.73%	120.79%	100.07%	110.51%
10,000	From 100 to 1,000[1]	69.81%	17.81%	35.59%	12.17%
	From 1,000 to 5,000[2]	123.57%	67.19%	78.30%	56.15%
25,000	From 100 to 1,000[1]	59.21%	7.55%	24.03%	5.19%
	From 1,000 to 5,000[2]	132.47%	31.21%	57.61%	21.92%

[1]Percent change = $(LCC_{1000}-LCC_{100})/LCC_{100}$
[2]Percent change = $(LCC_{5000}-LCC_{1000})/LCC_{1000}$

where:
LCC_{100} = life cycle cost when traffic volume is 100 vehicles per day
LCC_{1000} = life cycle cost when traffic volume is 1,000 vehicles per day
LCC_{5000} = life cycle cost when traffic volume is 5,000 vehicles per day
LCC_{10000} = life cycle cost when traffic volume is 10,000 vehicles per day
LCC_{25000} = life cycle cost when traffic volume is 25,000 vehicles per day

Table 6.6-Comparision of life-cycle costs for highway bridge, deterministic and probabilistic analysis

ADT Case[1]	LCC	Replacement Alternative, Dollars			Rehabilitation Alternative, Dollars		
		Agency	User	Total	Agency	User	Total
1	D	1,191,515	2,618,430	3,809,944	1,172,788	2,252,939	3,425,727
	P1	1,203,146	2,487,246	3,690,392	1,250,889	2,190,694	3,441,584
	P2	1,201,069	2,356,742	3,560,778	1,235,173	2,088,005	3,340,833
2	D	1,191,515	5,086,170	6,277,684	1,172,788	4,404,281	5,577,069
	P1	1,203,146	4,805,013	6,008,159	1,250,889	4,265,064	5,515,954
	P2	1,201,069	4,548,437	5,748,648	1,235,173	4,062,532	5,315,901
3	D	1,191,515	12,489,390	13,680,904	1,172,788	10,858,308	12,031,096
	P1	1,203,146	11,758,315	12,961,461	1,250,889	10,488,175	11,739,065
	P2	1,201,069	11,119,865	12,320,279	1,235,173	9,985,899	11,237,070
4	D	1,191,515	3,974,636	5,166,151	1,172,788	3,167,309	4,340,097
	P1	1,203,146	4,012,556	5,215,702	1,250,889	3,237,609	4,488,499
	P2	1,201,069	3,865,747	5,071,344	1,235,173	3,120,120	4,372,410
5	D	1,191,515	6,442,376	7,633,891	1,172,788	5,318,651	6,491,439
	P1	1,203,146	6,330,323	7,533,469	1,250,889	5,311,980	6,562,869
	P2	1,201,069	6,043,843	7,250,388	1,235,173	5,085,968	6,339,431
6	D	1,191,515	13,845,596	15,037,111	1,172,788	11,772,678	12,945,466
	P1	1,203,146	13,283,624	14,486,770	1,250,889	11,535,090	12,785,980
	P2	1,201,069	12,609,807	13,817,945	1,235,173	11,002,411	12,255,098
7	D	1,191,515	10,002,220	11,193,735	1,172,788	7,231,176	8,403,964
	P1	1,203,146	10,791,710	11,994,856	1,250,889	7,890,566	9,141,455
	P2	1,201,069	10,575,930	11,778,008	1,235,173	7,713,306	8,963,475
8	D	1,191,515	12,469,960	13,661,475	1,172,788	9,382,519	10,555,307
	P1	1,203,146	13,109,477	14,312,623	1,250,889	9,964,936	11,215,825
	P2	1,201,069	12,798,769	14,002,997	1,235,173	9,697,881	10,945,213
9	D	1,191,515	19,873,180	21,064,695	1,172,788	15,836,546	17,009,334
	P1	1,203,146	20,062,778	21,265,924	1,250,889	16,188,047	17,438,936
	P2	1,201,069	19,328,734	20,532,299	1,235,173	15,600,600	16,847,351

[1]Refer to Table 3.6 for ADT cases
LCC=life-cycle cost
D=deterministic
P1=probabilistic, mean values
P2=probabilistic, median values

Table 6.7-Estimated probability for highway bridge with limited variables

Analysis	Estimated Probability, Percent								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	17.02	17.85	17.99	0.23	2.52	9.34	NA	NA	0.30
Limited	10.57	13.31	14.82	0.42	2.62	8.45	NA	NA	0.51

[1]Refer to Table 3.6 for ADT cases
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

Table 6.8-Estimated life-cycle costs for highway bridge with limited variables

Analysis	Life-cycle Costs, Millions of Dollars								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	2.54	3.80	7.52	2.00	3.37	7.07	NA	NA	5.86
Limited	2.25	3.42	6.89	2.18	3.24	6.61	NA	NA	6.44

[1]Refer to Table 3.6 for ADT cases
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

Table 6.9-Modified bridge construction times

	Time, Days		
	Minimum	Most Likely	Maximum
Initial	90	240	370
Initial minus 25%	85	180	280
Initial minus 50%	80	120	180

Table 6.10-Modified bridge construction unit costs

	Unit Costs, $\$/ft^2$ ($\$/m^2$)		
	Mean	Std Deviation	Minimum
Initial	107.52 (1,157.33)	18.28 (196.76)	72.00 (775.00)
Initial plus 5%	112.90 (1,215.20)	18.28 (196.76)	75.60 (813.75)
Initial plus 10%	118.27 (1,273.04)	18.28 (196.76)	79.20 (852.50)
Initial plus 20%	129.02 (1,388.75)	18.28 (196.76)	86.40 (930.00)

Table 6.11-Bridge construction time and cost modifications

Modification	Decrease in Time	Increase in Costs
1a	25%	0%
1b	25%	5%
1c	25%	10%
2a	50%	0%
2b	50%	10%
2c	50%	20%

Table 6.12-Estimated probability for highway bridge with modified construction time and cost

	Estimated Probability, Percent								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	17.02	17.85	17.99	0.23	2.52	9.34	NA	NA	0.30
Mod 1a	28.77	28.60	28.28	0.07	5.29	16.97	NA	NA	0.54
Mod 1b	24.03	26.39	27.33	NA	4.58	16.38	NA	NA	0.50
Mod 1c	19.80	24.27	26.40	NA	4.03	15.79	NA	NA	0.46
Mod 2a	59.84	56.29	54.29	2.09	19.47	39.25	NA	NA	2.37
Mod 2b	44.62	49.25	51.41	0.25	14.83	36.42	NA	NA	1.85
Mod 2c	28.06	42.27	48.72	NA	10.57	33.63	NA	NA	1.29

[1]Refer to Table 3.6 for ADT cases
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

Table 6.13-Estimated life-cycle costs for highway bridge with modified construction time and cost

	Life-cycle Costs, Millions of Dollars								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	2.54	3.80	7.52	2.00	3.37	7.07	NA	NA	5.86
Mod 1a	2.58	3.83	7.55	1.82	3.43	7.20	NA	NA	6.09
Mod 1b	2.51	3.77	7.48	NA	3.38	7.17	NA	NA	6.03
Mod 1c	2.44	3.71	7.42	NA	3.33	7.12	NA	NA	5.96
Mod 2a	2.68	3.93	7.72	2.23	3.63	7.49	NA	NA	6.70
Mod 2b	2.53	3.81	7.59	1.84	3.52	7.36	NA	NA	6.61
Mod 2c	2.36	3.69	7.48	NA	3.40	7.24	NA	NA	6.52

[1]Refer to Table 3.6 for ADT cases
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

Table 6.14-Estimated probability for waterway bridge

Analysis	Estimated Probability, Percent								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	17.02	17.85	17.99	0.23	2.52	9.34	NA	NA	0.30
Waterway	73.59[2]	73.59[2]	73.59[2]	NA	NA	NA	NA	NA	NA

[1]Refer to Table 3.6 for ADT cases
[2]Probability that rehabilitation life-cycle costs less than replacement life-cycle costs
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

Table 6.15-Estimated life-cycle costs for waterway bridge

Analysis	Life-cycle Costs, Millions of Dollars								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	2.54	3.80	7.52	2.00	3.37	7.07	NA	NA	5.86
Waterway	1.48	1.48	1.48	NA	NA	NA	NA	NA	NA

[1]Refer to Table 3.6 for ADT cases
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

Table 6.16-Estimated probability for waterway bridge with modified construction time and cost

Analysis	Estimated Probability, Percent								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	17.02	17.85	17.99	0.23	2.52	9.34	NA	NA	0.30
Waterway	73.59[2]	73.59[2]	73.59[2]	NA	NA	NA	NA	NA	NA
Water + Mod 1a	--[3]	--[3]	--[3]	NA	NA	NA	NA	NA	NA
Water + Mod 1b	80.73[2]	80.73[2]	80.73[2]	NA	NA	NA	NA	NA	NA
Water + Mod 1c	90.60[2]	90.60[2]	90.60[2]	NA	NA	NA	NA	NA	NA
Water + Mod 2a	--[3]	--[3]	--[3]	NA	NA	NA	NA	NA	NA
Water + Mod 2b	85.12[2]	85.12[2]	85.12[2]	NA	NA	NA	NA	NA	NA
Water + Mod 2c	95.81[2]	95.81[2]	95.81[2]	NA	NA	NA	NA	NA	NA

[1]Refer to Table 3.6 for ADT cases
[2]Probability that rehabilitation life-cycle costs less than replacement life-cycle costs
[3]More than one intersection point
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

Table 6.17-Estimated life-cycle costs for waterway bridge with modified construction time and cost

Analysis	Life-cycle Costs, Millions of Dollars								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	2.54	3.80	7.52	2.00	3.37	7.07	NA	NA	5.86
Waterway	1.48	1.48	1.48	NA	NA	NA	NA	NA	NA
Water + Mod 1a	--[2]	--[2]	--[2]	NA	NA	NA	NA	NA	NA
Water + Mod 1b	1.53	1.53	1.53	NA	NA	NA	NA	NA	NA
Water + Mod 1c	1.65	1.65	1.65	NA	NA	NA	NA	NA	NA
Water + Mod 2a	--[2]	--[2]	--[2]	NA	NA	NA	NA	NA	NA
Water + Mod 2b	1.56	1.56	1.56	NA	NA	NA	NA	NA	NA
Water + Mod 2c	1.77	1.77	1.77	NA	NA	NA	NA	NA	NA

[1]Refer to Table 3.6 for ADT cases
[2]More than one intersection point
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

Table 6.18-Estimated probability for all bridges

Analysis	Estimated Probability, Percent								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	17.02	17.85	17.99	0.23	2.52	9.34	NA	NA	0.30
Mod 1a	28.77	28.60	28.28	0.07	5.29	16.97	NA	NA	0.54
Mod 1b	24.03	26.39	27.33	NA	4.58	16.38	NA	NA	0.50
Mod 1c	19.80	24.27	26.40	NA	4.03	15.79	NA	NA	0.46
Mod 2a	59.84	56.29	54.29	2.09	19.47	39.25	NA	NA	2.37
Mod 2b	44.62	49.25	51.41	0.25	14.83	36.42	NA	NA	1.85
Mod 2c	28.06	42.27	48.72	NA	10.57	33.63	NA	NA	1.29
Limited	10.57	13.31	14.82	0.42	2.62	8.45	NA	NA	0.51
Waterway	73.59[2]	73.59[2]	73.59[2]	NA	NA	NA	NA	NA	NA
Water + Mod 1a	--[3]	--[3]	--[3]	NA	NA	NA	NA	NA	NA
Water + Mod 1b	80.73[2]	80.73[2]	80.73[2]	NA	NA	NA	NA	NA	NA
Water + Mod 1c	90.60[2]	90.60[2]	90.60[2]	NA	NA	NA	NA	NA	NA
Water + Mod 2a	--[3]	--[3]	--[3]	NA	NA	NA	NA	NA	NA
Water + Mod 2b	85.12[2]	85.12[2]	85.12[2]	NA	NA	NA	NA	NA	NA
Water + Mod 2c	95.81[2]	95.81[2]	95.81[2]	NA	NA	NA	NA	NA	NA

[1]Refer to Table 3.6 for ADT cases
[2]Probability that rehabilitation life-cycle costs less than replacement life-cycle costs
[3]More than one intersection point
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

Table 6.19-Estimated life-cycle costs for all bridges

Analysis	Life-cycle Costs, Millions of Dollars								
	ADT Case 1[1]	ADT Case 2[1]	ADT Case 3[1]	ADT Case 4[1]	ADT Case 5[1]	ADT Case 6[1]	ADT Case 7[1]	ADT Case 8[1]	ADT Case 9[1]
Highway	2.54	3.80	7.52	2.00	3.37	7.07	NA	NA	5.86
Mod 1a	2.58	3.83	7.55	1.82	3.43	7.21	NA	NA	6.09
Mod 1b	2.51	3.77	7.48	NA	3.38	7.17	NA	NA	6.03
Mod 1c	2.44	3.71	7.42	NA	3.33	7.12	NA	NA	5.96
Mod 2a	2.68	3.93	7.72	2.23	3.63	7.49	NA	NA	6.70
Mod 2b	2.53	3.81	7.59	1.84	3.52	7.36	NA	NA	6.61
Mod 2c	2.36	3.69	7.48	NA	3.40	7.24	NA	NA	6.52
Limited	2.25	3.42	6.89	2.18	3.24	6.61	NA	NA	6.44
Waterway	1.48	1.48	1.48	NA	NA	NA	NA	NA	NA
Water + Mod 1a	--[2]	--[2]	--[2]	NA	NA	NA	NA	NA	NA
Water + Mod 1b	1.53	1.53	1.53	NA	NA	NA	NA	NA	NA
Water + Mod 1c	1.65	1.65	1.65	NA	NA	NA	NA	NA	NA
Water + Mod 2a	--[2]	--[2]	--[2]	NA	NA	NA	NA	NA	NA
Water + Mod 2b	1.56	1.56	1.56	NA	NA	NA	NA	NA	NA
Water + Mod 2c	1.77	1.77	1.77	NA	NA	NA	NA	NA	NA

[1]Refer to Table 3.6 for ADT cases
[2]More than one intersection point
NA-Rehabilitation life-cycle costs less than replacement life-cycle costs

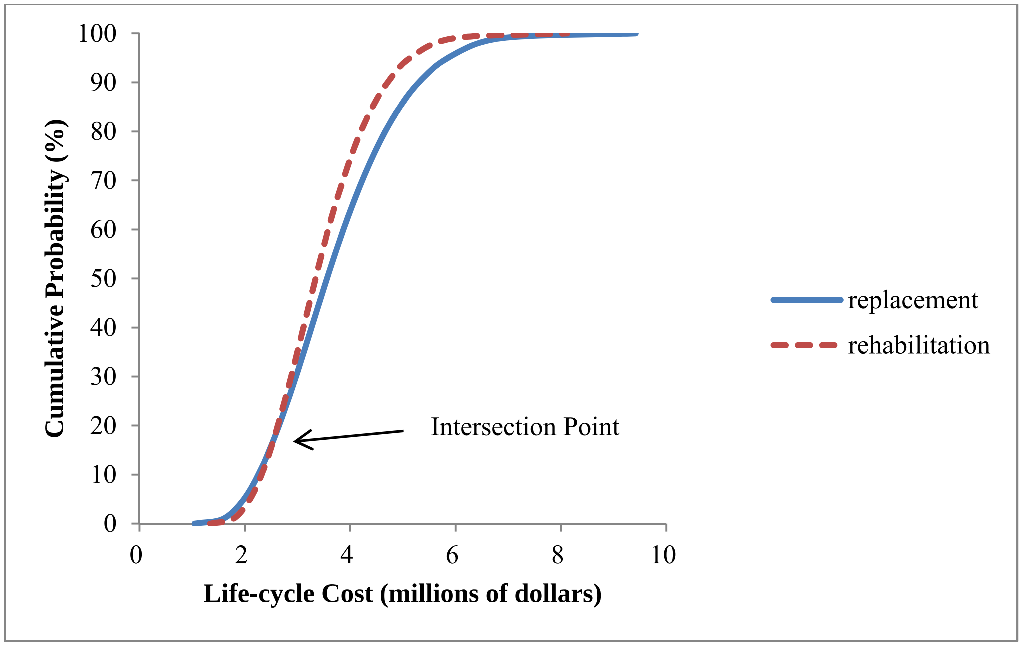


Figure 6.1-Ascending cumulative probability distributions for highway bridge, ADT case 1 (Table 3.6)

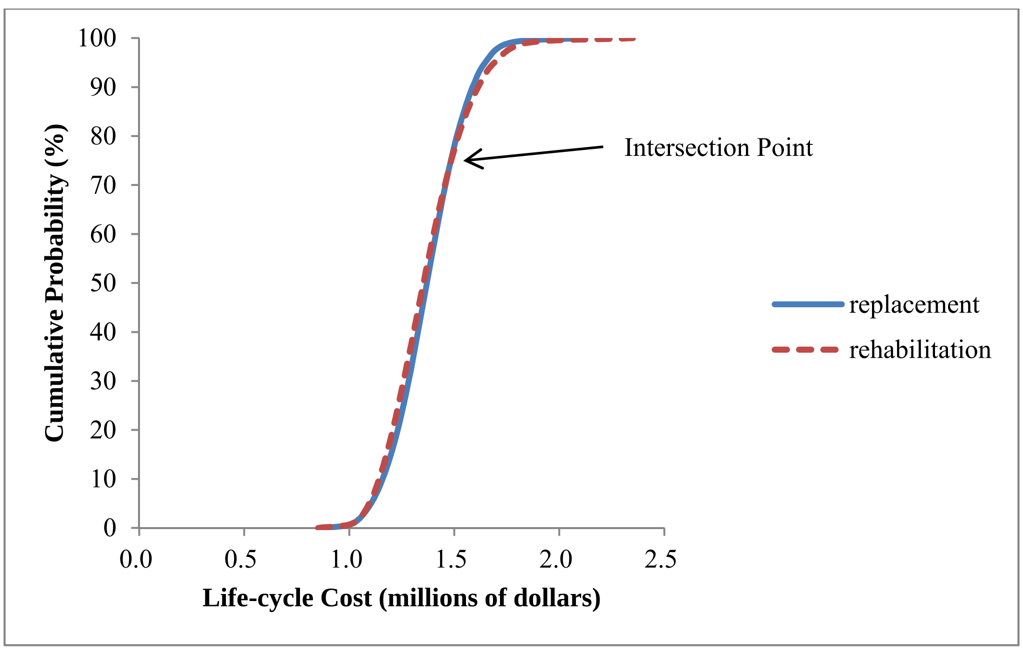


Figure 6.2-Ascending cumulative probability distributions for waterway bridge, ADT case 1, 2, 3 (Table 3.6)

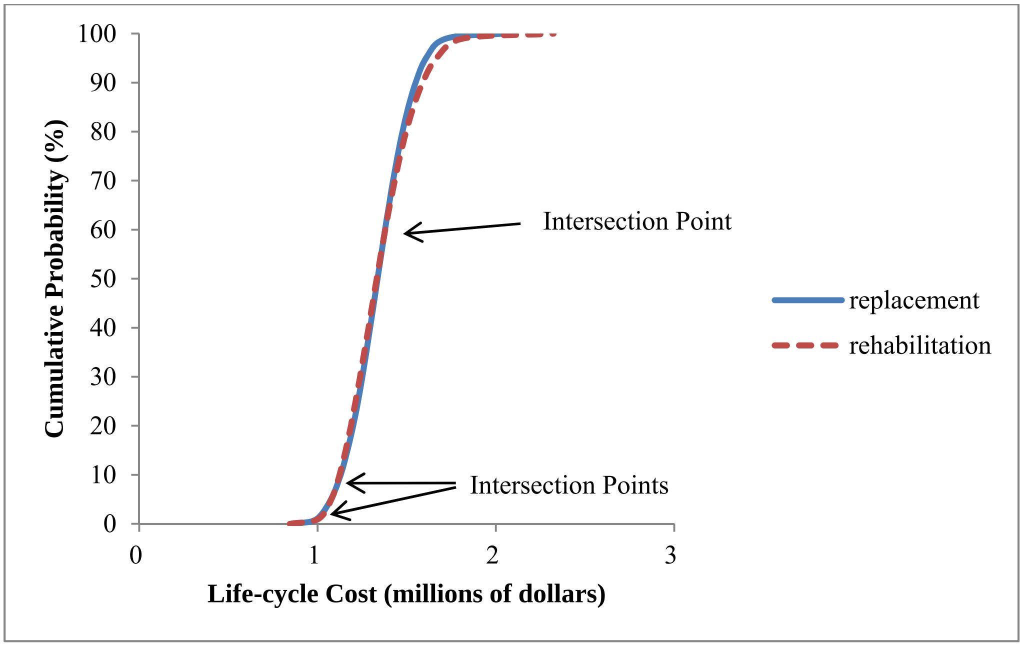


Figure 6.3-Ascending cumulative probability distributions for waterway bridge with modification 1a, ADT case 1 (Table 3.6)

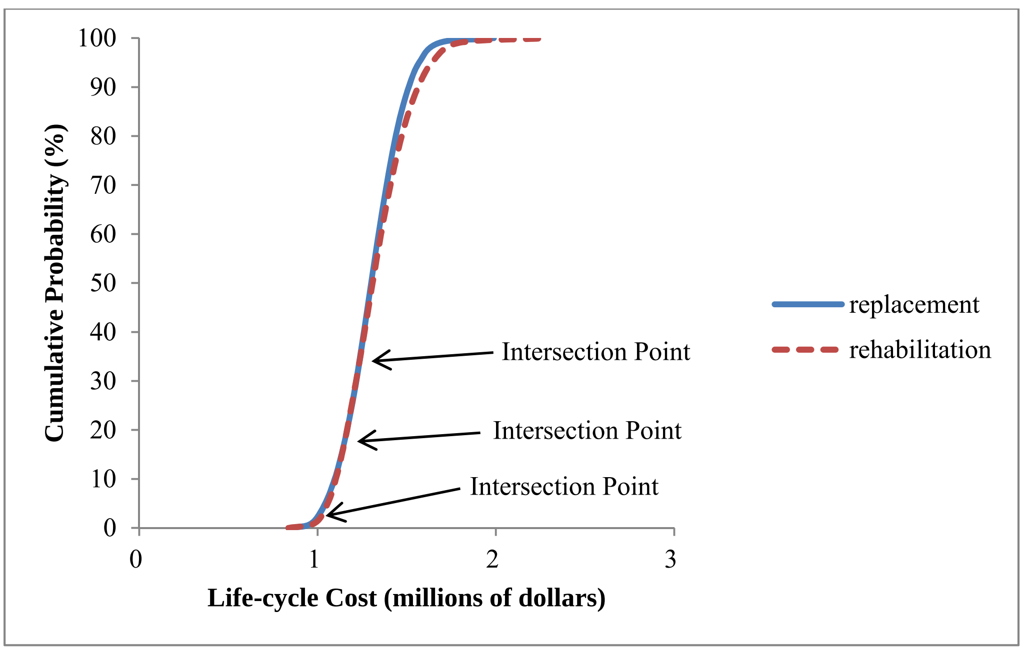


Figure 6.4-Ascending cumulative probability distributions for waterway bridge with modification 2a, ADT case 1 (Table 3.6)

CHAPTER SEVEN: SUMMARY AND CONCLUSIONS

This dissertation presents the results of a study to identify the parameters that had the most influence on life-cycle costs for reinforced concrete bridges rehabilitated with fiber reinforced polymer composites and how those parameters interacted. The use of LCCA was extended to bridge rehabilitation and lower traffic volumes. The study also introduced the use of time declining discount rates for longer analysis periods.The methodology was then used to determine and compare the life-cycle cost of a reinforced concrete tee-beam bridge rehabilitated with CFRP and a bridge replacement. Both a deterministic and probabilistic analysis was used to determine when the life-cycle cost of the replacement alternative is less than the rehabilitation alternative. Nine combinations of traffic volumes on and under the bridge were used to determine the effect of traffic volumes on life-cycle costs.

Sensitivity Analysis

The sensitivity analysis showed which parameters had the most influence on life-cycle costs. Most parameters had a small influence. Four parameters had the most influence: time to construct the new bridge, traffic volume under bridge, value of time for cars, and delay time under bridge during new bridge construction. By using a limited number of variations in these four parameters a “simulated” probabilistic analysis can be done with less effort than that needed to do a probabilistic analysis.

These four parameters individually had different influences on life-cycle costs. For the time to construct the new bridge and the value of time for cars the change in life-cycle costs increased as traffic volumes on and under the bridge increased. For the other two parameters the change in life-cycle costs decreased as traffic volume on the bridge increased and increased as traffic volume under the bridge increased. Although traffic volume on the bridge did not have as much influence on life-cycle costs it increased life-cycle costs as traffic volumes on the bridge increased and decreased life-cycle costs as traffic volumes under the bridge increased. Taken individually traffic volume under the bridge had a larger influence on life-cycle costs. However, when both are varied at the same time the traffic volume on the bridge had more of an influence. For high traffic volumes on the bridge the change in life-cycle costs did not vary much even though traffic volume under the bridge increased from 5,000 to 25,000 vehicles per day.

Bridge over Highway

For bridges over a highway the deterministic analysis showed that the rehabilitation alternative life-cycle cost is always less than the replacement alternative. This occurred for all traffic combinations. The analysis also showed that increases in traffic volumes, both on and under a bridge, significantly increased life-cycle costs for both alternatives as well as the difference in life-cycle costs.

Although life-cycle costs always increased as traffic volumes increased the percent difference in life-cycle costs between the replacement and rehabilitation alternatives did not. For low traffic volume on the bridge the percent increased slightly as traffic volume under the bridge increased. For medium and high traffic volume on the bridge the percent difference decreased as traffic volume under the bridge increased. For a constant traffic volume under the bridge the percent difference significantly increased as traffic volume on the bridge increased. This would indicate that traffic volumes on the bridge had more influence on life-cycle costs than traffic volume under the bridge.

The probabilistic analysis for a bridge over a highway showed that there is a small probability that the replacement alternative life-cycle cost is less than the rehabilitation alternative. The probability varied and depended on the traffic volume. The life-cycle costs were primarily driven by the traffic volume on the bridge. For low traffic volume on the bridge, the probability that the replacement life-cycle cost is lower ranged from 17.02 to 17.99 percent. For medium traffic volume on the bridge, the probability that the replacement life-cycle cost is lower ranged from 0.23 to 9.34 percent. For high traffic volume on the bridge, the probability that the replacement life-cycle cost is lower ranged from zero to 0.30 percent.

The probabilistic analysis showed different trends in the influence of traffic volumes than from the deterministic analysis. For low and high traffic volumes on the bridge the probability that replacement had the lower life-cycle costs varied very little, the range was one percent or less. For medium traffic volumes on the bridge the probability that replacement had the lower life-cycle cost increased significantly as traffic under the bridge increased. However, for a constant traffic volume under the bridge the probability that replacement had the lower life-cycle cost decreased significantly as traffic volume on the bridge decreased. This occurred for all levels of traffic.

Bridge over Highway with Limited Random Variables

Using more random variables that the four that had the most influence on life-cycle costs did not have a consistent impact on the results. This only applies to the probabilistic analysis. In some ADT cases the probabilities increased and in others they decreased. For low traffic volumes on the bridge the probabilities decreased. For medium traffic volumes on the bridge the probabilities increased slightly for ADT cases 4 and 5 (Table 3.6) but decreased for the ADT case 6 (Table 3.6). For high traffic volume on the bridge there was no change in probability for ADT cases 7 and 8 (Table 3.6) and a slightly increased probability for ADT case 9 (Table 3.6). The changes in probability transitioned from a decrease at low traffic volumes to no or slight increases at high traffic volumes.

Bridge over Highway with Modified Bridge Construction Time and Cost

Since user costs are a significant portion of the life-cycle costs and the time to construct the new bridge was one of the four parameters with the most influence on life-cycle costs the use of an accelerated bridge construction technology to reduce the time to construct the bridge may be considered. Any additional costs to construct the bridge (agency costs) would have to be weighed against the time savings and decreases in user costs.

For bridges over a highway with modified bridge construction time and cost the results were similar to those for the bridge over a highway. The only differences were the values of the life-cycle costs and the percent differences between the alternatives. The amount of reduction depended on traffic volume. If the bridge construction time can be reduced by 50 percent the percent difference in life-cycle costs can be significantly reduced. The reduction was largest for low traffic volumes on the bridge. For a constant traffic volume on the bridge the amount of reduction increased as traffic under the bridge increased. For a constant traffic volume under the bridge the amount of reduction decreased as traffic on the bridge increased.

Bridge over Waterway

For bridges over waterways the deterministic analysis results are both similar to the bridge over a highway and different. Since there is no vehicular traffic under the bridge all life-cycle costs are reduced. Like the bridge over a highway the percent difference in life-cycle costs also increased as traffic on the bridge increased. When compared to the bridge over highway the percent difference in life-cycle costs decreased significantly for the low traffic volume case. However, for the medium and high traffic volume cases the difference increased.

When compared to the bridge over a highway the probability distribution curves reversed position. The probability that rehabilitation, instead of replacement, had the lower life-cycle cost was about 74 percent for the low traffic volume on the bridge cases. For the other traffic cases the curves did not intersect and the rehabilitation alternative had the lower life-cycle cost. This is different than the bridge over highway where the curves did intersect for ADT cases 4, 5, 6, and 9 (Table 3.6) but at a low probability.

Bridge over Waterway with Modified Bridge Construction Time and Cost

For the bridge over a waterway with modifications to the bridge construction time and cost the deterministic analysis results are similar and different than other results. Like the bridge over waterway the percent difference in life-cycle costs increased as the traffic volume on the bridge increased. Like the modified bridge over highway the percent differences decreased when compared to the waterway bridge. However, unlike the modified bridge over highway the percent difference increased enough with the increased construction cost to be larger than the bridge over waterway. This shows that using accelerated bridge techniques had an adverse effect on life-cycle costs.

For the bridge over a waterway with modifications to the bridge construction time and cost the probability distribution curves also reversed position. The probability that rehabilitation, instead of replacement, had the lower life-cycle cost increased to about 81 to 96 percent for the low traffic volume on the bridge cases. The actual probability depended on the amount the bridge construction time was reduced and the amount the bridge construction cost increased. For the unlikely case where there is no increase in bridge construction cost the curves were close enough to have two or three intersection points and it was not possible to make any definitive conclusions. For the other traffic cases the curves also did not intersect and the rehabilitation alternative had the lower life-cycle cost.

Conclusions and Recommendations

LCCA is another tool that can be used to evaluate alternatives of equal utility to help select the preferred alternative for implementation. The results provide the decision maker with additional economic information to help in selecting the preferred alternative. However there may be other considerations that may cause a decision maker to not select the alternative with the lower life-cycle cost.

The sensitivity analysis showed that it is possible to simulate a probabilistic analysis using the deterministic approach if the right variables are chosen. Using minimum and maximum values for these variables a range of life-cycle costs can be obtained with a reduced number of iterations of the life-cycle cost model. A methodology to automate this analysis would make this approach viable.

Additional research to make the methodology used in this study more of an assessment tool is recommended. Such an extended methodology would fit in with the ever growing field of sustainability.

APPENDIX A: KYTC PROJECTS

Appendix A contains listings of KYTC projects that were used to determine the construction unit costs for the following:

- Prestressed concrete beam bridge
- Reinforced concrete deck
- Reinforced concrete bridge deck restoration
- Bridge removal
- Bridge deck removal
- Bridge rail retrofit

It also contains listings of KYTC projects that were used to determine the maintenance of traffic costs during the following:

- Bridge construction
- Bridge deck restoration

It also contains listings of KYTC projects that were used to determine the construction time for the following:

- Bridge construction
- Bridge deck restoration

The following items are used in the project listings:

- Date Let: The date the contractor's bids are opened
- Call: Identifies the project during project advertising and bid opening
- Contract ID: Identifies the project during construction for contract administration
- County: Identifies the county where the project is located
- District: Identifies the State highway district where the project is located
- SYP: Identifies the project in the State's six year improvement plan
- Proposal Description: Usually the State or Federal project number

A summary of which projects were used in each analysis is shown in Table A.1.

Date Let: 01-25-13 Call: 103 Contract ID: 13-1003
Bridge with Grade, Drain & Surface Brown Badgett Loop (CR 1092)
County: Hopkins District: 02 SYP: 02-01067.00
Proposal Description: BRZ 0203(305)

Date Let: 01-25-13 Call: 317 Contract ID: 13-2650
Bridge Deck Overlay Butler County (WN 9007)
County: Butler District: 03 SYP:
Proposal Description: FE02 016 9007 B00061N

Date Let: 02-22-13 Call: 100 Contract ID: 13-2903
Bridge Deck Restoration & Waterproofing Interstate 64
County: Jefferson District: 05 SYP: 05-01072.00
Proposal Description: IM 0642 (181)

Date Let: 02-22-13 Call: 104 Contract ID: 13-1009
Bridge with Grade, Drain & Surface KY 1428
County: Floyd District: 12 SYP: 12-01071.00
Proposal Description: BRZ 1203(345)

Date Let: 02-22-13 Call: 311 Contract ID: 13-2652
Bridge Deck Restoration & Waterproofing Campbell County (KY 9)
County: Campbell District: 06 SYP:
Proposal Description: FE02 019 0009 B00033N

Date Let: 03-22-13 Call: 104 Contract ID: 13-1318
Bridge with Grade, Drain & Surface Fulton-Fulgham Road (KY 307)
County: Hickman District: 01 SYP: 01-01018.00
Proposal Description: BRO 5005 (007)

Date Let: 03-22-13 Call: 332 Contract ID: 13-2913
Bridge Deck Restoration & Waterproofing Bridge over North Fork of Triplett Creek
County: Rowan District: 09 SYP:
Proposal Description: FE02 103 0377 B00027N

Date Let: 03-22-13 Call: 434 Contract ID: 13-2653
Bridge Deck Restoration & Waterproofing Wayne & McCreary Cos. Bridge Overlays and Joint Replacements
County: Various District: 08 SYP:
Proposal Description: 121GR13M073-FE02

Date Let: 04-19-13 Call: 101 Contract ID: 13-1306
Grade, Drain & Surface with Bridge Georgetown Northwest Bypass
County: Scott District: 07 SYP: 07-00102.10
Proposal Description: HPP 0122 (008)

Date Let: 04-19-13 Call: 406 Contract ID: 13-2654
Bridge Deck Overlay Hancock County
County: Hancock District: 02 SYP:
Proposal Description: 046GR13M082-FE02

Date Let: 04-19-13 Call: 425 Contract ID: 13-1020
Asphalt Rehab with Bridge(s) Martha Layne Collins Parkway (BG 9002)
County: Various District: 04 SYP: 04-02046.00
Proposal Description: 121GR13D020-FD04 SPP

Date Let: 04-19-13 Call: 426 Contract ID: 13-2907
Bridge Deck Restoration & Waterproofing New Circle Road Bridges
County: Fayette District: 07 SYP:
Proposal Description: 034GR13M058-FE02

Date Let: 05-24-13 Call: 352 Contract ID: 13-1034
Bridge with Grade, Drain & Surface Low Water Drive (CR 1336)
County: Harlan District: 11 SYP: 11-08510.00
Proposal Description: JL03 048 1336 000-001

Date Let: 05-24-13 Call: 368 Contract ID: 13-2914
Bridge Replacement Bridge over Little Goose Creek (MP 13.476)
County: Clay District: 11 SYP:
Proposal Description: CB01 026 0687 B00041N

Date Let: 05-24-13 Call: 369 Contract ID: 13-2909
Bridge Deck Restoration & Waterproofing Bridge over Levisa Fork of Big Sandy
County: Floyd District: 12 SYP:
Proposal Description: FE02 036 0023 B00038L,R

Date Let: 05-24-13 Call: 406 Contract ID: 13-2656
Bridge Deck Overlay KY 838 Crittenden and Livingston Countys
County: Various District: 01 SYP:
Proposal Description: 121GR13M093-FE01

Date Let: 05-24-13 Call: 420 Contract ID: 13-2904
Bridge Deck Restoration & Waterproofing KY 80 over KY 9006
County: Clay District: 11 SYP:
Proposal Description: 026GR13M092-FE02

Date Let: 06-14-13 Call: 200 Contract ID: 13-1033
Bridge Replacement Old Tunnel Mill Road (KY 458)
County: Washington District: 04 SYP: 04-01079.00
Proposal Description: 121GR13D033-NHPP BRO

Date Let: 06-14-13 Call: 201 Contract ID: 13-2911
Bridge Deck Restoration & Waterproofing Bridges over I-64
County: Bath District: 09 SYP: 09-02030.00
Proposal Description: 121GR13M096 - IM

Date Let: 06-14-13 Call: 202 Contract ID: 13-4106
Guardrail Russell - Greenup (US 23)
County: Greenup District: 09 SYP:
Proposal Description: 121GR13T006

Date Let: 06-14-13 Call: 405 Contract ID: 13-2917
Bridge Deck Restoration & Waterproofing Bridges Over Mountain Parkway
County: Wolfe District: 10 SYP:
Proposal Description: 119GR13M097-FE02

Date Let: 07-12-13 Call: 200 Contract ID: 13-1040
Bridge with Grade, Drain & Surface Ray Road (CR 1060)
County: Daviess District: 02 SYP: 02-01066.00
Proposal Description: 121GR13D040

Date Let: 07-12-13 Call: 366 Contract ID: 13-1041
Grade, Drain & Surface with Bridge Hooker Branch Road (CR 1276)
County: Clay District: 11 SYP: 11-08633.00
Proposal Description: JL04 026 1276 000-001

Date Let: 08-16-13 Call: 103 Contract ID: 13-1309
Bridge with Grade, Drain & Surface Huddy-Mcveigh Road (KY 199)
County: Pike District: 12 SYP: 12-01076.00
Proposal Description: BRO 5365 (012)

Date Let: 08-16-13 Call: 106 Contract ID: 13-1051
Bridge with Grade, Drain & Surface Dahl Road (KY 1677)
County: Pulaski District: 08 SYP: 08-01042.00
Proposal Description: BRZ 0803(173)

Date Let: 08-16-13 Call: 201 Contract ID: 13-2916
Bridge Deck Restoration & Waterproofing I-64 Bridges
County: Franklin District: 05 SYP: 05--02069
Proposal Description: 121GR13M095 - IM

Date Let: 08-16-13 Call: 202 Contract ID: 13-1203
Bridge with Grade, Drain & Surface Woodbine-Barbourville Road (KY 6)
County: Knox District: 11 SYP: 11--1076.00, 11-1075.00
Proposal Description: 061GR13D003-BRZ

Date Let: 08-16-13 Call: 344 Contract ID: 13-1206
Bridge with Grade & Drain Bridge Connector
County: Martin District: 12 SYP:
Proposal Description: FD39 080 NEW ROUTE

Date Let: 08-16-13 Call: 410 Contract ID: 13-2658
Bridge Deck Restoration & Waterproofing Robertson County KY 165 and KY 616
County: Robertson District: 06 SYP:
Proposal Description: 101GR13M123-FE02

Date Let: 08-16-13 Call: 430 Contract ID: 13-2657
Bridge Deck Overlay Boone County KY 8 and KY 536--Gallatin County KY 35
County: Various District: 06 SYP:
Proposal Description: 121GR13M104-FE02

Date Let: 09-27-13 Call: 101 Contract ID: 13-1208
Bridge with Grade, Drain & Surface Wilson Creek Bridge (KY 945)
County: Graves District: 01 SYP: 01--1058.00
Proposal Description: STP BRZ 0103 (324)

Date Let: 09-27-13 Call: 102 Contract ID: 13-1063
Bridge Replacement East Union-Carlisle Road (KY-1285)
County: Nicholas District: 09 SYP: 09-08503.00
Proposal Description: STP BRZ 0903(187)

Date Let: 09-27-13 Call: 105 Contract ID: 13-1053
Bridge with Grade, Drain & Surface KY 476
County: Perry District: 10 SYP: 10-01087.00
Proposal Description: BRO 5375(036)

Date Let: 09-27-13 Call: 111 Contract ID: 13-1061
Bridge Replacement KY-502
County: Hopkins District: 02 SYP: 02-01070.00
Proposal Description: STP BRZ 0203(318)

Date Let: 09-27-13 Call: 200 Contract ID: 13-1211
Asphalt Rehab with Bridge(s) Louisville-Cincinnati Road (1-71)
County: Henry District: 05 SYP: 05-02063.00
Proposal Description: 121GR13D011-NHPP IM

Date Let: 09-27-13 Call: 201 Contract ID: 13-1204
Grade, Drain & Surface with Bridge Richmond-Lancaster Road (KY 52)
County: Various District: 07 SYP: 07-00201.01
Proposal Description: 121GR13D004-FE02 STP

Date Let: 09-27-13 Call: 311 Contract ID: 13-2661
Bridge Deck Overlay Outerloop (KY 1065)
County: Jefferson District: 05 SYP:
Proposal Description: FE02 056 1065 B00290N

Date Let: 09-27-13 Call: 317 Contract ID: 13-1209
Grade, Drain & Surface with Bridge Kuttawa-Princeton Road (US 62)
County: Lyon District: 01 SYP: 01-00307.01
Proposal Description: FD04 SPP 072 0062 009-013

Date Let: 09-27-13 Call: 320 Contract ID: 13-2923
Bridge Deck Restoration & Waterproofing KY 1773 Bridge over Grassy Creek
County: Carter District: 09 SYP:
Proposal Description: FE02 022 1773 B00135N

Date Let: 09-27-13 Call: 322 Contract ID: 13-2924
Bridge Deck Restoration & Waterproofing KY 386 Bridge over McBride Creek
County: Nicholas District: 09 SYP:
Proposal Description: FE02 091 0386 B00033N

Date Let: 09-27-13 Call: 323 Contract ID: 13-2921
Bridge Deck Restoration & Waterproofing KY 699 Bridge over Leatherwood Creek
County: Perry District: 10 SYP:
Proposal Description: FE02 097 0699 B00045N

Date Let: 10-25-13 Call: 109 Contract ID: 13-1066
Bridge Replacement Anthoston-Niagara Road (KY-136)
County: Henderson District: 02 SYP: 02-01069.00
Proposal Description: STP BRZ 0203(319)

Date Let: 10-25-13 Call: 301 Contract ID: 13-2660
Bridge Deck Restoration & Waterproofing Henderson County KY 285
County: Henderson District: 02 SYP:
Proposal Description: CB06 051 0285 B00029N

Date Let: 10-25-13 Call: 304 Contract ID: 13-2659
Bridge Deck Restoration & Waterproofing Ohio County KY 1245
County: Ohio District: 02 SYP:
Proposal Description: CB06 092 1245 B00112N

Date Let: 10-25-13 Call: 321 Contract ID: 13-2663
Bridge Deck Restoration & Waterproofing Union County KY 359
County: Union District: 02 SYP:
Proposal Description: FE02 113 0359 B00009N

Date Let: 10-25-13 Call: 400 Contract ID: 13-2664
Bridge Deck Restoration & Waterproofing Davies County KY 3143, KY 554 and US 431
County: Daviess District: 02 SYP:
Proposal Description: 030GR13M136 - FE02

Date Let: 10-25-13 Call: 404 Contract ID: 13-2918
Bridge Deck Restoration & Waterproofing Bridge Overlays in Powell County
County: Powell District: 10 SYP:
Proposal Description: 099GR13M121 - FE02

Date Let: 10-25-13 Call: 406 Contract ID: 13-2920
Bridge Deck Restoration & Waterproofing District 9 Bridge Overlays
County: Various District: 09 SYP:
Proposal Description: 121GR13M132 - FE02

Date Let: 11-22-13 Call: 104 Contract ID: 13-1076
Bridge Replacement Stanton-Slade Road (KY 11)
County: Powell District: 10 SYP: 10-01085.00
Proposal Description: STP BRO 5260(035)

Date Let: 11-22-13 Call: 105 Contract ID: 13-1214
Bridge with Grade, Drain & Surface Gray-Indian Creek Road (KY 3437)
County: Knox District: 11 SYP: 11-01082.00
Proposal Description: STP BRZ 1103 (273)

Date Let: 11-22-13 Call: 106 Contract ID: 13-1219
Bridge with Grade, Drain & Surface Beaver Dam - Leitchfield Road (US 62)
County: Ohio District: 02 SYP: 02-01071.00
Proposal Description: STP BRO 5038 (101)

Date Let: 11-22-13 Call: 107 Contract ID: 13-1220
Bridge with Grade, Drain & Surface Sedalia to Mayfield Road (KY 79)
County: Graves District: 01 SYP: 01-01060.00
Proposal Description: STP BRZ 0103 (325)

Date Let: 11-22-13 Call: 108 Contract ID: 13-1221
Bridge with Grade, Drain & Surface Glomawr to Hazard Road (KY 451)
County: Perry District: 10 SYP: 10-1088.00
Proposal Description: STP BRZ 1003 (229)

Date Let: 11-22-13 Call: 109 Contract ID: 13-1218
Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
County: Hart District: 04 SYP: 04-00013.00
Proposal Description: NHPP IM 0652 (089)

Date Let: 11-22-13 Call: 111 Contract ID: 13-1073
Bridge with Grade, Drain & Surface Buffalo Branch Road (CR-1327)
County: Bell District: 11 SYP: 11-01083.00
Proposal Description: STP BRZ 1103(274)

Date Let: 11-22-13 Call: 304 Contract ID: 13-2925
Bridge Deck Restoration & Waterproofing Bluegrass Parkway
County: Nelson District: 04 SYP:
Proposal Description: FE02 090 9002 B00017L,R

Date Let: 11-22-13 Call: 406 Contract ID: 13-2919
Bridge Deck Restoration & Waterproofing District 10 Bridge Overlays
County: Various District: 10 SYP:
Proposal Description: 121GR13M122 - FE02

Date Let: 12-13-13 Call: 105 Contract ID: 13-1015
Bridge with Grade, Drain & Surface Patty Loveless Drive (KY 80)
County: Pike District: 12 SYP: 12-01070.00
Proposal Description: STP BRO 0806(042)

Date Let: 12-13-13 Call: 106 Contract ID: 13-1080
Grade, Drain & Surface with Bridge Gratz-Moxley Road (KY-355)
County: Owen District: 06 SYP: 06-01066.00
Proposal Description: STP BRZ 0603(237)

Date Let: 12-13-13 Call: 113 Contract ID: 13-1235
Grade & Drain with Bridge Partridge to Oven Fork Road (US 119, Section 3B)
County: Letcher District: 12 SYP: 12-00311.37
Proposal Description: APD 1191 (040)

Date Let: 12-13-13 Call: 300 Contract ID: 13-1213
Grade, Drain & Surface with Bridge Morgantown Road (KY 79)
County: Logan District: 03 SYP: 03-01068.00
Proposal Description: FD04 SPP 071 0079 006-007

Date Let: 12-13-13 Call: 303 Contract ID: 13-2666
Bridge Deck Restoration & Waterproofing Warren County KY 185
County: Warren District: 03 SYP:
Proposal Description: FE02 114 0185 B00003N

Date Let: 12-13-13 Call: 306 Contract ID: 13-1056
Grade, Drain & Surface with Bridge US-68 and Louie B. Nunn Parkway
County: Metcalfe District: 03 SYP: 03-08505.00
Proposal Description: JL03 085 0068 009-011

Date Let: 12-13-13 Call: 307 Contract ID: 13-1081
Grade, Drain & Surface with Bridge New Moody Lane-Commerce Parkway (New Route)
County: Oldham District: 05 SYP: 05-08201.01
Proposal Description: FD04 SPP 093 new route

Date Let: 12-13-13 Call: 401 Contract ID: 13-2926
Bridge Deck Restoration & Waterproofing District 4 Bridge Overlays
County: Various District: 04 SYP:
Proposal Description: 121GR13M135-FE02

Date Let: 12-13-13 Call: 402 Contract ID: 13-1227
Bridge with Grade, Drain & Surface Baizetown-Windy Hill Road (KY 505 over Western KY Parkway)
County: Ohio District: 02 SYP: 02-04015.00
Proposal Description: 121GR13D027 - CB01 & FE02

Date Let: 01-24-14 Call: 101 Contract ID: 14-1006
Bridge with Grade, Drain & Surface KY 1505
County: Rockcastle District: 08 SYP: 08-01052.00
Proposal Description: STP BRZ 0803(181)

Date Let: 01-24-14 Call: 301 Contract ID: 14-1004
Bridge Replacement Daniel Boone Drive (KY-11)
County: Knox District: 11 SYP: 11-00150.00
Proposal Description: FD04 SPP 061 0011 009-011

Date Let: 01-24-14 Call: 313 Contract ID: 14-1208
Grade, Drain & Surface with Bridge Morgantown Road (KY 79)
County: Logan District: 03 SYP: 03-01068.00
Proposal Description: FD04 SPP 071 0079 006-007

Date Let: 03-28-14 Call: 112 Contract ID: 14-1013
Bridge Replacement Pacies Branch Road (CR 1245)
County: Letcher District: 12 SYP: 12-01091.00
Proposal Description: STP BRZ 1203 (370)

Date Let: 03-28-14 Call: 300 Contract ID: 14-2904
Bridge Deck Restoration & Waterproofing Bridge over Harrods Creek
County: Oldham District: 05 SYP:
Proposal Description: CB06 093 1694 B00025N

Date Let: 04-25-14 Call: 104 Contract ID: 14-1214
Bridge Replacement US 42 (East Main Street) over Beargrass Creek
County: Jefferson District: 05 SYP: 05-01052.00
Proposal Description: NHPP BRO 8703 (003)

Date Let: 04-25-14 Call: 105 Contract ID: 14-1017
Bridge Replacement Bloomfield Road (US 62)
County: Nelson District: 04 SYP: 04-01075.00
Proposal Description: STP BRO 5038 (102)

Date Let: 04-25-14 Call: 302 Contract ID: 14-1218
Grade, Drain & Surface with Bridge Cumberland Parkway (9008) and US 127 Interchange
County: Russell District: 08 SYP: 08-08504.00
Proposal Description: FD04 SPP 104 0127 017-018

Date Let: 04-25-14 Call: 328 Contract ID: 14-2908
Bridge Deck Restoration & Waterproofing Bridge over Culp Creek Rd
County: Greenup District: 09 SYP:
Proposal Description: FE02 045 0067 B00077N

Date Let: 04-25-14 Call: 329 Contract ID: 14-2901
Bridge Deck Restoration & Waterproofing US 31E
County: Nelson District: 04 SYP:
Proposal Description: FE02 090 0031 B00044N

Date Let: 04-25-14 Call: 403 Contract ID: 14-2907
Bridge Deck Restoration & Waterproofing Fleming County Bridge Overlays
County: Fleming District: 09 SYP:
Proposal Description: 035GR14M058-FE02

Date Let: 05-30-14 Call: 100 Contract ID: 14-1226
Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
County: Warren District: 03 SYP: 03-0016.03
Proposal Description: HPP STP 0150 (012)

Date Let: 05-30-14 Call: 103 Contract ID: 14-1027
Bridge with Grade, Drain & Surface Outland School Road (KY-1536)
County: Calloway District: 01 SYP: 01-01061.00
Proposal Description: BRZ 0103 (331)

Date Let: 05-30-14 Call: 108 Contract ID: 14-1225
Bridge Replacement Tousey Road (CR 1872) Over Spring Fork
County: Grayson District: 04 SYP: 04-01071.00
Proposal Description: STP BRZ 0403 (190)

Date Let: 05-30-14 Call: 109 Contract ID: 14-1021
Bridge with Grade & Drain Stinson Road (CR-1700)
County: Wayne District: 08 SYP: 08-01051.00
Proposal Description: STP BRZ 0803 (182)

Date Let: 05-30-14 Call: 110 Contract ID: 14-1224
Bridge Replacement Elk Lick Creek Road (CR 1224)
County: Lee District: 10 SYP: 10-01091.00
Proposal Description: STP BRZ 1003 (221)

Date Let: 05-30-14 Call: 200 Contract ID: 14-1028
Asphalt Rehab Interstate/Parkway Edward T. Breathitt Parkway (PW 9004)
County: Hopkins District: 02 SYP: 02-00232.00, 02-00232.10
Proposal Description: 121GR14D019-NHPP

Date Let: 05-30-14 Call: 352 Contract ID: 14-2657
Bridge Deck Restoration & Waterproofing Davies County
County: Daviess District: 02 SYP:
Proposal Description: FE02 030 0060 00069R

Date Let: 05-30-14 Call: 353 Contract ID: 14-2658
Bridge Deck Restoration & Waterproofing Hopkins
County: Hopkins District: 02 SYP:
Proposal Description: FE02 054 9004 00014

Date Let: 05-30-14 Call: 354 Contract ID: 14-2912
Bridge Deck Restoration & Waterproofing Bridge over Licking River
County: Morgan District: 10 SYP:
Proposal Description: FE02 088 0772 B00070N

Date Let: 05-30-14 Call: 355 Contract ID: 14-2913
Bridge Deck Restoration & Waterproofing Bridge over Middle Fork of Red River
County: Powell District: 10 SYP:
Proposal Description: FE02 099 9000 B00011L

Date Let: 05-30-14 Call: 440 Contract ID: 14-2909
Bridge Deck Restoration & Waterproofing KY 114 Overlays
County: Floyd District: 12 SYP:
Proposal Description: 036GR14M064-FE02

Date Let: 05-30-14 Call: 444 Contract ID: 14-2655
Bridge Deck Restoration & Waterproofing Davies County US 231
County: Daviess District: 02 SYP:
Proposal Description: 030GR14M072-FE02

Date Let: 05-30-14 Call: 445 Contract ID: 14-2656
Bridge Deck Restoration & Waterproofing Ballard County
County: Ballard District: 01 SYP:
Proposal Description: 004GR14M071-FE02

Date Let: 05-30-14 Call: 446 Contract ID: 14-2914
Bridge Deck Restoration & Waterproofing Bridges over Mountain Parkway
County: Powell District: 10 SYP:
Proposal Description: 121GR14M068-FE02

Date Let: 06-27-14 Call: 101 Contract ID: 14-1232
Bridge with Grade, Drain & Surface Bent Branch Road (KY-1426)
County: Pike District: 12 SYP: 12-01102.00
Proposal Description: STP BRZ 1203 (374)

Date Let: 06-27-14 Call: 109 Contract ID: 14-1222
Bridge with Grade, Drain & Surface Frenchburg to Owingsville Road (KY 36)
County: Menifee District: 10 SYP: 10-01090.00
Proposal Description: STP BRO 1003 (238)

Date Let: 06-27-14 Call: 110 Contract ID: 14-1031
Bridge with Grade, Drain & Surface KY 32 over Seas Branch
County: Rowan District: 09 SYP: 09-01076.00
Proposal Description: STP BRO 5253(023)

Date Let: 06-27-14 Call: 207 Contract ID: 14-1033
Bridge with Grade, Drain & Surface Lower Johns Creek Road (KY-194)
County: Floyd District: 12 SYP: 12-01075.00
Proposal Description: 121GR14D033-STP

Date Let: 06-27-14 Call: 316 Contract ID: 14-2917
Bridge Deck Restoration & Waterproofing Bridge over Wilson Creek
County: Nelson District: 04 SYP:
Proposal Description: FE02 090 0061 B00062N

Date Let: 07-11-14 Call: 100 Contract ID: 14-2915
Bridge Deck Restoration & Waterproofing Interstate 64
County: Franklin District: 05 SYP: 05-00520.00
Proposal Description: IM 0643 (052)

Date Let: 07-11-14 Call: 107 Contract ID: 14-1026
Bridge Replacement Hacker Branch Road (CR-1136)
County: Owsley District: 10 SYP: 10-01093.00
Proposal Description: STP BRZ 1003 (227)

Date Let: 07-11-14 Call: 108 Contract ID: 14-1223
Bridge Replacement Rye Branch Road (CR 1756)
County: Magoffin District: 10 SYP: 10-01092.00
Proposal Description: STP BRZ 1003 (239)

Date Let: 07-11-14 Call: 109 Contract ID: 14-1237
Bridge with Grade, Drain & Surface KG Estates Road (CR 1162)
County: Lawrence District: 12 SYP: 12-01106.00
Proposal Description: STP BRZ 1203 (373)

Date Let: 07-11-14 Call: 113 Contract ID: 14-1024
Bridge with Grade, Drain & Surface Hazard-Hyden Road (KY-80)
County: Perry District: 10 SYP: 10-01082.00
Proposal Description: STP BRO 5271 (039)

Date Let: 07-11-14 Call: 115 Contract ID: 14-1037
Bridge with Grade & Drain Stinson Road (CR-1700)
County: Wayne District: 08 SYP: 08-01051.00
Proposal Description: STP BRZ 0803 (182)

Date Let: 08-22-14 Call: 106 Contract ID: 14-1045
Bridge with Grade, Drain & Surface Morehead-Grayson Road (US-60)
County: Rowan District: 09 SYP: 09-01061.00
Proposal Description: STP BRO 5211(106)

Date Let: 08-22-14 Call: 107 Contract ID: 14-1253
Bridge Replacement Glasgow Street (CS 1053)
County: Metcalfe District: 03 SYP: 03-01075.00
Proposal Description: STP BRZ 0303 (256)

Date Let: 08-22-14 Call: 108 Contract ID: 14-1252
Bridge Replacement Mobley Mill Road (CR 1327)
County: Nelson District: 04 SYP: 04-01083.00
Proposal Description: STP BRZ 0403 (194)

Date Let: 08-22-14 Call: 109 Contract ID: 14-1228
Bridge with Grade, Drain & Surface Upper Wolf Creek Road (CR 1134)
County: Owsley District: 10 SYP: 10-01108.00
Proposal Description: STP BRZ 1003 (240)

Date Let: 08-22-14 Call: 111 Contract ID: 14-1255
Bridge with Grade & Drain Curtis Road (CR 1226)
County: Boyle District: 07 SYP: 07-01133.00
Proposal Description: STP BRZ 0703 (322)

Date Let: 08-22-14 Call: 200 Contract ID: 14-1029
Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
County: Hart District: 04 SYP: 04-00015.00, 04-00016.00, 04-00017.00
Proposal Description: 121GR14D029-NHPP

Date Let: 08-22-14 Call: 203 Contract ID: 14-1241
Asphalt Pavement & Roadway Rehab Julian M. Carroll Parkway (9003)
County: Graves District: 01 SYP: 01-00234.00
Proposal Description: 121GR14D041-NHPP

Date Let: 08-22-14 Call: 313 Contract ID: 14-1043
Bridge with Grade, Drain & Surface KY-49
County: Marion District: 04 SYP: 04-08304.00
Proposal Description: FD04 SPP 078 0049 013-016

Date Let: 08-22-14 Call: 319 Contract ID: 14-2660
Bridge Deck Restoration & Waterproofing Anderson County US 62 Tyron Bridge
County: Anderson District: 07 SYP:
Proposal Description: FE02 003 0062 B00003N

Date Let: 08-22-14 Call: 435 Contract ID: 14-2923
Bridge Deck Restoration & Waterproofing Bridge Overlays in Harlan County
County: Harlan District: 11 SYP:
Proposal Description: 048GR14M083 - FE02

Date Let: 08-22-14 Call: 445 Contract ID: 14-2922
Bridge Deck Restoration & Waterproofing Bridge Overlays in Perry County
County: Perry District: 10 SYP:
Proposal Description: 097GR14M081 - FE02

Date Let: 09-26-14 Call: 100 Contract ID: 14-2980
Bridge Deck Restoration & Waterproofing Bridge over Ohio River
County: Boone District: 06 SYP: 06-02039.00
Proposal Description: IM 2759 (130)

Date Let: 09-26-14 Call: 103 Contract ID: 14-1048
Bridge Replacement Tebb's Bend (CR-1236)
County: Taylor District: 04 SYP: 04-01058.00
Proposal Description: STP BRZ 0403 (195)

Date Let: 09-26-14 Call: 104 Contract ID: 14-1018
Bridge with Grade, Drain & Surface Oscar Bowling Road (CR 1113A)
County: Clay District: 11 SYP: 11-01069
Proposal Description: STP BRZ 1103 (280)

Date Let: 09-26-14 Call: 112 Contract ID: 14-1209
Grade, Drain & Surface with Bridge Kenneth Barrett Road (KY 30)
County: Owsley District: 10 SYP: 10-01084.00
Proposal Description: STP BRO 0302 (018)

Date Let: 09-26-14 Call: 113 Contract ID: 14-1262
Bridge with Grade, Drain & Surface Booneville-Jackson Road (KY 30)
County: Breathitt District: 10 SYP: 10-01096.00
Proposal Description: STP BRO 5263 (020)

Date Let: 09-26-14 Call: 116 Contract ID: 14-1261
Bridge Replacement Hade Bell Road (CR 1167)
County: Allen District: 03 SYP: 03-01081.00
Proposal Description: STP BRZ 0303 (263)

Date Let: 09-26-14 Call: 117 Contract ID: 14-1049
Bridge with Grade, Drain & Surface Wildie Road (CR-1071)
County: Rockcastle District: 08 SYP: 08-01058.00
Proposal Description: STP BRZ 0803 (186)

Date Let: 09-26-14 Call: 118 Contract ID: 14-1256
Bridge with Grade, Drain & Surface KG Estates Road (CR 1162)
County: Lawrence District: 12 SYP: 12-01106.00
Proposal Description: STP BRZ 1203 (373)

Date Let: 09-26-14 Call: 119 Contract ID: 14-1047
Grade & Drain with Bridge KY 343
County: Letcher District: 12 SYP: 12-01097.00
Proposal Description: STP BRZ 1203 (376)

Date Let: 09-26-14 Call: 306 Contract ID: 14-1053
Bridge with Grade, Drain & Surface 10th Street (KY-2386)
County: Whitley District: 11 SYP: 11-08306.00
Proposal Description: FD04 SPP 118 2386 000-001

Date Let: 09-26-14 Call: 404 Contract ID: 14-2926
Bridge Deck Restoration & Waterproofing Western Kentucky Parkway Bridge Overlays
County: Hardin District: 04 SYP:
Proposal Description: 047GR14M085 - FE02

Bridge Replacement Pryorsburg to Dublin Road (KY 1748)
Date Let: 10-24-14 Call: 108 Contract ID: 14-1271
County: Graves District: 01 SYP: 01-01134.00
Proposal Description: STP BRZ 0103 (335)

Date Let: 10-24-14 Call: 110 Contract ID: 14-1274
Bridge with Grade, Drain & Surface Upper Wolf Creek Road (CR 1134)
County: Owsley District: 10 SYP: 10-01108.00
Proposal Description: STP BRZ 1003 (240)

Date Let: 10-24-14 Call: 111 Contract ID: 14-1278
Bridge Replacement Wildie Road (CR 1071)
County: Rockcastle District: 08 SYP: 08-01057.00
Proposal Description: STP BRZ 0803 (191)

Date Let: 10-24-14 Call: 118 Contract ID: 14-1280
Grade & Drain with Bridge Simpsonville - Buck Creek Road (KY 1848)
County: Shelby District: 05 SYP: 05-00348.01
Proposal Description: STP 5389 (003)

Date Let: 10-24-14 Call: 302 Contract ID: 14-1061
Bridge Replacement Hemp Patch Branch Road (CR-1002)
County: Knott District: 12 SYP: 12-04092.00
Proposal Description: FD04 SPP 060 1002 000-001

Date Let: 10-24-14 Call: 304 Contract ID: 14-1276
Grade & Drain with Asphalt Surface Chalybeate School Road (KY 743)
County: Edmonson District: 03 SYP: 03-08602.00
Proposal Description: FD04 SPP 031 0743 003-006

Date Let: 10-24-14 Call: 306 Contract ID: 14-1282
Asphalt Rehab with Bridge(s) Louie B. Nunn Cumberland Parkway (9008)
County: Barren District: 03 SYP: 03-02037.00
Proposal Description: FD04 SPP 005 9008 000-009

Date Let: 10-24-14 Call: 319 Contract ID: 14-2903
Bridge Deck Restoration & Waterproofing Bridge over Tygarts Creek
County: Carter District: 09 SYP:
Proposal Description: FE02 022 6062 B00035N

Date Let: 10-24-14 Call: 403 Contract ID: 14-2927
Bridge Deck Restoration & Waterproofing Bridge Overlays in Wayne County
County: Wayne District: 08 SYP:
Proposal Description: 116GR14M087 - FE02

Table A.1-Summary of KYTC projects

Date Let	Call	Bridge Construction	Deck Construction	Deck Restoration	Bridge Removal	Deck Removal	Bridge Rail Retrofit	MOT Bridge Construction	MOT Deck Restoration	Bridge Construction Time	Bridge Restoration Time
01-25-13	103	X	X		X			X		X	
01-25-13	317			X					X		X
02-22-13	100			X					X		X
02-22-13	104	X	X		X					X	
02-22-13	311			X					X		X
03-22-13	104				X			X			
03-22-13	332			X					X		X
03-22-13	434			X					X		X
04-19-13	101	X	X					X			
04-19-13	406			X					X		X
04-19-13	425					X		X			
04-19-13	426			X					X		X
05-24-13	352				X			X			
05-24-13	368				X						
05-24-13	369			X					X		X
05-24-13	406			X					X		X
05-24-13	420			X					X		X
06-14-13	200									X	
06-14-13	201			X					X		X
06-14-13	202						X				
06-14-13	405								X		
07-12-13	200				X			X			
07-12-13	366	X	X					X		X	
08-16-13	103				X			X			
08-16-13	106	X	X		X			X		X	
08-16-13	201			X					X		X
08-16-13	202				X						
08-16-13	344							X			
08-16-13	410			X					X		X
08-16-13	430			X					X		X
09-27-13	101				X			X			
09-27-13	102				X			X			
09-27-13	105	X	X		X			X		X	
09-27-13	111				X			X			
09-27-13	200			X			X				X
09-27-13	201			X							X
09-27-13	311			X					X		X
09-27-13	317	X	X					X		X	
09-27-13	320			X					X		X
09-27-13	322			X					X		X
09-27-13	323			X					X		X

Table A.1-Summary of KYTC projects (continued)

Date Let	Call	Bridge Construction	Deck Construction	Deck Restoration	Bridge Removal	Deck Removal	Bridge Rail Retrofit	MOT Bridge Construction	MOT Deck Restoration	Bridge Construction Time	Bridge Restoration Time
10-25-13	109				X			X			
10-25-13	301			X					X		X
10-25-13	304			X					X		X
10-25-13	321			X					X		X
10-25-13	400			X					X		X
10-25-13	404			X					X		X
10-25-13	406			X					X		X
11-22-13	104	X	X		X			X		X	
11-22-13	105				X			X			
11-22-13	106	X	X		X			X		X	
11-22-13	107				X			X			
11-22-13	108	X	X		X			X		X	
11-22-13	109	X	X		X						
11-22-13	111	X	X		X			X		X	
11-22-13	304			X					X		X
11-22-13	406			X					X		X
12-13-13	105				X						
12-13-13	106	X	X		X			X		X	
12-13-13	113	X	X					X			
12-13-13	300							X		X	
12-13-13	303			X					X		X
12-13-13	306	X	X					X		X	
12-13-13	307	X	X					X			
12-13-13	401			X					X		X
12-13-13	402							X			
01-24-14	101							X			
01-24-14	301							X			
01-24-14	313	X	X		X			X		X	
03-28-14	112				X			X			
03-28-14	300								X		
04-25-14	104									X	
04-25-14	105				X			X			
04-25-14	302			X							X
04-25-14	328			X					X		X
04-25-14	329			X					X		X
04-25-14	403			X					X		X
05-30-14	100	X	X								
05-30-14	103				X			X			
05-30-14	108							X			
05-30-14	109							X			
05-30-14	110				X			X			

Table A.1-Summary of KYTC projects (continued)

Date Let	Call	Bridge Construction	Deck Construction	Deck Restoration	Bridge Removal	Deck Removal	Bridge Rail Retrofit	MOT Bridge Construction	MOT Deck Restoration	Bridge Construction Time	Bridge Restoration Time
05-30-14	200			X							X
05-30-14	352			X					X		X
05-30-14	353			X					X		X
05-30-14	354			X					X		X
05-30-14	355			X					X		X
05-30-14	440			X					X		X
05-30-14	444			X					X		X
05-30-14	445			X					X		X
05-30-14	446			X					X		X
06-27-14	101				X						
06-27-14	109	X	X		X			X		X	
06-27-14	110				X			X			
06-27-14	207				X			X			
06-27-14	316			X					X		X
07-11-14	100			X					X		X
07-11-14	107				X			X			
07-11-14	108	X	X		X			X		X	
07-11-14	109							X			
07-11-14	113	X	X		X			X		X	
07-11-14	115				X			X			
08-22-14	106				X			X			
08-22-14	107				X			X			
08-22-14	108				X			X			
08-22-14	109							X			
08-22-14	111				X			X			
08-22-14	200	X	X		X			X			
08-22-14	203			X							X
08-22-14	313	X	X		X			X		X	
08-22-14	319								X		
08-22-14	435			X					X		X
08-22-14	445			X					X		X
09-26-14	100			X					X		X
09-26-14	103				X						
09-26-14	104				X			X		X	
09-26-14	112				X			X		X	
09-26-14	113				X			X		X	
09-26-14	116				X			X			
09-26-14	117				X			X			
09-26-14	118				X			X			
09-26-14	119				X			X			
09-26-14	306							X			
09-26-14	404			X					X		X

Table A.1-Summary of KYTC projects (continued)

Date Let	Call	Bridge Construction	Deck Construction	Deck Restoration	Bridge Removal	Deck Removal	Bridge Rail Retrofit	MOT Bridge Construction	MOT Deck Restoration	Bridge Construction Time	Bridge Restoration Time
10-24-14	108				X			X			
10-24-14	110				X			X			
10-24-14	111				X			X			
10-24-14	118							X			
10-24-14	302				X			X		X	
10-24-14	304							X			
10-24-14	306			X							X
10-24-14	319			X					X		X
10-24-14	403			X					X		X

APPENDIX B: CONSTRUCTION TIME

Appendix E contains summaries of construction times for the following:

- Prestressed concrete beam bridge
- Reinforced concrete bridge deck restoration

Bridge Construction Time

An analysis of the contract time for completion of prestressed concrete beam bridge projects was done for projects with a calendar completion date, Table B.1, and one for projects with a specified number of working days for completion, Table B.2.

Table B.1-Projects with calendar date completion

Date Let	Call	County	District	Date Let	Completion Date	Time (days)
Jan 2013	103	Hopkins	2	1/25/2013	10/30/2013	278
Feb 2013	104	Floyd	12	2/22/2013	10/31/2013	251
Jun 2013	200	Washington	4	6/14/2013	10/31/2013	139
Jul 2013	366	Clay	11	7/12/2013	7/30/2014	383
Aug 2013	106	Pulaski	8	8/16/2013	11/30/2013	106
Nov 2013	106	Ohio	2	11/22/2013	9/1/2014	283
Nov 2013	111	Bell	11	11/22/2013	7/1/2014	221
Dec 2013	106	Owen	6	12/13/2013	8/30/2014	260
Dec 2013	300	Logan	3	12/13/2013	11/1/2014	323
Jan 2014	313	Logan	3	1/24/2014	11/1/2014	281
Apr 2014	104	Jefferson	5	4/25/2014	10/1/2014	159
Sep 2014	104	Clay	11	9/26/2014	7/30/2015	307
Oct 2014	302	Knott	12	10/24/2014	8/31/2015	311

The average time from bid opening to completion date is 254 days. Assuming two weeks used to award contract and issue a notice to proceed, the average completion time is 240 calendar days. The time from bid opening to completion date ranges from 106 to 383 days or from 92 to 369 days adjusted.

Table B.2-Projects with working days completion

Date Let	Call	County	District	Date Let	Time (days)
Sep 2013	105	Perry	10	9/27/2013	135
Sep 2013	317	Lyon	1	9/27/2013	150
Nov 2013	104	Powell	10	11/22/2013	85
Nov 2013	108	Perry	10	11/22/2013	220
Dec 2013	306	Metcalfe	3	12/13/2013	270
Jun 2014	109	Menifee	10	6/27/2014	150
Jul 2014	108	Magoffin	10	7/11/2014	50
Jul 2014	113	Perry	10	7/11/2014	240
Aug 2014	313	Marion	4	8/22/2014	170
Sep 2014	112	Owsley	10	9/26/2014	165
Sep 2014	113	Breathitt	10	9/26/2014	220

The average completion time is 168.6 working days. Assuming five working days per week, the average completion time is 236.1 calendar days. The completion time ranges from 50 to 270 working days or from 70 to 378 working days adjusted.

Bridge Deck Overlay Construction Time

An analysis of the contract time for completion of concrete deck restoration projects was done. The completion dates were working days, calendar days, weekends, or not specified. Bridges without a specified completion date were usually part of a larger project where the overall completion date controlled. The completion dates are summarized in Table B.3. The completion dates specified in the project proposals are summarized in Tables B.4, B.5, and B.6. The most common completion date was 30 calendar days, for 65 percent of the bridges where a date was specified and 77 percent of the bridges where calendar days were specified. The average calendar day completion date was 30.8 days. The study used 30 calendar days.

Table B.3-Bridge deck restoration completion date summary

Completion Date	Number Times Used
20 working days	2
30 working days	2
40 working days	1
2 weekends	9
14 calendar days	1
20 calendar days	8
25 calendar days	1
30 calendar days	60
40 calendar days	1
45 calendar days	4
60 calendar days	3
Sub total	92
None specified	16
Total	108

Table B.4-Specified completion dates, working days

Letting	Call	Bridge Number	Completion Date
Jan 2013	317	016B00061N	40 working days
Mar 2013	434	074B00011N	30 working days
Mar 2013	434	116B00001N	20 working days
Apr 2013	406	046B00030N	20 working days
Apr 2013	406	046B00013N	30 working days

Table B.5-Specified completion dates, calendar days

Letting	Call	Bridge Number	Completion Date
Feb 2013	100	056B00040R	2 weekends
Feb 2013	311	019B00033N	60 calendar days
Mar 2013	332	103B00027N	45 calendar days
Apr 2013	426	034B00027L	2 weekends
Apr 2013	426	034B00027R	2 weekends
Apr 2013	426	034B00028L	2 weekends
Apr 2013	426	034B00028R	2 weekends
Apr 2013	426	034B00029L	2 weekends
Apr 2013	426	034B00029R	2 weekends
Apr 2013	426	034B00031L	2 weekends
Apr 2013	426	034B00031R	2 weekends
May 2013	369	036B00038L	30 calendar days
May 2013	369	036B00038R	30 calendar days
May 2013	406	028B00047N	20 calendar days
May 2013	406	028B00048N	20 calendar days
May 2013	406	070B00058N	20 calendar days
May 2013	420	026B00061N	30 calendar days
May 2013	420	026B00067N	30 calendar days
Jun 2013	201	006B00017N	30 calendar days
Jun 2013	201	006B00042N	30 calendar days
Jun 2013	201	103B00029N	30 calendar days
Aug 2013	410	101B00009N	30 calendar days
Aug 2013	430	008B00036N	30 calendar days
Aug 2013	430	039B00010N	30 calendar days
Aug 2013	430	008B00021N	25 calendar days
Sep 2013	311	056B00290N	60 calendar days
Oct 2013	301	051B00029N	30 calendar days
Oct 2013	304	092B00112N	30 calendar days
Oct 2013	321	092B00112N	40 calendar days
Oct 2013	400	030B00115N	30 calendar days
Oct 2013	400	030B00084N	20 calendar days
Oct 2013	400	030B00048N	14 calendar days
Oct 2013	404	099B00009R	30 calendar days
Oct 2013	404	099B00017N	30 calendar days
Oct 2013	404	099B00042N	30 calendar days
Oct 2013	406	022B00106N	30 calendar days
Oct 2013	406	068B00030N	30 calendar days
Oct 2013	406	068B00031N	30 calendar days
Oct 2013	406	091B00035N	30 calendar days
Nov 2013	304	090B00017L	30 calendar days
Nov 2013	304	090B00017R	30 calendar days
Nov 2013	406	013B00026N	30 calendar days
Nov 2013	406	077B00026N	30 calendar days
Nov 2013	406	088B00042N	30 calendar days
Nov 2013	406	097B00036N	30 calendar days
Dec 2013	303	114B00003N	60 calendar days
Dec 2013	401	078B00038N	30 calendar days
Dec 2013	401	109B00004N	30 calendar days
Dec 2013	401	109B00025N	30 calendar days

Table B.5-Specified completion dates, calendar days (continued)

Letting	Call	Bridge Number	Completion Date
Apr 2014	328	045B00077N	30 calendar days
Apr 2014	329	090B00044N	30 calendar days
Apr 2014	403	035B00022N	30 calendar days
Apr 2014	403	035B00025N	30 calendar days
May 2014	352	030B00069R	30 calendar days
May 2014	353	054B00014L	30 calendar days
May 2014	353	054B00014R	30 calendar days
May 2014	354	088B00070N	30 calendar days
May 2014	355	099B00011L	30 calendar days
May 2014	440	036B00021N	30 calendar days
May 2014	440	036B00022N	30 calendar days
May 2014	444	030B00034N	30 calendar days
May 2014	444	030B00033N	30 calendar days
May 2014	444	030B00032N	30 calendar days
May 2014	445	004B00032N	30 calendar days
May 2014	445	004B00051N	30 calendar days
May 2014	445	004B00050N	30 calendar days
May 2014	446	099B00033N	30 calendar days
May 2014	446	119B00019N	30 calendar days
Jul 2014	100	037B00057L	30 calendar days
Jul 2014	100	037B00057R	30 calendar days
Aug 2014	435	048B00065N	45 calendar days
Aug 2014	435	048B00147N	45 calendar days
Aug 2014	435	048B00129N	30 calendar days
Aug 2014	445	097B00042N	30 calendar days
Aug 2014	445	097B00089N	45 calendar days
Sep 2014	404	047B00092L	30 calendar days
Sep 2014	404	047B00092R	30 calendar days
Sep 2014	404	047B00093L	30 calendar days
Sep 2014	404	047B00093R	30 calendar days
Oct 2014	319	022B00035N	30 calendar days
Oct 2014	403	116B00009N	30 calendar days
Oct 2014	403	116B00010N	30 calendar days
Oct 2014	403	116B00020N	30 calendar days
May 2014	200	051B00062L	20 calendar days
May 2014	200	051B00062R	20 calendar days
May 2014	200	117B00071L	20 calendar days
May 2014	200	117B00071R	20 calendar days

Table B.6-Specified completion dates, not specified

Letting	Call	Bridge Number	Completion Date
Aug 2013	201	037B00055L	None specified
Aug 2013	201	037B00055R	None specified
Aug 2013	201	037B00056L	None specified
Aug 2013	201	106B00059L	None specified
Sep 2013	320	022B00135N	None specified
Sep 2013	322	091B00033N	None specified
Sep 2013	323	097B00045N	None specified
Jun 2014	316	090B00062N	None specified
Sep 2014	100	008B00052N	None specified
Sep 2013	200	052B00001N	None specified
Sep 2013	200	052B00038N	None specified
Sep 2013	200	052B00051L	None specified
Sep 2013	201	040B00004N	None specified
Apr 2014	302	104B00022N	None specified
Aug 2014	203	079B00075L	None specified
Oct 2014	306	005B00068R	None specified

APPENDIX C: CONSTRUCTION UNIT COSTS

Appendix C contains summaries of bid items and construction unit costs for the following:

- Prestressed concrete beam bridge
- Reinforced concrete deck
- Reinforced concrete bridge deck restoration
- Bridge removal
- Bridge deck removal
- Bridge rail retrofit

Precast Prestressed Concrete I-Beam Bridges

The cost analysis for the construction of precast prestressed concrete I-beam bridges included the following bid items:

- Approach Slab
- Armored Edge for Concrete
- Bridge Chain Link Fence-4 ft
- Bridge Chain Link Fence-6 ft
- Bridge Chain Link Fence-8 ft
- Bridge Chain Link Fence-9 ft
- Concrete-Class A
- Concrete-Class AA
- Crushed Aggregate Slope Protection
- Cyclopean Stone Rip Rap
- Deck Drain
- Drilled Shaft-Common 54 in
- Drilled Shaft-Rock 48 in
- Expansion Dam-4 in Neoprene
- Fabric-Geotextile Type IV
- Guardrail-Steel W Beam-S Face Br
- High Strength Geotextile Fabric
- Masonry Coating
- Mechanical Reinforcement Coupler #5
- Mechanical Reinforcement Coupler #7
- Mechanical Reinforcement Coupler #8
- Mechanical Reinforcement Coupler #9
- Mechanical Reinforcement Coupler #10
- Mechanical Reinforcement Coupler #11
- Mechanical Reinforcement Coupler-#5 Epoxy Coated
- Mechanical Reinforcement Coupler-#6 Epoxy Coated
- Mechanical Reinforcement Coupler-#8 Epoxy Coated
- Pile Points-12 in
- Pile Points-14 in
- Piles-Steel HP12X53
- Piles-Steel HP14X73
- Piles-Steel HP14X89
- Precast PC I-Beam Type 3
- Precast PC I-Beam Type 4
- Precast PC I-Beam Type 5
- Precast PC I-Beam Type 6
- Precast PC I-Beam Type 7
- Precast PC I-Beam Type 8
- Precast PC I-Beam Type 9
- Precast PC I-Beam Type HN 42-49
- Precast PC I-Beam Type HN 54-49

- Precast PC I-Beam Type HN 60-49
- Precast PC I-Beam Type NH 66-61 Hybrid
- Precast PC I-Beam Type HN 72-49
- Pre-drilling For Piles
- Protective Fence
- Rail System Type III
- Reinforced Concrete Slope Wall-6 in
- Steel Reinforcement
- Steel Reinforcement-Epoxy Coated
- Structural Steel
- Structure Excavation-Common
- Structure Excavation-Solid Rock
- Structure Excavation-Unclassified
- Structure Granular Backfill
- Test Piles

All the items were not used with every bridge. The results of the analysis are summarized in Table C.1.

Table C.1-Bridge construction unit costs analysis summary

Cost Analysis Case	n	Unit Cost, $\$/ft^2$ ($\$/m^2$)	
		Mean	Standard Deviation
Excluding costs greater than $\$160.00/ft^2$ ($\$1,722.22/m^2$)	116	107.52 (1,157.33)	18.28 (196.76)
Excluding costs greater than $\$200.00/ft^2$ ($\$2,152.77/m^2$)	129	115.00 (1,237.84)	28.55 (307.31)
Excluding costs greater than $\$300.00/ft^2$ ($\$3,229.16/m^2$)	139	122.20 (1,315.34)	38.00 (409.03)
All costs included	140	123.61 (1,330.52)	41.35 (445.09)

The following are summaries of unit costs for each project used in the analysis.

Bridge with Grade, Drain & Surface Brown Badgett Loop (CR 1092)
Date Let: 01-25-13 Call: 103 County: Hopkins District: 02
Precast PC I Beam Type: HN42-49 Bridge Area: 7,754 ft^2 (720.4 m^2)

	Total Bridge Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	983,665.96	126.86 (1,365.50)
Bidder 2	981,309.92	126.56 (1,362.28)
Bidder 3	977,545.41	126.07 (1,357.00)
Bidder 4	1,017,754.23	131.26 (1,412.87)
Bidder 5	1,221,990.50	157.59 (1,696.28)
Bidder 6	1,545,127.00	199.27 (2,144.92)

Bridge with Grade, Drain & Surface KY 1428
Date Let: 02-22-13 Call: 104 County: Floyd District: 12
Precast PC I Beam Type: HN 54 49 Bridge Area: 4,247 ft^2 (394.6 m^2)

	Total Bridge Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	540,809.24	127.34 (1,370.67)
Bidder 2	660,500.16	155.52 (1,674.00)

Grade, Drain & Surface with Bridge Georgetown Northwest Bypass
Date Let: 04-19-13 Call: 101 County: Scott District: 07
Precast PC I Beam Type: 7 Bridge Area: 23,005 ft^2 (2,137.2 m^2)

	Total Bridge Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	2,593,598.05	112.74 (1,213.52)
Bidder 2	2,363,143.85	102.72 (1,105.66)
Bidder 3	2,566,733.50	111.57 (1,200.92)
Bidder 4	2,363,143.85	102.72 (1,105.66)
Bidder 5	2,666,685.96	115.92 (1,247.75)
Bidder 6	2,531,536.50	110.04 (1,184.46)

Grade, Drain & Surface with Bridge Hooker Branch Road (CR 1276)
Date Let: 07-12-13 Call: 366 County: Clay District: 11
Precast PC I Beam Type: HN60-49 Bridge Area: 4,394 ft^2 (408.2 m^2)

	Total Bridge Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	409,850.90	93.28 (1,004.05)
Bidder 2	468,446.40	106.61 (1,147.54)
Bidder 3	528,910.00	120.37 (1,295.65)
Bidder 4	468,446.40	106.61 (1,147.54)
Bidder 5	610,850.80	139.02 (1,496.39)

Bridge with Grade, Drain & Surface Dahl Road (KY 1677)
Date Let: 08-16-13 Call: 106 County: Pulaski District: 08
Precast PC I Beam Type: 4 Bridge Area: 3,033 ft^2 (281.8 m^2)

	Total Bridge Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	388,415.12	128.06 (1,378.42)
Bidder 2	378,227.30	124.70 (1,342.25)
Bidder 3	377,942.10	124.61 (1,341.29)
Bidder 4	467,270.30	154.06 (1,658.28)
Bidder 5	461,502.81	152.16 (1,637.83)

Bridge with Grade, Drain & Surface KY 476
Date Let: 09-27-13 Call: 105 County: Perry District: 10
Precast PC I Beam Type: HN42-49 Bridge Area: 9,131 ft^2 (848.3 m^2)

	Total Bridge Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	953,767.85	104.45 (1,124.29)
Bidder 2	1,073,528.50	117.57 (1,265.51)
Bidder 3	1,207,156.65	132.20 (1,422.98)
Bidder 4	1,228,610.40	134.55 (1,448.28)
Bidder 5	1,197,482.40	131.14 (1,411.57)

Grade, Drain & Surface with Bridge Kuttawa-Princeton Road (US 62)
Date Let: 09-27-13 Call: 317 County: Lyon District: 01
Precast PC I Beam Type: HN42-49 Bridge Area: 21,250 ft^2 (1,974.2 m^2)

	Total Bridge Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	2,656,685.48	125.02 (1,345.70)
Bidder 2	3,136,758.70	147.61 (1,588.85)

Bridge Replacement Stanton-Slade Road (KY 11)
Date Let: 11-22-13 Call: 104 County: Powell District: 10
Precast PC I Beam Type: HN42-49 Bridge Area: 3,094 ft^2 (287.4 m^2)

	Total Bridge Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	314,411.95	101.62 (1,093.82)
Bidder 2	350,178.40	113.18 (1,218.25)
Bidder 3	346,511.15	111.99 (1,205.45)
Bidder 4	425,193.50	137.43 (1,479.28)

Bridge with Grade, Drain & Surface Beaver Dam - Leitchfield Road (US 62)
Date Let: 11-22-13 Call: 106 County: Ohio District: 02
Precast PC I Beam Type: HN 54 49 Bridge Area: 5,891 ft^2 (547.3 m^2)

	Total Bridge Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	592,289.20	100.54 (1,082.20)
Bidder 2	677,616.50	115.03 (1,238.17)
Bidder 3	681,994.58	115.77 (1,246.13)
Bidder 4	740,171.61	125.64 (1,352.37)
Bidder 5	733,344.00	124.49 (1,339.99)

Bridge with Grade, Drain & Surface Glomawr to Hazard Road (KY 451)
Date Let: 11-22-13 Call: 108 County: Perry District: 10
Precast PC I Beam Type: 8 Bridge Area: 14,457 ft^2 (1,343.1 m^2)

	Total Bridge Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	1,408,871.81	97.45 (1,048.94)
Bidder 2	1,556,763.50	107.68 (1,159.05)
Bidder 3	1,688,817.80	116.82 (1,257.44)
Bidder 4	1,730,651.40	119.71 (1,288.54)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
I 65 over CSX
Precast PC I Beam Type: HN60-49 Bridge Area: 17,868 ft^2 (1,660.0 m^2)

	Total Bridge Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	1,662,428.24	93.04 (1,001.47)
Bidder 2	1,918,818.37	107.39 (1,155.93)
Bidder 3	1,785,208.22	99.91 (1,075.42)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
KY 88 over I 65
Precast PC I Beam Type: HN60-49 Bridge Area: 12,450 ft^2 (1,156.6 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	1,057,793.56	84.96 (914.50)
Bidder 2	1,229,649.65	98.77 (1,063.15)
Bidder 3	1,070,577.12	85.99 (925.59)

Bridge with Grade, Drain & Surface Buffalo Branch Road (CR-1327)
Date Let: 11-22-13 Call: 111 County: Bell District: 11
Precast PC I Beam Type: 3 Bridge Area: 1,560 ft^2 (144.9 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	281,673.40	180.56 (1,943.52)
Bidder 2	318,622.80	204.25 (2,198.52)
Bidder 3	353,081.80	226.33 (2,436.19)
Bidder 4	381,694.47	244.68 (2,633.70)

Grade, Drain & Surface with Bridge Gratz-Moxley Road (KY-355)
Date Let: 12-13-13 Call: 106 County: Owen District: 06
Precast PC I Beam Type: 3 Bridge Area: 5,946 ft^2 (552.4 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	992,004.30	166.84 (1,795.84)
Bidder 2	1,068,053.04	179.63 (1,933.51)
Bidder 3	1,123,253.00	188.91 (2,033.40)
Bidder 4	1,027,904.07	172.87 (1,860.75)
Bidder 5	1,073,563.91	180.55 (1,943.42)
Bidder 6	1,193,574.50	200.74 (2,160.74)
Bidder 7	1,082,909.97	182.12 (1,960.32)
Bidder 8	1,059,069.04	178.11 (1,917.15)
Bidder 9	1,227,857.03	206.50 (2,222.74)

Grade & Drain with Bridge Partridge to Oven Fork Road (US 119, Section 3B)
Date Let: 12-13-13 Call: 113 County: Letcher District: 12
Precast PC I Beam Type: 5 Bridge Area: 19,487 ft^2 (1,810.4 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	1,793,854.84	92.05 (990.81)
Bidder 2	1,722,941.60	88.41 (951.63)
Bidder 3	1,725,437.71	88.54 (953.03)
Bidder 4	1,736,084.00	89.09 (958.95)

Grade, Drain & Surface with Bridge US-68 and Louie B. Nunn Parkway
Date Let: 12-13-13 Call: 306 County: Metcalfe District: 03
Precast PC I Beam Type: NH 66 61-hybrid Bridge Area: 10,833 ft^2 (1,006.4 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	1,109,589.75	102.43 (1,102.54)
Bidder 2	1,207,097.72	111.43 (1,199.42)
Bidder 3	1,192,771.23	110.11 (1,185.21)

Grade, Drain & Surface with Bridge New Moody Lane-Commerce Parkway (New Route)
Date Let: 12-13-13 Call: 307 County: Oldham District: 05
Precast PC I Beam Type: 9 Bridge Area: 70,013 ft^2 (6,504.4 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	5,027,348.20	71.81 (772.95)
Bidder 2	5,023,597.00	71.75 (772.31)
Bidder 3	4,931,802.20	70.44 (758.21)
Bidder 4	5,726,496.80	81.79 (880.38)
Bidder 5	5,319,013.65	75.97 (817.73)
Bidder 6	4,911,871.39	70.16 (755.19)
Bidder 7	5,900,494.25	84.28 (907.18)
Bidder 8	6,201,200.45	88.57 (953.36)

Grade, Drain & Surface with Bridge Morgantown Road (KY 79)
Date Let: 01-24-14 Call: 313 County: Logan District: 03
Precast PC I Beam Type: 4 Bridge Area: 10,101 ft^2 (938.4 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	1,068,699.60	105.80 (1,138.82)
Bidder 2	1,157,056.51	114.55 (1,233.00)
Bidder 3	1,070,175.60	105.95 (1,140.43)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over Commonwealth
Precast PC I Beam Type: HN 7249 Bridge Area: 6,956 ft^2 (646.2 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	601,307.18	86.44 (930.43)
Bidder 2	631,882.20	90.84 (977.79)
Bidder 3	430,103.74	61.83 (665.53)
Bidder 4	750,060.00	107.83 (1,160.67)
Bidder 5	631,765.00	90.82 (977.57)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over US 68 / KY80 / RR
Precast PC I Beam Type: 3 and 5 Bridge Area: 21,549 ft^2 (2,002.0 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	1,940,838.98	90.07 (969.50)
Bidder 2	1,883,527.05	87.41 (940.87)
Bidder 3	2,014,000.83	93.46 (1,005.99)
Bidder 4	2,243,972.40	104.13 (1,120.84)
Bidder 5	2,192,051.65	101.72 (1,094.90)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over I-65
Precast PC I Beam Type: 4 Bridge Area: 30,634 ft^2 (2,846.0 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	2,974,736.68	97.11 (1,045.28)
Bidder 2	3,006,586.90	98.15 (1,056.47)
Bidder 3	3,526,927.89	115.13 (1,239.24)
Bidder 4	3,350,120.80	109.36 (1,177.14)
Bidder 5	3,110,601.58	101.54 (1,092.96)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
Kelly Road over US 31W Connector
Precast PC I Beam Type: 4 Bridge Area: 8,375 ft^2 (778.1 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	867,698.02	103.61 (1,115.24)
Bidder 2	885,617.00	105.75 (1,138.28)
Bidder 3	810,713.61	96.80 (1,041.94)
Bidder 4	1,003,107.85	119.77 (1,289.19)
Bidder 5	954,296.82	113.95 (1,226.54)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over CSX Railroad
Precast PC I Beam Type: 6 Bridge Area: 23,789 ft^2 (2,210.1 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	2,436,053.06	102.40 (1,102.22)
Bidder 2	2,444,569.55	102.76 (1,106.10)
Bidder 3	2,716,159.60	114.18 (1,229.02)
Bidder 4	2,849,711.05	119.79 (1,289.40)
Bidder 5	2,474,524.83	104.02 (1,119.66)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over CSX Railroad
Precast PC I Beam Type: 6 Bridge Area: 19,983 ft^2 (1,856.5 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	2,157,217.14	107.95 (1,161.96)
Bidder 2	2,125,711.10	106.38 (1,145.06)
Bidder 3	2,594,414.26	129.83 (1,397.47)
Bidder 4	2,464,408.75	123.33 (1,327.51)
Bidder 5	2,180,766.94	109.13 (1,174.66)

Bridge with Grade, Drain & Surface Frenchburg to Owingsville Road (KY 36)
Date Let: 06-27-14 Call: 109 County: Menifee District: 10
Precast PC I Beam Type: 4 Bridge Area: 3,266 ft^2 (303.4 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	632,362.40	193.62 (2,084.10)
Bidder 2	664,557.10	203.48 (2,190.23)
Bidder 3	704,802.05	215.80 (2,322.84)
Bidder 4	696,419.65	213.23 (2,295.18)
Bidder 5	755,729.70	231.39 (2,490.65)
Bidder 6	669,235.62	204.91 (2,205.62)
Bidder 7	1,041,093.57	318.77 (3,431.20)

Bridge Replacement Rye Branch Road (CR 1756)
Date Let: 07-11-14 Call: 108 County: Magoffin District: 10
Precast PC I Beam Type: 3 Bridge Area: 1,225 ft^2 (113.8 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	196,067.76	160.06 (1,722.86)
Bidder 2	229,058.00	186.99 (2,012.74)
Bidder 3	237,249.50	193.67 (2,084.64)

Bridge with Grade, Drain & Surface Hazard-Hyden Road (KY-80)
Date Let: 07-11-14 Call: 113 County: Perry District: 10
Precast PC I Beam Type: HN 54 49 Bridge Area: 19,127 ft^2 (1,777.0 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	2,101,305.10	109.86 (1,182.52)
Bidder 2	2,075,194.30	108.50 (1,167.88)
Bidder 3	2,222,734.40	116.21 (1,250.87)
Bidder 4	2,174,378.91	113.68 (1,223.64)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
US 31W Over I-65
Precast PC I Beam Type: HN 54 49 Bridge Area: 18,511 ft^2 (1,719.7 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	2,140,669.33	115.64 (1,244.73)
Bidder 2	2,150,760.60	116.19 (1,250.65)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
BRIDGE-25019
Precast PC I Beam Type: HN42-49 Bridge Area: 28,193 ft^2 (2,619.2 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	2,480,276.07	87.97 (946.90)
Bidder 2	2,346,756.95	83.24 (895.98)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
Old Sonora Bridge over I-65
Precast PC I Beam Type: HN42-49 Bridge Area: 9,415 ft^2 (874.6 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	930,306.37	98.81 (1,063.58)
Bidder 2	966,810.45	102.69 (1,105.34)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
KY-84 over I-65
Precast PC I Beam Type: HN42-49 Bridge Area: 21,172 ft^2 (1,967.0 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	1,975,288.03	93.30 (1,004.27)
Bidder 2	2,004,266.30	94.67 (1,019.02)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
BRIDGE-25021
Precast PC I Beam Type: 3 Bridge Area: 12,079 ft^2 (1,122.2 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	1,331,592.97	110.24 (1,186.61)
Bidder 2	1,219,610.70	100.97 (1,086.83)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
BRIDGE-25020
Precast PC I Beam Type: 4 Bridge Area: 13,135 ft^2 (1,220.3 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	1,174,748.09	89.44 (962.72)
Bidder 2	1,126,785.90	85.78 (923.32)

Bridge with Grade, Drain & Surface KY-49
Date Let: 08-22-14 Call: 313 County: Marion District: 04
Precast PC I Beam Type: HN60-49 Bridge Area: 4,518 ft^2 (419.7 m^2)

	Total Bridge Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	489,029.27	108.24 (1,165.08)
Bidder 2	466,779.00	103.32 (1,112.12)
Bidder 3	489,029.27	108.24 (1,165.08)

Reinforced Concrete Decks

The cost analysis for the construction of a cast in place reinforced concrete bridge deck used the bid data for the precast prestressed concrete I-beam bridges but included only the following bid items:

- Armored Edge for Concrete
- Concrete-Class AA
- Guardrail-Steel W Beam-S Face Br
- Masonry Coating
- Mechanical Reinforcement Coupler-#5 Epoxy Coated
- Mechanical Reinforcement Coupler-#6 Epoxy Coated
- Mechanical Reinforcement Coupler-#8 Epoxy Coated
- Rail System Type III
- Steel Reinforcement-Epoxy Coated
- Structural Steel

These are the items used to construct a reinforced concrete bridge deck and rails. All the items were not used with every bridge. The results of the analysis are summarized in Table C.2.

Table C.2-Bridge deck construction unit costs analysis summary

Cost Analysis Case	n	Unit Cost, $\$/ft^2$ ($\$/m^2$)	
		Mean	Standard Deviation
Excluding costs greater than $60.00/ft^2 ($645.8/m^2)	117	38.17 (410.86)	7.19 (77.39)
Excluding costs greater than $70.00/ft^2 ($753.47/m^2)	133	41.46 (446.27)	11.25 (121.09)
Excluding costs greater than $90.00/ft^2 ($968.75/m^2)	139	43.16 (464.57)	13.65 (146.93)
All costs included	140	43.55 (468.77)	14.35 (154.46)

The following are summaries of unit costs for each project used in the analysis.

Bridge with Grade, Drain & Surface Brown Badgett Loop (CR 1092)
Date Let: 01-25-13 Call: 103 County: Hopkins District: 02
Bridge Area: 7,754 ft^2 (720.4 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	374,562.74	48.31 (520.00)
Bidder 2	320,991.08	41.40 (445.62)
Bidder 3	322,714.70	41.62 (447.99)
Bidder 4	328,259.30	42.33 (455.63)
Bidder 5	385,821.70	49.76 (535.61)
Bidder 6	502,134.00	64.76 (697.07)

Bridge with Grade, Drain & Surface KY 1428
Date Let: 02-22-13 Call: 104 County: Floyd District: 12
Bridge Area: 4,247 ft^2 (394.6 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	188,594.24	44.41 (478.02)
Bidder 2	193,942.16	45.67 (491.59)

Grade, Drain & Surface with Bridge Georgetown Northwest Bypass
Date Let: 04-19-13 Call: 101 County: Scott District: 07
Bridge Area: 23,005 ft^2 (2,137.2 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	789,544.06	34.32 (369.42)
Bidder 2	696,445.40	30.27 (325.82)
Bidder 3	848,473.40	36.88 (396.97)
Bidder 4	696,445.40	30.27 (325.82)
Bidder 5	823,942.16	35.82 (385.56)
Bidder 6	774,779.00	33.68 (362.53)

Grade, Drain & Surface with Bridge Hooker Branch Road (CR 1276)
Date Let: 07-12-13 Call: 366 County: Clay District: 11
Bridge Area: 4,394 ft^2 (408.2 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	160,080.90	36.43 (392.13)
Bidder 2	173,152.40	39.41 (424.20)
Bidder 3	206,638.00	47.03 (506.22)
Bidder 4	173,152.40	39.41 (424.20)
Bidder 5	289,514.80	65.89 (709.23)

Bridge with Grade, Drain & Surface Dahl Road (KY 1677)
Date Let: 08-16-13 Call: 106 County: Pulaski District: 08
Bridge Area: 3,033 ft^2 (281.8 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	169,285.62	55.81 (600.73)
Bidder 2	141,644.80	46.70 (502.67)
Bidder 3	140,723.10	46.40 (499.44)
Bidder 4	189,435.30	62.46 (672.31)
Bidder 5	167,441.80	55.21 (594.27)

Bridge with Grade, Drain & Surface KY 476
Date Let: 09-27-13 Call: 105 County: Perry District: 10
Bridge Area: 9,131 ft^2 (848.3 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	370,598.60	40.59 (436.91)
Bidder 2	404,720.00	44.32 (477.05)
Bidder 3	451,054.40	49.40 (531.74)
Bidder 4	447,115.40	48.97 (527.11)
Bidder 5	439,449.28	48.13 (518.07)

Grade, Drain & Surface with Bridge Kuttawa-Princeton Road (US 62)
Date Let: 09-27-13 Call: 317 County: Lyon District: 01
Bridge Area: 21,250 ft^2 (1,974.2 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	929,414.09	43.74 (470.81)
Bidder 2	1,030,090.70	48.47 (521.72)

Bridge Replacement Stanton-Slade Road (KY 11)
Date Let: 11-22-13 Call: 104 County: Powell District: 10
Bridge Area: 3,094 ft^2 (287.4 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	134,704.00	43.54 (468.66)
Bidder 2	140,863.40	45.53 (490.08)
Bidder 3	163,743.15	52.92 (569.62)
Bidder 4	183,640.50	59.35 (638.84)

Bridge with Grade, Drain & Surface Beaver Dam - Leitchfield Road (US 62)
Date Let: 11-22-13 Call: 106 County: Ohio District: 02
Bridge Area: 5,891 ft^2 (547.3 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	197,055.80	33.45 (360.05)
Bidder 2	208,444.00	35.38 (380.83)
Bidder 3	228,546.58	38.80 (417.64)
Bidder 4	272,236.18	46.21 (497.40)
Bidder 5	226,501.60	38.45 (413.87)

Bridge with Grade, Drain & Surface Glomawr to Hazard Road (KY 451)
Date Let: 11-22-13 Call: 108 County: Perry District: 10
Bridge Area: 14,457 ft^2 (1,343.1 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	479,784.14	33.19 (357.25)
Bidder 2	553,461.60	38.28 (412.04)
Bidder 3	544,464.80	37.66 (405.37)
Bidder 4	628,118.90	43.45 (467.69)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
I 65 over CSX
Bridge Area: 17,868 ft^2 (1,660.0 m^2)

	Total Deck Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	552,841.61	30.94 (333.03)
Bidder 2	653,784.74	36.59 (393.85)
Bidder 3	626,778.27	35.08 (377.60)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
KY 88 over I 65
Bridge Area: 12,450 ft^2 (1,156.6 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	434,348.06	34.89 (375.55)
Bidder 2	491,563.06	39.48 (424.96)
Bidder 3	427,794.26	34.36 (369.85)

Bridge with Grade, Drain & Surface Buffalo Branch Road (CR-1327)
Date Let: 11-22-13 Call: 111 County: Bell District: 11
Bridge Area: 1,560 ft^2 (144.9 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	93,996.80	60.25 (648.52)
Bidder 2	102,298.80	65.58 (705.89)
Bidder 3	88,843.80	56.95 (613.00)
Bidder 4	107,388.68	68.84 (740.98)

Grade, Drain & Surface with Bridge Gratz-Moxley Road (KY-355)
Date Let: 12-13-13 Call: 106 County: Owen District: 06
Bridge Area: 5,946 ft^2 (552.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	394,310.20	66.32 (713.86)
Bidder 2	494,948.64	83.24 (895.98)
Bidder 3	415,842.00	69.94 (752.82)
Bidder 4	396,160.00	66.63 (717.20)
Bidder 5	469,930.44	79.03 (850.67)
Bidder 6	476,207.40	80.09 (862.08)
Bidder 7	356,904.54	60.02 (646.05)
Bidder 8	414,673.02	69.74 (750.67)
Bidder 9	513,881.10	86.42 (930.21)

Grade & Drain with Bridge Partridge to Oven Fork Road (US 119, Section 3B)
Date Let: 12-13-13 Call: 113 County: Letcher District: 12
Bridge Area: 19,487 ft^2 (1,810.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	660,790.19	33.91 (365.00)
Bidder 2	595,658.00	30.57 (329.05)
Bidder 3	611,642.00	31.39 (337.88)
Bidder 4	613,430.00	31.48 (338.85)

Grade, Drain & Surface with Bridge US-68 and Louie B. Nunn Parkway
Date Let: 12-13-13 Call: 306 County: Metcalfe District: 03
Bridge Area: 10,833 ft^2 (1,006.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	396,517.75	36.60 (393.96)
Bidder 2	421,614.70	38.92 (418.93)
Bidder 3	449,834.00	41.52 (446.92)

Grade, Drain & Surface with Bridge New Moody Lane-Commerce Parkway (New Route)
Date Let: 12-13-13 Call: 307 County: Oldham District: 05
Bridge Area: 70,013 ft^2 (6,504.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	1,682,584.50	24.03 (258.66)
Bidder 2	1,988,200.00	28.40 (305.69)
Bidder 3	1,955,443.50	27.93 (300.63)
Bidder 4	1,930,523.00	27.57 (296.76)
Bidder 5	2,121,907.75	30.31 (326.25)
Bidder 6	1,729,120.75	24.70 (265.87)
Bidder 7	2,237,843.25	31.96 (344.01)
Bidder 8	2,072,025.25	29.59 (318.50)

Grade, Drain & Surface with Bridge Morgantown Road (KY 79)
Date Let: 01-24-14 Call: 313 County: Logan District: 03
Bridge Area: 10,101 ft^2 (938.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	371,972.90	36.83 (396.43)
Bidder 2	411,978.60	40.79 (439.06)
Bidder 3	371,972.90	36.83 (396.43)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over Commonwealth
Bridge Area: 6,956 ft^2 (646.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	223,066.30	32.07 (345.20)
Bidder 2	222,886.60	32.04 (344.87)
Bidder 3	273,223.54	39.28 (422.80)
Bidder 4	265,272.80	38.14 (410.53)
Bidder 5	230,975.40	33.21 (357.47)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over US 68 / KY80 / RR
Bridge Area: 21,549 ft^2 (2,002.0 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	624,505.90	28.98 (311.94)
Bidder 2	620,306.95	28.79 (309.89)
Bidder 3	750,441.56	34.82 (374.80)
Bidder 4	778,171.10	36.11 (388.68)
Bidder 5	706,382.55	32.78 (352.84)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over I-65
Bridge Area: 30,634 ft^2 (2,846.0 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	898,475.20	29.33 (315.70)
Bidder 2	909,123.30	29.68 (319.47)
Bidder 3	1,090,286.74	35.59 (383.09)
Bidder 4	1,092,353.60	35.66 (383.84)
Bidder 5	948,302.98	30.96 (333.25)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
Kelly Road over US 31W Connector
Bridge Area: 8,375 ft^2 (778.1 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	302,192.70	36.08 (388.36)
Bidder 2	313,699.35	37.46 (403.21)
Bidder 3	371,265.58	44.33 (477.16)
Bidder 4	374,129.30	44.67 (480.82)
Bidder 5	337,891.17	40.35 (434.32)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over CSX Railroad
Bridge Area: 23,789 ft^2 (2,210.1 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	671,408.20	28.22 (303.76)
Bidder 2	700,294.60	29.44 (316.89)
Bidder 3	831,716.36	34.96 (376.30)
Bidder 4	912,564.90	38.36 (412.90)
Bidder 5	712,685.38	29.96 (322.49)

Bridge with Grade & Drain I-65 to US 31W Connector (KY 3145)
Date Let: 05-30-14 Call: 100 County: Warren District: 03
US 31W Connector over CSX Railroad
Bridge Area: 19,983 ft^2 (1,856.5 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	583,108.80	29.18 (314.09)
Bidder 2	590,965.25	29.57 (318.29)
Bidder 3	725,392.67	36.30 (390.73)
Bidder 4	764,209.90	38.24 (411.61)
Bidder 5	631,280.89	31.59 (340.03)

Bridge with Grade, Drain & Surface Frenchburg to Owingsville Road (KY 36)
Date Let: 06-27-14 Call: 109 County: Menifee District: 10
Bridge Area: 3,266 ft^2 (303.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	200,295.40	61.33 (660.15)
Bidder 2	197,115.60	60.35 (649.60)
Bidder 3	227,349.80	69.61 (749.27)
Bidder 4	141,010.90	43.18 (464.78)
Bidder 5	228,554.20	69.98 (753.26)
Bidder 6	178,867.82	54.77 (589.54)
Bidder 7	259,361.00	79.41 (854.76)

Bridge Replacement Rye Branch Road (CR 1756)
Date Let: 07-11-14 Call: 108 County: Magoffin District: 10
Bridge Area: 1,225 ft^2 (113.8 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	81,495.30	66.53 (716.12)
Bidder 2	94,896.00	77.47 (833.88)
Bidder 3	118,925.00	97.08 (1,044.96)

Bridge with Grade, Drain & Surface Hazard-Hyden Road (KY-80)
Date Let: 07-11-14 Call: 113 County: Perry District: 10
Bridge Area: 19,127 ft^2 (1,777.0 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	759,953.90	39.73 (427.65)
Bidder 2	709,489.70	37.09 (399.23)
Bidder 3	771,836.00	40.35 (434.32)
Bidder 4	729,488.55	38.14 (410.53)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
US 31W over I-65
Bridge Area: 18,511 ft^2 (1,719.7 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	763,114.63	41.22 (443.69)
Bidder 2	664,422.95	35.89 (386.32)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
BRIDGE-25019
Bridge Area: 28,193 ft^2 (2,619.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	1,029,149.37	36.50 (392.88)
Bidder 2	901,926.55	31.99 (344.34)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
Old Sonora Bridge over I-65
Bridge Area: 9,415 ft^2 (874.6 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	367,202.37	39.00 (419.79)
Bidder 2	374,662.55	39.79 (428.29)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
KY-84 over I-65
Bridge Area: 21,172 ft^2 (1,967.0 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	724,093.73	34.20 (368.12)
Bidder 2	677,549.45	32.00 (344.44)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
BRIDGE-25021
Bridge Area: 12,079 ft^2 (1,122.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	590,611.37	48.90 (526.35)
Bidder 2	513,926.05	42.55 (458.00)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
BRIDGE-25020
Bridge Area: 13,135 ft^2 (1,220.3 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	516,154.59	39.30 (423.02)
Bidder 2	457,776.85	34.85 (375.12)

Bridge with Grade, Drain & Surface KY-49
Date Let: 08-22-14 Call: 313 County: Marion District: 04
Bridge Area: 4,518 ft^2 (419.7 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	192,216.07	42.54 (457.89)
Bidder 2	191,335.00	42.35 (455.85)
Bidder 3	192,216.07	42.54 (457.89)

Bridge Deck Restorations

The cost analysis for bridge deck restoration work included the following bid items:

- Armored Edge For Concrete
- Blast Cleaning
- Concrete Class M Full Depth Patch
- Concrete Overlay-Latex
- Epoxy Sand Slurry
- Hydrodemolition
- Machine Preparation Of Slab
- Partial Depth Patching

These are the items that KYTC used to prepare and apply a latex modified concrete overlay to an existing bridge deck that does not have an existing overlay. Hydrodemolition was not used with most of the bridges included in the analysis. The calculated unit costs are per unit of overlay area and are summarized in Table C.3. In the statistical analysis the bridges were grouped by overlay area. As the overlay area increased the mean unit cost decreased. The standard deviation also decreased.

Table C.3-Bridge deck restoration unit costs summary

Overlay Area, A, ft^2 (m^2)	Number bridges	n	Unit Costs, $\$/ft^2$ ($\$/m^2$)	
			Mean	Standard Deviation
A < 1,000 (A < 92.9)	2	13	41.75 (449.39)	7.93 (85.36)
1,000 ≤ A < 3,000 (92.9 ≤ A < 278.7)	16	83	31.55 (339.60)	7.80 (83.96)
3,000 ≤ A < 5,000 (278.7 ≤ A < 464.5)	24	146	22.24 (239.39)	6.55 (70.50)
5,000 ≤ A < 10,000 (464.5 ≤ A < 929.0)	47	250	16.54 (178.03)	4.79 (51.56)
10,000 ≤ A < 20,000 (929.0 ≤ A < 1,858.1)	14	72	13.47 (144.99)	3.11 (33.48)
20,000 ≤ A < 30,000 (1,858.1 ≤ A < 2,787.1)	3	18	12.33 (132.72)	2.12 (22.82)
54,578 (5,070.5)	1	8	10.17 (109.47)	1.25 (13.45)
242,904 (22,566.6)	1	5	9.04 (97.31)	1.17 (12.59)

The following are summaries of unit costs for each project used in the analysis.

Bridge Deck Overlay Butler County (WN 9007)
Date Let: 01-25-13 Call: 317 County: Butler District: 03
Bridge Number: 016B00061N, NB only Overlay Area: 24,115 ft^2 (2,240.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	226,110.00	9.38 (100.97)
Bidder 2	216,069.20	8.96 (96.44)
Bidder 3	252,862.00	10.49 (112.91)
Bidder 4	233,310.00	9.67 (104.09)
Bidder 5	226,604.00	9.40 (101.18)
Bidder 6	274,630.00	11.39 (122.60)
Bidder 7	378,625.00	15.70 (168.99)

Bridge Deck Restoration & Waterproofing Interstate 64
Date Let: 02-22-13 Call: 100 County: Jefferson District: 05
Bridge Number: 056B00040R Overlay Area: 11,384 ft^2 (1,057.6 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	196,818.00	17.29 (186.11)
Bidder 2	194,986.00	17.13 (184.39)
Bidder 3	215,921.00	18.97 (204.19)
Bidder 4	172,151.50	15.12 (162.75)
Bidder 5	192,894.00	16.94 (182.34)
Bidder 6	198,961.00	17.48 (188.15)

Bridge Deck Restoration & Waterproofing Campbell County (KY 9)
Date Let: 02-22-13 Call: 311 County: Campbell District: 06
Bridge Number: 019B00033N Overlay Area: 28,512 ft^2 (2,648.9 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	316,951.90	11.12 (119.69)
Bidder 2	361,645.00	12.68 (136.49)
Bidder 3	378,254.00	13.27 (142.84)
Bidder 4	360,743.80	12.65 (136.16)
Bidder 5	437,256.00	15.34 (165.12)
Bidder 6	365,085.00	12.80 (137.78)

Bridge Deck Restoration & Waterproofing Bridge over North Fork of Triplett Creek
Date Let: 03-22-13 Call: 332 County: Rowan District: 09
Bridge Number: 103B00027N Overlay Area: 1,980 ft^2 183.9 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	73,187.50	36.96 (397.83)
Bidder 2	66,938.40	33.81 (363.93)
Bidder 3	72,960.00	36.85 (396.65)
Bidder 4	84,126.00	42.49 (457.36)
Bidder 5	103,042.00	52.04 (560.15)

Bridge Deck Restoration & Waterproofing Wayne & McCreary Cos. Bridge Overlays and Joint Replacements
Date Let: 03-22-13 Call: 434 County: Various District: 08
Bridge Number: 074B00011N Overlay Area: 3,360 ft^2 (312.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	59,040.80	17.57 (189.12)
Bidder 2	59,270.00	17.64 (189.87)
Bidder 3	62,695.00	18.66 (200.85)
Bidder 4	78,150.00	23.26 (250.37)
Bidder 5	79,846.00	23.76 (255.75)
Bidder 6	102,094.00	30.39 (327.11)

Bridge Deck Restoration & Waterproofing Wayne & McCreary Cos. Bridge Overlays and Joint Replacements
Date Let: 03-22-13 Call: 434 County: Various District: 08
Bridge Number: 116B00001N Overlay Area: 1,760 ft^2 (163.5 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	53,907.20	30.63 (329.70)
Bidder 2	49,405.00	28.07 (302.14)
Bidder 3	62,430.00	35.47 (381.79)
Bidder 4	76,500.00	43.47 (467.91)
Bidder 5	80,807.00	45.91 (494.17)
Bidder 6	106,666.00	60.61 (652.40)

Bridge Deck Overlay Hancock County
Date Let: 04-19-13 Call: 406 County: Hancock District: 02
Bridge Number: 046B00030N Overlay Area: 8,895 ft^2 (826.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	141,040.00	15.86 (170.71)
Bidder 2	139,144.00	15.64 (168.35)
Bidder 3	180,160.00	20.25 (217.97)
Bidder 4	150,860.00	16.96 (182.56)
Bidder 5	196,100.00	22.05 (237.34)

Bridge Deck Overlay Hancock County
Date Let: 04-19-13 Call: 406 County: Hancock District: 02
Bridge Number: 046B00013N Overlay Area: 2,880 ft^2 (267.6 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	82,486.00	28.64 (308.28)
Bidder 2	90,432.00	31.40 (337.99)
Bidder 3	104,253.50	36.20 (389.65)
Bidder 4	98,380.00	34.16 (367.69)
Bidder 5	95,610.00	33.20 (357.36)

Bridge Deck Restoration & Waterproofing New Circle Road Bridges
Date Let: 04-19-13 Call: 426 County: Fayette District: 07
Bridge Number: 034B00027L Overlay Area: 5,111 ft^2 (474.8 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	98,277.40	19.23 (206.99)
Bidder 2	107,070.80	20.95 (225.50)
Bidder 3	121,356.00	23.74 (255.53)
Bidder 4	131,036.60	25.64 (275.99)

Bridge Deck Restoration & Waterproofing New Circle Road Bridges
Date Let: 04-19-13 Call: 426 County: Fayette District: 07
Bridge Number: 034B00027R Overlay Area: 5,111 ft^2 (474.8 m^2)

	Total Deck Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	98,277.40	19.23 (206.99)
Bidder 2	107,070.80	20.95 (225.50)
Bidder 3	121,356.00	23.74 (255.53)
Bidder 4	131,036.60	25.64 (275.99)

Bridge Deck Restoration & Waterproofing New Circle Road Bridges
Date Let: 04-19-13 Call: 426 County: Fayette District: 07
Bridge Number: 034B00028L Overlay Area: 5,859 ft^2 (544.3 m^2)

	Total Deck Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	98,138.30	16.75 (180.29)
Bidder 2	98,520.60	16.82 (181.05)
Bidder 3	107,052.00	18.27 (196.66)
Bidder 4	111,114.20	18.96 (204.08)

Bridge Deck Restoration & Waterproofing New Circle Road Bridges
Date Let: 04-19-13 Call: 426 County: Fayette District: 07
Bridge Number: 034B00028R Overlay Area: 5,859 ft^2 (544.3 m^2)

	Total Deck Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	98,138.30	16.75 (180.29)
Bidder 2	98,520.60	16.82 (181.05)
Bidder 3	107,052.00	18.27 (196.66)
Bidder 4	111,114.20	18.96 (204.08)

Bridge Deck Restoration & Waterproofing New Circle Road Bridges
Date Let: 04-19-13 Call: 426 County: Fayette District: 07
Bridge Number: 034B00029L Overlay Area: 5,282 ft^2 (490.7 m^2)

	Total Deck Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	91,930.70	17.40 (187.29)
Bidder 2	93,212.40	17.65 (189.98)
Bidder 3	100,871.00	19.10 (205.59)
Bidder 4	103,387.30	19.57 (210.65)

Bridge Deck Restoration & Waterproofing New Circle Road Bridges
Date Let: 04-19-13 Call: 426 County: Fayette District: 07
Bridge Number: 034B00029R Overlay Area: 5,282 ft^2 (490.7 m^2)

	Total Deck Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	91,930.70	17.40 (187.29)
Bidder 2	93,212.40	17.65 (189.98)
Bidder 3	100,871.00	19.10 (205.59)
Bidder 4	103,387.30	19.57 (210.65)

Bridge Deck Restoration & Waterproofing New Circle Road Bridges
Date Let: 04-19-13 Call: 426 County: Fayette District: 07
Bridge Number: 034B00031L Overlay Area: 7,103 ft^2 (659.9 m^2)

	Total Deck Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	118,720.50	16.71 (179.86)
Bidder 2	119,089.00	16.77 (180.51)
Bidder 3	129,482.00	18.23 (196.23)
Bidder 4	134,504.50	18.94 (203.87)

Bridge Deck Restoration & Waterproofing New Circle Road Bridges
Date Let: 04-19-13 Call: 426 County: Fayette District: 07
Bridge Number: 034B00031R Overlay Area: 7,103 ft^2 (659.9 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	118,720.50	16.71 (179.86)
Bidder 2	119,089.00	16.77 (180.51)
Bidder 3	129,482.00	18.23 (196.23)
Bidder 4	134,504.50	18.94 (203.87)

Bridge Deck Restoration & Waterproofing Bridge over Levisa Fork of Big Sandy
Date Let: 05-24-13 Call: 369 County: Floyd District: 12
Bridge Number: 036B00038L Overlay Area: 15,390 ft^2 (1,429.8 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	149,266.80	9.70 (104.41)
Bidder 2	118,243.50	7.68 (82.67)
Bidder 3	170,171.50	11.06 (119.05)
Bidder 4	208,984.80	13.58 (146.17)
Bidder 5	222,013.20	14.43 (155.32)
Bidder 6	219,462.40	14.26 (153.49)

Bridge Deck Restoration & Waterproofing Bridge over Levisa Fork of Big Sandy
Date Let: 05-24-13 Call: 369 County: Floyd District: 12
Bridge Number: 036B00038R Overlay Area: 15,390 ft^2 (1,429.8 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	149,266.80	9.70 (104.41)
Bidder 2	118,243.50	7.68 (82.67)
Bidder 3	170,171.50	11.06 (119.05)
Bidder 4	208,984.80	13.58 (146.17)
Bidder 5	222,013.20	14.43 (155.32)
Bidder 6	219,462.40	14.26 (153.49)

Bridge Deck Overlay KY 838 Crittenden and Livingston Countys
Date Let: 05-24-13 Call: 406 County: Various District: 01
Bridge Number: 028B00047N Overlay Area: 2,520 ft^2 (234.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	78,950.00	31.33 (337.23)
Bidder 2	62,225.00	24.69 (265.76)
Bidder 3	72,210.00	28.65 (308.38)
Bidder 4	78,150.00	31.01 (333.79)
Bidder 5	100,150.00	39.74 (427.76)

Bridge Deck Overlay KY 838 Crittenden and Livingston Countys
Date Let: 05-24-13 Call: 406 County: Various District: 01
Bridge Number: 028B00048N Overlay Area: 2,160 ft^2 (200.7 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	69,325.00	32.09 (345.41)
Bidder 2	55,950.00	25.90 (278.78)
Bidder 3	64,730.00	29.97 (322.59)
Bidder 4	70,345.00	32.57 (350.58)
Bidder 5	87,790.00	40.64 (437.44)

Bridge Deck Overlay KY 838 Crittenden and Livingston Countys
Date Let: 05-24-13 Call: 406 County: Various District: 01
Bridge Number: 070B00058N Overlay Area: 2,520 ft^2 (234.1 m^2)

	Total Deck Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	78,950.00	31.33 (337.23)
Bidder 2	62,225.00	24.69 (265.76)
Bidder 3	72,210.00	28.65 (308.38)
Bidder 4	78,150.00	31.01 (333.79)
Bidder 5	100,150.00	39.74 (427.76)

Bridge Deck Restoration & Waterproofing KY 80 over KY 9006
Date Let: 05-24-13 Call: 420 County: Clay District: 11
Bridge Number: 026B00061N Overlay Area: 15,308 ft^2 (1,422.2 m^2)

	Total Deck Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	190,382.00	12.44 (133.90)
Bidder 2	206,123.20	13.47 (144.99)
Bidder 3	208,883.00	13.65 (146.93)
Bidder 4	248,457.90	16.23 (174.70)
Bidder 5	235,408.00	15.38 (165.55)
Bidder 6	200,501.00	13.10 (141.01)
Bidder 7	231,608.00	15.13 (162.86)

Bridge Deck Restoration & Waterproofing KY 80 over KY 9006
Date Let: 05-24-13 Call: 420 County: Clay District: 11
Bridge Number: 026B00067N Overlay Area: 5,940 ft^2 (551.8 m^2)

	Total Deck Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	76,706.00	12.91 (138.96)
Bidder 2	79,218.90	13.34 (143.59)
Bidder 3	80,648.00	13.58 (146.17)
Bidder 4	102,467.90	17.25 (185.68)
Bidder 5	91,280.00	15.37 (165.44)
Bidder 6	78,866.50	13.28 (142.94)
Bidder 7	92,652.50	15.60 (167.92)

Bridge Deck Restoration & Waterproofing Bridges over I-64
Date Let: 06-14-13 Call: 201 County: Bath District: 09
Bridge Number: 006B00017N Overlay Area: 8,040 ft^2 (746.9 m^2)

	Total Deck Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	71,136.00	8.85 (95.26)
Bidder 2	75,540.00	9.40 (101.18)
Bidder 3	92,251.00	11.47 (123.46)
Bidder 4	55,350.00	6.88 (74.06)
Bidder 5	80,700.00	10.04 (108.07)
Bidder 6	120,887.60	15.04 (161.89)
Bidder 7	123,906.00	15.41 (165.87)
Bidder 8	115,592.00	14.38 (154.78)
Bidder 9	115,640.00	14.38 (154.78)

Bridge Deck Restoration & Waterproofing Bridges over I-64
Date Let: 06-14-13 Call: 201 County: Bath District: 09
Bridge Number: 006B00042N Overlay Area: 8,528 ft^2 (792.3 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	110,282.50	12.93 (139.18)
Bidder 2	107,992.00	12.66 (136.27)
Bidder 3	144,802.80	16.98 (182.77)
Bidder 4	93,457.00	10.96 (117.97)
Bidder 5	118,890.50	13.94 (150.05)
Bidder 6	176,764.46	20.73 (223.13)
Bidder 7	188,213.00	22.07 (237.56)
Bidder 8	177,563.50	20.82 (224.10)
Bidder 9	221,990.00	26.03 (280.18)

Bridge Deck Restoration & Waterproofing Bridges over I-64
Date Let: 06-14-13 Call: 201 County: Bath District: 09
Bridge Number: 103B00029N Overlay Area: 8,658 ft^2 (804.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	88,174.50	10.18 (109.58)
Bidder 2	88,090.50	10.17 (109.47)
Bidder 3	115,304.70	13.32 (143.37)
Bidder 4	75,838.00	8.76 (94.29)
Bidder 5	96,648.50	11.16 (120.12)
Bidder 6	143,742.58	16.60 (178.68)
Bidder 7	149,040.00	17.21 (185.25)
Bidder 8	141,916.00	16.39 (176.42)
Bidder 9	175,412.50	20.26 (218.08)

Bridge Deck Restoration & Waterproofing I-64 Bridges
Date Let: 08-16-13 Call: 201 County: Franklin District: 05
Bridge Number: 037B00055L Overlay Area: 4,770 ft^2 (443.1 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	173,197.50	36.31 (390.84)
Bidder 2	148,853.00	31.21 (335.94)
Bidder 3	159,960.00	33.53 (360.91)
Bidder 4	164,700.00	34.53 (371.68)
Bidder 5	95,620.00	20.05 (215.82)

Bridge Deck Restoration & Waterproofing I-64 Bridges
Date Let: 08-16-13 Call: 201 County: Franklin District: 05
Bridge Number: 037B00055R Overlay Area: 4,700 ft^2 (436.6 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	173,197.50	36.31 (390.84)
Bidder 2	148,853.00	31.21 (335.94)
Bidder 3	159,960.00	33.53 (360.91)
Bidder 4	164,700.00	34.53 (371.68)
Bidder 5	95,620.00	20.05 (215.82)

Bridge Deck Restoration & Waterproofing I-64 Bridges
Date Let: 08-16-13 Call: 201 County: Franklin District: 05
Bridge Number: 037B00056L Overlay Area: 4,500 ft^2 (418.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	163,535.00	36.34 (391.16)
Bidder 2	140,550.00	31.23 (336.16)
Bidder 3	151,070.00	33.57 (361.34)
Bidder 4	155,500.00	34.56 (372.00)
Bidder 5	90,280.00	20.06 (215.92)

Bridge Deck Restoration & Waterproofing I-64 Bridges
Date Let: 08-16-13 Call: 201 County: Franklin District: 05
Bridge Number: 106B00059L Overlay Area: 6,780 ft^2 (629.9 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	246,410.75	36.34 (391.16)
Bidder 2	211,795.30	31.24 (336.26)
Bidder 3	227,660.00	33.58 (361.45)
Bidder 4	234,310.00	34.56 (372.00)
Bidder 5	136,050.00	20.07 (216.03)

Bridge Deck Restoration & Waterproofing Robertson County KY 165 and KY 616
Date Let: 08-16-13 Call: 410 County: Robertson District: 06
Bridge Number: 101B00009N Overlay Area: 7,560 ft^2 (702.3 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	101,846.00	13.47 (144.99)
Bidder 2	102,990.00	13.62 (146.60)
Bidder 3	108,271.00	14.32 (154.14)
Bidder 4	101,165.00	13.38 (144.02)
Bidder 5	122,425.00	16.19 (174.27)
Bidder 6	141,524.00	18.72 (201.50)
Bidder 7	163,096.00	21.57 (232.18)

Bridge Deck Overlay Boone County KY 8 and KY 536--Gallatin County KY 35
Date Let: 08-16-13 Call: 430 County: Various District: 06
Bridge Number: 008B00036N Overlay Area: 4,920 ft^2 (457.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	59,935.00	12.18 (131.10)
Bidder 2	50,680.00	10.30 (110.87)
Bidder 3	63,317.50	12.87 (138.53)
Bidder 4	76,690.00	15.59 (167.81)
Bidder 5	84,872.50	17.25 (185.68)
Bidder 6	82,230.00	16.71 (179.86)

Bridge Deck Overlay Boone County KY 8 and KY 536--Gallatin County KY 35
Date Let: 08-16-13 Call: 430 County: Various District: 06
Bridge Number: 039B00010N Overlay Area: 11,200 ft^2 (1,040.5 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	116,584.00	10.41 (112.05)
Bidder 2	123,600.00	11.04 (118.83)
Bidder 3	124,038.60	11.07 (119.16)
Bidder 4	131,568.00	11.75 (126.48)
Bidder 5	150,274.00	13.42 (144.45)
Bidder 6	197,455.00	17.63 (189.77)

Bridge Deck Overlay Boone County KY 8 and KY 536--Gallatin County KY 35
Date Let: 08-16-13 Call: 430 County: Various District: 06
Bridge Number: 008B00021N Overlay Area: 9,540 ft^2 (886.3 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	117,875.00	12.36 (133.04)
Bidder 2	107,410.00	11.26 (121.20)
Bidder 3	136,392.50	14.30 (153.92)
Bidder 4	154,390.00	16.18 (174.16)
Bidder 5	167,007.50	17.51 (188.48)
Bidder 6	166,270.00	17.43 (187.61)

Bridge Deck Overlay Outerloop (KY 1065)
Date Let: 09-27-13 Call: 311 County: Jefferson District: 05
Bridge Number: 056B00290N Overlay Area: 54,578 ft^2 (5,070.5 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	542,275.50	9.94 (106.99)
Bidder 2	531,847.00	9.74 (104.84)
Bidder 3	458,843.00	8.41 (90.52)
Bidder 4	555,711.00	10.18 (109.58)
Bidder 5	573,765.00	10.51 (113.13)
Bidder 6	508,018.00	9.31 (100.21)
Bidder 7	575,630.00	10.55 (113.56)
Bidder 8	694,372.00	12.72 (136.92)

Bridge Deck Restoration & Waterproofing KY 1773 Bridge over Grassy Creek
Date Let: 09-27-13 Call: 320 County: Carter District: 09
Bridge Number: 022B00135N Overlay Area: 3,784 ft^2 (351.5 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	100,185.00	26.48 (285.03)
Bidder 2	114,988.00	30.39 (327.11)
Bidder 3	128,957.00	34.08 (366.83)

Bridge Deck Restoration & Waterproofing KY 386 Bridge over McBride Creek
Date Let: 09-27-13 Call: 322 County: Nicholas District: 09
Bridge Number: 091B00033N Overlay Area: 2,178 ft^2 (202.3 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	56,052.80	25.74 (277.06)
Bidder 2	89,783.80	41.22 (443.69)

Bridge Deck Restoration & Waterproofing KY 699 Bridge over Leatherwood Creek
Date Let: 09-27-13 Call: 323 County: Perry District: 10
Bridge Number: 097B00045N Overlay Area: 2,904 ft^2 (269.8 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	93,368.00	32.15 (346.06)
Bidder 2	115,983.70	39.94 (429.91)
Bidder 3	127,867.00	44.03 (473.93)
Bidder 4	128,447.00	44.23 (476.09)

Bridge Deck Restoration & Waterproofing Henderson County KY 285
Date Let: 10-25-13 Call: 301 County: Henderson District: 02
Bridge Number: 051B00029N Overlay Area: 2,772 ft^2 (257.5 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	67,190.00	24.24 (260.92)
Bidder 2	74,022.00	26.70 (287.40)
Bidder 3	92,995.00	33.55 (361.13)
Bidder 4	107,180.00	38.67 (416.24)
Bidder 5	77,116.00	27.82 (299.45)
Bidder 6	118,650.00	42.80 (460.69)

Bridge Deck Restoration & Waterproofing Ohio County KY 1245
Date Let: 10-25-13 Call: 304 County: Ohio District: 02
Bridge Number: 092B00112N Overlay Area: 7,332 ft^2 (681.2 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	89,627.50	12.22 (131.53)
Bidder 2	104,580.50	14.26 (153.49)
Bidder 3	112,245.00	15.31 (164.79)
Bidder 4	130,044.50	17.74 (190.95)
Bidder 5	118,889.00	16.22 (174.59)
Bidder 6	148,890.00	20.31 (218.61)

Bridge Deck Restoration & Waterproofing Union County KY 359
Date Let: 10-25-13 Call: 321 County: Union District: 02
Bridge Number: 092B00112N Overlay Area: 6,248 ft^2 (580.5 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	85,264.00	13.65 (146.93)
Bidder 2	93,633.00	14.99 (161.35)
Bidder 3	109,429.00	17.51 (188.48)
Bidder 4	113,342.00	18.14 (195.26)

Bridge Deck Restoration & Waterproofing Davies County KY 3143, KY 554 and US 431
Date Let: 10-25-13 Call: 400 County: Daviess District: 02
Bridge Number: 030B00115N Overlay Area: 2,736 ft^2 (254.2 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	45,263.00	16.54 (178.03)
Bidder 2	45,761.00	16.73 (180.08)
Bidder 3	50,896.00	18.60 (200.21)
Bidder 4	57,810.50	21.13 (227.44)
Bidder 5	69,201.50	25.29 (272.22)
Bidder 6	63,418.00	23.18 (249.51)
Bidder 7	71,670.00	26.20 (282.01)
Bidder 8	81,814.00	29.90 (321.84)

Bridge Deck Restoration & Waterproofing Davies County KY 3143, KY 554 and US 431
Date Let: 10-25-13 Call: 400 County: Daviess District: 02
Bridge Number: 030B00084N Overlay Area: 6,750 ft^2 (627.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	100,530.00	14.89 (160.27)
Bidder 2	106,334.00	15.75 (169.53)
Bidder 3	116,358.00	17.24 (185.57)
Bidder 4	124,393.00	18.43 (198.38)
Bidder 5	145,747.00	21.59 (232.39)
Bidder 6	137,887.00	20.43 (219.91)
Bidder 7	165,306.00	24.49 (263.61)
Bidder 8	186,606.00	27.65 (297.62)

Bridge Deck Restoration & Waterproofing Davies County KY 3143, KY 554 and US 431
Date Let: 10-25-13 Call: 400 County: Daviess District: 02
Bridge Number: 030B00048N Overlay Area: 4,400 ft^2 (408.8 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	63,089.00	14.34 (154.35)
Bidder 2	61,265.00	13.92 (149.83)
Bidder 3	75,698.00	17.20 (185.14)
Bidder 4	85,617.50	19.46 (209.46)
Bidder 5	102,584.50	23.31 (250.91)
Bidder 6	91,180.00	20.72 (223.03)
Bidder 7	108,938.00	24.76 (266.51)
Bidder 8	119,155.00	27.08 (291.49)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Powell County
Date Let: 10-25-13 Call: 404 County: Powell District: 10
Bridge Number: 099B00009R Overlay Area: 4,770 ft^2 (443.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	44,413.50	9.31 (100.21)
Bidder 2	66,670.50	13.98 (150.48)
Bidder 3	69,943.00	14.66 (157.80)
Bidder 4	78,126.00	16.38 (176.31)
Bidder 5	76,864.00	16.10 (173.41)
Bidder 6	79,103.00	16.58 (178.46)
Bidder 7	73,981.00	15.51 (166.95)
Bidder 8	108,884.00	22.83 (245.74)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Powell County
Date Let: 10-25-13 Call: 404 County: Powell District: 10
Bridge Number: 099B00017N Overlay Area: 4,246 ft^2 (394.5 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	45,292.50	10.67 (114.85)
Bidder 2	65,107.50	15.33 (165.01)
Bidder 3	71,434.00	16.82 (181.05)
Bidder 4	80,256.00	18.90 (203.44)
Bidder 5	79,872.00	18.81 (202.47)
Bidder 6	81,702.00	19.24 (207.10)
Bidder 7	95,541.00	22.50 (242.19)
Bidder 8	115,169.00	27.12 (291.92)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Powell County
Date Let: 10-25-13 Call: 404 County: Powell District: 10
Bridge Number: 099B00042N Overlay Area: 6,240 ft^2 (579.7 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	62,524.50	10.02 (107.85)
Bidder 2	92,035.50	14.75 (158.77)
Bidder 3	96,098.80	15.40 (165.76)
Bidder 4	108,950.00	17.46 (187.94)
Bidder 5	110,808.00	17.76 (191.17)
Bidder 6	114,449.00	18.34 (197.41)
Bidder 7	134,451.00	21.55 (231.96)
Bidder 8	153,515.40	24.60 (264.79)

Bridge Deck Restoration & Waterproofing District 9 Bridge Overlays
Date Let: 10-25-13 Call: 406 County: Various District: 09
Bridge Number: 022B00106N Overlay Area: 5,760 ft^2 (535.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	99,885.00	17.34 (186.65)
Bidder 2	97,942.00	17.00 (182.99)
Bidder 3	106,405.00	18.47 (198.81)
Bidder 4	105,610.00	18.34 (197.41)
Bidder 5	119,840.00	20.81 (224.00)
Bidder 6	105,330.00	18.29 (196.87)
Bidder 7	106,980.00	18.57 (199.89)

Bridge Deck Restoration & Waterproofing District 9 Bridge Overlays
Date Let: 10-25-13 Call: 406 County: Various District: 09
Bridge Number: 068B00030N Overlay Area: 3,612 ft^2 (335.6 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	66,413.00	18.39 (197.95)
Bidder 2	66,421.00	18.39 (197.95)
Bidder 3	71,770.00	19.87 (213.88)
Bidder 4	69,175.00	19.15 (206.13)
Bidder 5	81,799.00	22.65 (243.80)
Bidder 6	72,646.00	20.11 (216.46)
Bidder 7	70,244.00	19.45 (209.36)

Bridge Deck Restoration & Waterproofing District 9 Bridge Overlays
Date Let: 10-25-13 Call: 406 County: Various District: 09
Bridge Number: 068B00031N Overlay Area: 5,200 ft^2 (483.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	86,947.00	16.72 (179.97)
Bidder 2	83,524.00	16.06 (172.87)
Bidder 3	92,695.00	17.83 (191.92)
Bidder 4	91,120.00	17.52 (188.58)
Bidder 5	101,727.00	19.56 (210.54)
Bidder 6	91,656.00	17.63 (189.77)
Bidder 7	92,264.00	17.74 (190.95)

Bridge Deck Restoration & Waterproofing District 9 Bridge Overlays
Date Let: 10-25-13 Call: 406 County: Various District: 09
Bridge Number: 091B00035N Overlay Area: 3,840 ft^2 (356.7 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	71,089.00	18.51 (199.24)
Bidder 2	72,163.00	18.79 (202.25)
Bidder 3	76,540.00	19.93 (214.52)
Bidder 4	73,570.00	19.16 (206.24)
Bidder 5	87,792.00	22.86 (246.06)
Bidder 6	78,320.00	20.40 (219.58)
Bidder 7	75,142.00	19.57 (210.65)

Bridge Deck Restoration & Waterproofing Bluegrass Parkway
Date Let: 11-22-13 Call: 304 County: Nelson District: 04
Bridge Number: 090B00017L Overlay Area: 4,180 ft^2 (388.3 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	75,600.50	18.09 (194.72)
Bidder 2	80,099.00	19.16 (206.24)
Bidder 3	81,242.00	19.44 (209.25)
Bidder 4	83,138.00	19.89 (214.09)
Bidder 5	55,643.00	13.31 (143.27)
Bidder 6	74,313.00	17.78 (191.38)
Bidder 7	77,967.00	18.65 (200.75)
Bidder 8	84,885.00	20.31 (218.61)

Bridge Deck Restoration & Waterproofing Bluegrass Parkway
Date Let: 11-22-13 Call: 304 County: Nelson District: 04
Bridge Number: 090B00017R Overlay Area: 4,180 ft^2 (388.3 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	75,600.50	18.09 (194.72)
Bidder 2	80,099.00	19.16 (206.24)
Bidder 3	81,242.00	19.44 (209.25)
Bidder 4	83,138.00	19.89 (214.09)
Bidder 5	55,643.00	13.31 (143.27)
Bidder 6	74,313.00	17.78 (191.38)
Bidder 7	77,967.00	18.65 (200.75)
Bidder 8	84,885.00	20.31 (218.61)

Bridge Deck Restoration & Waterproofing District 10 Bridge Overlays
Date Let: 11-22-13 Call: 406 County: Various District: 10
Bridge Number: 013B00026N Overlay Area: 990 ft^2 (92.0 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	43,878.80	44.32 (477.05)
Bidder 2	48,699.20	49.19 (529.47)
Bidder 3	38,193.00	38.58 (415.27)
Bidder 4	46,453.00	46.92 (505.04)
Bidder 5	40,766.60	41.18 (443.26)
Bidder 6	55,335.00	55.89 (601.59)

Bridge Deck Restoration & Waterproofing District 10 Bridge Overlays
Date Let: 11-22-13 Call: 406 County: Various District: 10
Bridge Number: 077B00026N Overlay Area: 2,640 ft^2 (245.3 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	66,095.20	25.04 (269.53)
Bidder 2	70,418.70	26.67 (287.07)
Bidder 3	60,558.00	22.94 (246.92)
Bidder 4	71,736.00	27.17 (292.45)
Bidder 5	73,462.90	27.83 (299.56)
Bidder 6	80,190.00	30.38 (327.01)

Bridge Deck Restoration & Waterproofing District 10 Bridge Overlays
Date Let: 11-22-13 Call: 406 County: Various District: 10
Bridge Number: 088B00042N Overlay Area: 5,580 ft^2 (518.4 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	103,268.50	18.51 (199.24)
Bidder 2	103,758.20	18.59 (200.10)
Bidder 3	97,296.00	17.44 (187.72)
Bidder 4	110,341.50	19.77 (212.80)
Bidder 5	116,521.00	20.88 (224.75)
Bidder 6	126,000.00	22.58 (243.05)

Bridge Deck Restoration & Waterproofing District 10 Bridge Overlays
Date Let: 11-22-13 Call: 406 County: Various District: 10
Bridge Number: 097B00036N Overlay Area: 2,574 ft^2 (239.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	70,449.00	27.37 (294.61)
Bidder 2	71,260.10	27.68 (297.94)
Bidder 3	72,633.00	28.22 (303.76)
Bidder 4	68,254.50	26.52 (285.46)
Bidder 5	86,026.50	33.42 (359.73)
Bidder 6	87,525.00	34.00 (365.97)

Bridge Deck Restoration & Waterproofing Warren County KY 185
Date Let: 12-13-13 Call: 303 County: Warren District: 03
Bridge Number: 114B00003N Overlay Area: 17,440 ft^2 (1,620.2 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	152,990.00	8.77 (94.40)
Bidder 2	205,218.00	11.77 (126.69)
Bidder 3	194,020.00	11.13 (119.80)
Bidder 4	222,468.00	12.76 (137.35)
Bidder 5	237,557.00	13.62 (146.60)
Bidder 6	251,700.00	14.43 (155.32)
Bidder 7	301,906.00	17.31 (186.32)

Bridge Deck Restoration & Waterproofing District 4 Bridge Overlays
Date Let: 12-13-13 Call: 401 County: Various District: 04
Bridge Number: 078B00038N Overlay Area: 5,082 ft^2 (472.1 m^2)

	Total Deck Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	82,059.00	16.15 (173.84)
Bidder 2	85,860.00	16.89 (181.80)
Bidder 3	92,283.00	18.16 (195.47)
Bidder 4	100,722.00	19.82 (213.34)
Bidder 5	45,562.00	8.97 (96.55)
Bidder 6	96,307.00	18.95 (203.98)
Bidder 7	100,110.00	19.70 (212.05)

Bridge Deck Restoration & Waterproofing District 4 Bridge Overlays
Date Let: 12-13-13 Call: 401 County: Various District: 04
Bridge Number: 109B00004N Overlay Area: 858 ft^2 (79.7 m^2)

	Total Deck Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	25,458.90	29.67 (319.36)
Bidder 2	33,722.40	39.30 (423.02)
Bidder 3	29,520.70	34.41 (370.38)
Bidder 4	37,274.20	43.44 (467.58)
Bidder 5	23,974.00	27.94 (300.74)
Bidder 6	42,173.50	49.15 (529.04)
Bidder 7	36,641.00	42.71 (459.72)

Bridge Deck Restoration & Waterproofing District 4 Bridge Overlays
Date Let: 12-13-13 Call: 401 County: Various District: 04
Bridge Number: 109B00025N Overlay Area: 3,096 ft^2 (287.6 m^2)

	Total Deck Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	61,216.00	19.77 (212.80)
Bidder 2	64,897.00	20.96 (225.61)
Bidder 3	68,126.00	22.00 (236.81)
Bidder 4	75,872.00	24.51 (263.82)
Bidder 5	35,450.00	11.45 (123.25)
Bidder 6	83,568.00	26.99 (290.52)
Bidder 7	87,670.00	28.32 (304.83)

Bridge Deck Restoration & Waterproofing Bridge over Culp Creek Rd
Date Let: 04-25-14 Call: 328 County: Greenup District: 09
Bridge Number: 045B00077N Overlay Area: 11,328 ft^2 (1,052.4 m^2)

	Total Deck Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	164,093.00	14.49 (155.97)
Bidder 2	171,420.50	15.13 (162.86)
Bidder 3	172,398.00	15.22 (163.83)
Bidder 4	205,479.00	18.14 (195.26)
Bidder 5	235,419.00	20.78 (223.67)

Bridge Deck Restoration & Waterproofing US 31E
Date Let: 04-25-14 Call: 329 County: Nelson District: 04
Bridge Number: 090B00044N Overlay Area: 6,390 ft^2 (593.7 m^2)

	Total Deck Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	93,112.80	14.57 (156.83)
Bidder 2	123,845.80	19.38 (208.60)
Bidder 3	126,313.08	19.77 (212.80)
Bidder 4	107,798.00	16.87 (181.59)

Bridge Deck Restoration & Waterproofing Fleming County Bridge Overlays
Date Let: 04-25-14 Call: 403 County: Fleming District: 09
Bridge Number: 035B00022N Overlay Area: 5,040 ft^2 (468.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	53,587.10	10.63 (114.42)
Bidder 2	62,480.60	12.40 (133.47)
Bidder 3	81,521.53	16.17 (174.05)
Bidder 4	74,219.50	14.73 (158.55)
Bidder 5	89,191.00	17.70 (190.52)

Bridge Deck Restoration & Waterproofing Fleming County Bridge Overlays
Date Let: 04-25-14 Call: 403 County: Fleming District: 09
Bridge Number: 035B00025N Overlay Area: 4,200 ft^2 (390.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	45,100.50	10.74 (115.60)
Bidder 2	53,160.00	12.66 (136.27)
Bidder 3	69,058.57	16.44 (176.96)
Bidder 4	63,098.50	15.02 (161.67)
Bidder 5	75,645.00	18.01 (193.86

Bridge Deck Restoration & Waterproofing Davies County
Date Let: 05-30-14 Call: 352 County: Daviess District: 02
Bridge Number: 030B00069R Overlay Area: 8,635 ft^2 (802.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	130,874.00	15.16 (163.18)
Bidder 2	191,254.00	22.15 (238.42)
Bidder 3	170,172.00	19.71 (212.16)
Bidder 4	208,061.00	24.10 (259.41)
Bidder 5	183,927.00	21.30 (229.27)
Bidder 6	185,470.00	21.48 (231.21)

Bridge Deck Restoration & Waterproofing Hopkins
Date Let: 05-30-14 Call: 353 County: Hopkins District: 02
Bridge Number: 054B00014L Overlay Area: 5,966 ft^2 (554.3 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	75,190.00	12.60 (135.62)
Bidder 2	95,654.00	16.03 (172.54)
Bidder 3	97,488.00	16.34 (175.88)
Bidder 4	103,324.50	17.32 (186.43)
Bidder 5	112,621.00	18.88 (203.22)
Bidder 6	114,708.00	19.23 (206.99)

Bridge Deck Restoration & Waterproofing Hopkins
Date Let: 05-30-14 Call: 353 County: Hopkins District: 02
Bridge Number: 054B00014R Overlay Area: 5,966 ft^2 (554.3 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	73,822.85	12.37 (133.15)
Bidder 2	95,654.00	16.03 (172.54)
Bidder 3	97,388.00	16.32 (175.67)
Bidder 4	103,324.50	17.32 (186.43)
Bidder 5	112,621.00	18.88 (203.22)
Bidder 6	110,908.00	18.59 (200.10)

Bridge Deck Restoration & Waterproofing Bridge over Licking River
Date Let: 05-30-14 Call: 354 County: Morgan District: 10
Bridge Number: 088B00070N Overlay Area: 11,592 ft^2 (1,076.9 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	144,884.00	12.50 (134.55)
Bidder 2	179,175.00	15.46 (166.41)
Bidder 3	189,522.00	16.35 (175.99)
Bidder 4	167,753.50	14.47 (155.75)
Bidder 5	232,763.00	20.08 (216.14)
Bidder 6	201,475.00	17.38 (187.08)

Bridge Deck Restoration & Waterproofing Bridge over Middle Fork of Red River
Date Let: 05-30-14 Call: 355 County: Powell District: 10
Bridge Number: 099B00011L Overlay Area: 6,210 ft^2 (576.9 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	78,533.00	12.65 (136.16)
Bidder 2	100,762.00	16.23 (174.70)
Bidder 3	84,875.00	13.67 (147.14)
Bidder 4	77,810.00	12.53 (134.87)
Bidder 5	105,507.50	16.99 (182.88)

Bridge Deck Restoration & Waterproofing KY 114 Overlays
Date Let: 05-30-14 Call: 440 County: Floyd District: 12
Bridge Number: 036B00021N Overlay Area: 5,016 ft^2 (466.0 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	90,262.75	17.99 (193.64)
Bidder 2	101,227.40	20.18 (217.21)
Bidder 3	95,070.00	18.95 (203.98)
Bidder 4	94,805.00	18.90 (203.44)
Bidder 5	91,467.00	18.24 (196.33)

Bridge Deck Restoration & Waterproofing KY 114 Overlays
Date Let: 05-30-14 Call: 440 County: Floyd District: 12
Bridge Number: 036B00022N Overlay Area: 4,770 ft^2 (443.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	86,767.75	18.19 (195.79)
Bidder 2	96,766.80	20.29 (218.40)
Bidder 3	91,209.00	19.12 (205.81)
Bidder 4	90,670.50	19.01 (204.62)
Bidder 5	87,413.50	18.33 (197.30)

Bridge Deck Restoration & Waterproofing Davies County US 231
Date Let: 05-30-14 Call: 444 County: Daviess District: 02
Bridge Number: 030B00034N Overlay Area: 3,960 ft^2 (367.9 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	68,322.50	17.25 (185.68)
Bidder 2	85,820.00	21.67 (233.25)
Bidder 3	85,820.00	21.67 (233.25)
Bidder 4	80,680.00	20.37 (219.26)
Bidder 5	96,720.00	24.42 (262.85)
Bidder 6	94,525.00	23.87 (256.93)
Bidder 7	88,120.00	22.25 (239.50)

Bridge Deck Restoration & Waterproofing Davies County US 231
Date Let: 05-30-14 Call: 444 County: Daviess District: 02
Bridge Number: 030B00033N Overlay Area: 4,440 ft^2 (412.5 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	75,625.50	17.03 (183.31)
Bidder 2	95,732.00	21.56 (232.07)
Bidder 3	91,187.00	20.54 (221.09)
Bidder 4	89,693.00	20.20 (217.43)
Bidder 5	107,340.75	24.18 (260.27)
Bidder 6	104,505.75	23.54 (253.38)
Bidder 7	97,606.00	21.98 (236.59)

Bridge Deck Restoration & Waterproofing Davies County US 231
Date Let: 05-30-14 Call: 444 County: Daviess District: 02
Bridge Number: 030B00032N Overlay Area: 3,960 ft^2 (367.9 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	64,360.00	16.25 (174.91)
Bidder 2	85,820.00	21.67 (233.25)
Bidder 3	80,690.00	20.38 (219.37)
Bidder 4	80,680.00	20.37 (219.26)
Bidder 5	95,920.00	24.22 (260.70)
Bidder 6	92,790.00	23.43 (252.20)
Bidder 7	88,120.00	22.25 (239.50)

Bridge Deck Restoration & Waterproofing Ballard County
Date Let: 05-30-14 Call: 445 County: Ballard District: 01
Bridge Number: 004B00032N Overlay Area: 3,960 ft^2 (367.9 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	83,937.00	21.20 (228.19)
Bidder 2	88,775.00	22.42 (241.33)
Bidder 3	105,725.00	26.70 (287.40)
Bidder 4	135,006.00	34.09 (366.94)
Bidder 5	110,117.00	27.81 (299.34)

Bridge Deck Restoration & Waterproofing Ballard County
Date Let: 05-30-14 Call: 445 County: Ballard District: 01
Bridge Number: 004B00051N Overlay Area: 2,376 ft^2 (220.7 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	52,165.00	21.95 (236.27)
Bidder 2	56,820.00	23.91 (257.36)
Bidder 3	66,775.00	28.10 (302.46)
Bidder 4	83,547.00	35.16 (378.46)
Bidder 5	82,742.00	34.82 (374.80)

Bridge Deck Restoration & Waterproofing Ballard County
Date Let: 05-30-14 Call: 445 County: Ballard District: 01
Bridge Number: 004B00050N Overlay Area: 2,376 ft^2 (220.7 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	53,013.00	22.31 (240.14)
Bidder 2	54,480.00	22.93 (246.82)
Bidder 3	67,405.00	28.37 (305.37)
Bidder 4	82,833.00	34.86 (375.23)
Bidder 5	91,590.00	38.55 (414.95)

Bridge Deck Restoration & Waterproofing Bridges over Mountain Parkway
Date Let: 05-30-14 Call: 446 County: Powell District: 10
Bridge Number: 099B00033N Overlay Area: 10,436 ft^2 (969.5 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	170,896.00	16.38 (176.31)
Bidder 2	160,302.00	15.36 (165.33)
Bidder 3	177,654.60	17.02 (183.20)
Bidder 4	180,838.00	17.33 (186.54)
Bidder 5	158,673.80	15.20 (163.61)

Bridge Deck Restoration & Waterproofing Bridges over Mountain Parkway
Date Let: 05-30-14 Call: 446 County: Powell District: 10
Bridge Number: 119B00019N Overlay Area: 8,288 ft^2 (770.0 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	122,440.00	14.77 (158.98)
Bidder 2	107,510.00	12.97 (139.61)
Bidder 3	124,245.00	14.99 (161.35)
Bidder 4	102,130.00	12.32 (132.61)
Bidder 5	116,345.00	14.04 (151.12)

Bridge Deck Restoration & Waterproofing Bridge over Wilson Creek
Date Let: 06-27-14 Call: 316 County: Nelson District: 04
Bridge Number: 090B00062N Overlay Area: 6,150 ft^2 (571.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	59,893.00	9.74 (104.84)
Bidder 2	94,819.00	15.42 (165.98)
Bidder 3	87,856.00	14.29 (153.82)
Bidder 4	90,041.00	14.64 (157.58)
Bidder 5	123,084.00	20.01 (215.39)

Bridge Deck Restoration & Waterproofing Interstate 64
Date Let: 07-11-14 Call: 100 County: Franklin District: 05
Bridge Number: 037B00057L Overlay Area: 4,770 ft^2 (443.1 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	148,480.00	31.13 (335.08)
Bidder 2	160,300.00	33.61 (361.77)
Bidder 3	166,570.00	34.92 (375.87)
Bidder 4	148,130.00	31.05 (334.22)
Bidder 5	152,080.00	31.88 (343.15)

Bridge Deck Restoration & Waterproofing Interstate 64
Date Let: 07-11-14 Call: 100 County: Franklin District: 05
Bridge Number: 037B00057R Overlay Area: 4,770 ft^2 (443.1 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	148,480.00	31.13 (335.08)
Bidder 2	160,300.00	33.61 (361.77)
Bidder 3	166,570.00	34.92 (375.87)
Bidder 4	148,130.00	31.05 (334.22)
Bidder 5	152,080.00	31.88 (343.15)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Harlan County
Date Let: 08-22-14 Call: 435 County: Harlan District: 11
Bridge Number: 048B00065N Overlay Area: 13,830 ft^2 (1,284.9 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	202,984.50	14.68 (158.01)
Bidder 2	191,187.00	13.82 (148.76)
Bidder 3	195,393.50	14.13 (152.09)
Bidder 4	201,785.00	14.59 (157.04)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Harlan County
Date Let: 08-22-14 Call: 435 County: Harlan District: 11
Bridge Number: 048B00147N Overlay Area: 9,152 ft^2 (850.3 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	122,432.00	13.38 (144.02)
Bidder 2	107,691.50	11.77 (126.69)
Bidder 3	139,840.00	15.28 (164.47)
Bidder 4	117,290.00	12.82 (137.99)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Harlan County
Date Let: 08-22-14 Call: 435 County: Harlan District: 11
Bridge Number: 048B00129N Overlay Area: 7,520 ft^2 (698.6 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	126,851.60	16.87 (181.59)
Bidder 2	121,111.40	16.11 (173.41)
Bidder 3	120,557.00	16.03 (172.54)
Bidder 4	122,410.00	16.28 (175.24)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Perry County
Date Let: 08-22-14 Call: 445 County: Perry District: 10
Bridge Number: 097B00042N Overlay Area: 6,986 ft^2 (649.0 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	192,580.60	27.57 (296.76)
Bidder 2	188,308.00	26.96 (290.19)
Bidder 3	180,060.50	25.77 (277.38)
Bidder 4	262,902.50	37.63 (405.04)
Bidder 5	170,101.20	24.35 (262.10)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Perry County
Date Let: 08-22-14 Call: 445 County: Perry District: 10
Bridge Number: 097B00089N Overlay Area: 20,672 ft^2 (1,920.5 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	271,794.50	13.15 (141.54)
Bidder 2	274,015.00	13.26 (142.73)
Bidder 3	294,015.00	14.22 (153.06)
Bidder 4	306,895.00	14.85 (159.84)
Bidder 5	282,292.00	13.66 (147.03)

Bridge Deck Restoration & Waterproofing Bridge over Ohio River
Date Let: 09-26-14 Call: 100 County: Boone District: 06
Bridge Number: 008B00052N Overlay Area: 242,904 ft^2 (22,566.6 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	1,751,140.00	7.21 (77.61)
Bidder 2	2,383,350.00	9.81 (105.59)
Bidder 3	2,202,850.00	9.07 (97.63)
Bidder 4	2,491,337.50	10.26 (110.44)
Bidder 5	2,152,700.00	8.86 (95.37)

Bridge Deck Restoration & Waterproofing Western Kentucky Parkway Bridge Overlays
Date Let: 09-26-14 Call: 404 County: Hardin District: 04
Bridge Number: 047B00092L Overlay Area: 5,190 ft^2 (482.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	62,953.45	12.13 (130.57)
Bidder 2	50,207.50	9.67 (104.09)
Bidder 3	51,749.10	9.97 (107.32)
Bidder 4	62,977.40	12.13 (130.57)
Bidder 5	72,664.50	14.00 (150.69)
Bidder 6	84,094.00	16.20 (174.37)

Bridge Deck Restoration & Waterproofing Western Kentucky Parkway Bridge Overlays
Date Let: 09-26-14 Call: 404 County: Hardin District: 04
Bridge Number: 047B00092R Overlay Area: 5,190 ft^2 (482.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	62,953.45	12.13 (130.57)
Bidder 2	50,207.50	9.67 (104.09)
Bidder 3	51,749.10	9.97 (107.32)
Bidder 4	62,977.40	12.13 (130.57)
Bidder 5	72,664.50	14.00 (150.69)
Bidder 6	84,094.00	16.20 (174.37)

Bridge Deck Restoration & Waterproofing Western Kentucky Parkway Bridge Overlays
Date Let: 09-26-14 Call: 404 County: Hardin District: 04
Bridge Number: 047B00093L Overlay Area: 6,270 ft^2 (582.5 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	74,357.20	11.86 (127.66)
Bidder 2	59,958.00	9.56 (102.90)
Bidder 3	62,031.60	9.89 (106.45)
Bidder 4	74,720.80	11.92 (128.31)
Bidder 5	85,550.00	13.64 (146.82)
Bidder 6	99,890.00	15.93 (171.47)

Bridge Deck Restoration & Waterproofing Western Kentucky Parkway Bridge Overlays
Date Let: 09-26-14 Call: 404 County: Hardin District: 04
Bridge Number: 047B00093R Overlay Area: 6,270 ft^2 (582.5 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	74,357.20	11.86 (127.66)
Bidder 2	59,958.00	9.56 (102.90)
Bidder 3	62,031.60	9.89 (106.45)
Bidder 4	74,720.80	11.92 (128.31)
Bidder 5	85,550.00	13.64 (146.82)
Bidder 6	99,890.00	15.93 (171.47)

Bridge Deck Restoration & Waterproofing Bridge over Tygarts Creek
Date Let: 10-24-14 Call: 319 County: Carter District: 09
Bridge Number: 022B00035N Overlay Area: 7,840 ft^2 (728.4 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	123,668.50	15.77 (169.75)
Bidder 2	121,139.00	15.45 (166.30)
Bidder 3	146,880.00	18.73 (201.61)
Bidder 4	131,227.40	16.74 (180.19)
Bidder 5	90,260.00	11.51 (123.89)
Bidder 6	118,462.60	15.11 (162.64)
Bidder 7	202,561.00	25.84 (278.14)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Wayne County
Date Let: 10-24-14 Call: 403 County: Wayne District: 08
Bridge Number: 116B00009N Overlay Area: 3,816 ft^2 (354.5 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	71,358.00	18.70 (201.28)
Bidder 2	98,020.00	25.69 (276.52)
Bidder 3	113,131.10	29.65 (319.15)
Bidder 4	141,528.50	37.09 (399.23)
Bidder 5	97,926.80	25.66 (276.20)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Wayne County
Date Let: 10-24-14 Call: 403 County: Wayne District: 08
Bridge Number: 116B00010N Overlay Area: 2,736 ft^2 (254.2 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	55,004.00	20.10 (216.35)
Bidder 2	76,455.00	27.94 (300.74)
Bidder 3	87,926.30	32.14 (345.95)
Bidder 4	107,372.50	39.24 (422.37)
Bidder 5	78,709.40	28.77 (309.68)

Bridge Deck Restoration & Waterproofing Bridge Overlays in Wayne County
Date Let: 10-24-14 Call: 403 County: Wayne District: 08
Bridge Number: 116B00020N Overlay Area: 1,320 ft^2 (122.6 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	28,364.00	21.49 (231.32)
Bidder 2	40,230.00	30.48 (328.08)
Bidder 3	46,245.80	35.03 (377.06)
Bidder 4	55,644.00	42.15 (453.70)
Bidder 5	42,637.40	32.30 (347.67)

The following roadway projects also included bridge deck restoration work.

Asphalt Rehab with Bridge(s) Louisville-Cincinnati Road (1-71)
Date Let: 09-27-13 Call: 200 County: Henry District: 05
Bridge Number: 052B00001N Overlay Area: 8,040 ft^2 (746.9 m^2)

	Total Deck Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	75,910.00	9.44 (101.61)
Bidder 2	97,879.00	12.17 (131.00)
Bidder 3	82,249.20	10.23 (110.11)
Bidder 4	93,034.00	11.57 (124.54)

Asphalt Rehab with Bridge(s) Louisville-Cincinnati Road (1-71)
Date Let: 09-27-13 Call: 200 County: Henry District: 05
Bridge Number: 052B00038N Overlay Area: 9,482 ft^2 (880.9 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	80,785.00	8.52 (91.71)
Bidder 2	89,842.50	9.48 (102.04)
Bidder 3	87,553.00	9.23 (99.35)
Bidder 4	96,349.00	10.16 (109.36)

Asphalt Rehab with Bridge(s) Louisville-Cincinnati Road (1-71)
Date Let: 09-27-13 Call: 200 County: Henry District: 05
Bridge Number: 052B00051L Overlay Area: 13,868 ft^2 (1,288.4 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	123,265.00	8.89 (95.69)
Bidder 2	137,309.50	9.90 (106.56)
Bidder 3	133,616.60	9.63 (103.66)
Bidder 4	146,901.00	10.59 (113.99)

Grade, Drain & Surface with Bridge Richmond-Lancaster Road (KY 52)
Date Let: 09-27-13 Call: 201 County: Various District: 07
Bridge Number: 040B00004N Overlay Area: 3,080 ft^2 (286.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	58,960.00	19.14 (206.02)
Bidder 2	72,649.38	23.59 (253.92)
Bidder 3	88,352.00	28.69 (308.82)
Bidder 4	87,778.00	28.50 (306.77)

Grade, Drain & Surface with Bridge Cumberland Parkway (9008) and US 127 Interchange
Date Let: 04-25-14 Call: 302 County: Russell District: 08
Bridge Number: 104B00022N Overlay Area: 17,216 ft^2 (1,599.4 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	206,665.38	12.00 (129.17)
Bidder 2	200,646.00	11.65 (125.40)
Bidder 3	200,646.00	11.65 (125.40)
Bidder 4	236,609.00	13.74 (147.90)

Asphalt Rehab Interstate/Parkway Edward T. Breathitt Parkway (PW 9004)
Date Let: 05-30-14 Call: 200 County: Hopkins District: 02
Bridge Number: 051B00062L Overlay Area: 6,954 ft^2 (646.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	87,186.50	12.54 (134.98)
Bidder 2	81,049.80	11.66 (125.51)
Bidder 3	89,475.75	12.87 (138.53)

Asphalt Rehab Interstate/Parkway Edward T. Breathitt Parkway (PW 9004)
Date Let: 05-30-14 Call: 200 County: Hopkins District: 02
Bridge Number: 051B00062R Overlay Area: 6,954 ft^2 (646.1 m^2)

	Total Deck Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	87,186.50	12.54 (134.98)
Bidder 2	81,049.80	11.66 (125.51)
Bidder 3	89,475.75	12.87 (138.53)

Asphalt Rehab Interstate/Parkway Edward T. Breathitt Parkway (PW 9004)
Date Let: 05-30-14 Call: 200 County: Hopkins District: 02
Bridge Number: 117B00071L Overlay Area: 11,040 ft^2 (1,025.7 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	94,819.50	8.59 (92.46)
Bidder 2	95,236.65	8.63 (92.89)
Bidder 3	109,586.50	9.93 (106.89)

Asphalt Rehab Interstate/Parkway Edward T. Breathitt Parkway (PW 9004)
Date Let: 05-30-14 Call: 200 County: Hopkins District: 02
Bridge Number: 117B00071R Overlay Area: 11,040 ft^2 (1,025.7 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	94,819.50	8.59 (92.46)
Bidder 2	95,236.65	8.63 (92.89)
Bidder 3	109,586.50	9.93 (106.89)

Asphalt Pavement & Roadway Rehab Julian M. Carroll Parkway (9003)
Date Let: 08-22-14 Call: 203 County: Graves District: 01
Bridge Number: 079B00075L, SB only Overlay Area: 8,726 ft^2 (810.7 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	93,975.00	10.77 (115.93)
Bidder 2	95,366.30	10.93 (117.65)

Asphalt Rehab with Bridge(s) Louie B. Nunn Cumberland Parkway (9008)
Date Let: 10-24-14 Call: 306 County: Barren District: 03
Bridge Number: 005B00068R, EB only Overlay Area: 8,558 ft^2 (795.1 m^2)

	Total Deck Items, $	Unit Cost, $/ft^2$ ($/m^2$)
Bidder 1	122,270.00	14.29 (153.82)

Bridge Removals

The cost analysis for structure removal included the following bid items:

- Remove structure
- Remove exist superstructure and abutment

The length and width of the structures used to calculate the area of the structures that were removed were taken from the National Bridge Inventory (NBI) database for Kentucky. The calculated unit costs are summarized in Table C.4.

Table C.4-Bridge removal costs summary

Structure type-main	Number of bridges	n	Unit Costs, $\$/ft^2$ ($\$/m^2$)	
			Mean	Standard Deviation
101	4	14	28.75 (310.46)	21.83 (235.74)
104	17	69	28.37 (306.36)	15.83 (170.94)
204	10	23	14.13 (152.59)	4.03 (43.52)
122	4	15	22.20 (218.13)	12.20 (131.74)
119	1	4	10.66 (115.11)	6.35 (68.57)
505	8	19	24.51 (264.68)	18.76 (202.58)
302	12	32	19.45 (210.04)	9.29 (100.32)
402	3	10	23.36 (252.26)	17.64 (190.49)
403	2	6	25.39 (274.18)	7.69 (83.04)
310	6	23	23.95 (258.63)	12.84 (138.66)
702	1	6	26.52 (286.38)	11.00 (119.22)
All	68	221	23.73 (256.25)	14.69 (158.63)

Structure Type Codes
101 = concrete slab
104 = concrete tee beam
204 = continuous concrete tee beam
122 = concrete channel beam
119 = concrete culvert
505 = prestressed concrete box beam or girders - multiple
302 = steel stringer/multi-beam or girder
402 = continuous steel stringer/multi-beam or girder
403 = continuous steel girder and floorbeam system
310 = steel thru truss
702 = timber stringer/multi-beam or girder

The following are summaries of unit costs for each project used in the analysis. Unit costs marked with an asterisk were not used in the cost analysis.

Concrete Slab Bridges (NBI Item 43=101)

Bridge Replacement East Union-Carlisle Road (KY-1285)
Date Let: 09-27-13 Call: 102 County: Nicholas District: 09
NBI Structure Number: 091B00005N Bridge Area: 417 ft^2 (38.7 m^2)

	Total Removal Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	9,000.00	21.57 (232.18)
Bidder 2	5,000.00	11.98 (128.95)
Bidder 3	5,000.00	11.98 (128.95)
Bidder 4	50,000.00	119.84 (1,289.94) *
Bidder 5	10,000.00	23.97 (258.01)
Bidder 6	28,500.00	68.31 (735.28)

Bridge with Grade, Drain & Surface Bent Branch Road (KY-1426)
Date Let: 06-27-14 Call: 101 County: Pike District: 12
NBI Structure Number: 098B00015N Bridge Area: 841 ft^2 (78.1 m^2)

	Total Removal Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	70,000.00	83.27 (896.31)

Bridge with Grade, Drain & Surface Wildie Road (CR-1071)
Date Let: 09-26-14 Call: 117 County: Rockcastle District: 08
NBI Structure Number: 102C00009N Bridge Area: 1,024 ft^2 (95.1 m^2)

	Total Removal Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	41,500.00	40.52 (436.15)
Bidder 2	22,500.00	21.97 (236.48)
Bidder 3	10,000.00	9.76 (105.06)

Bridge Replacement Wildie Road (CR 1071)
Date Let: 10-24-14 Call: 111 County: Rockcastle District: 08
NBI Structure Number: 102C00008N Bridge Area: 991 ft^2 (92.1 m^2)

	Total Removal Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	16,000.00	16.15 (173.84)
Bidder 2	22,500.00	22.71 (244.45)
Bidder 3	34,000.00	34.32 (369.42)
Bidder 4	21,000.00	21.20 (228.19)
Bidder 5	14,662.50	14.80 (159.31)

Concrete Tee Beam Bridges (NBI Item 43=104)

Bridge with Grade, Drain & Surface KY 1428
Date Let: 02-22-13 Call: 104 County: Floyd District: 12
NBI Structure Number: 036B00003N Bridge Area: 2,344 ft^2 (217.8 m^2)

	Total Removal Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	70,000.00	29.86 (321.41)
Bidder 2	130,000.00	55.46 (596.96)

Bridge with Grade, Drain & Surface Fulton-Fulgham Road (KY 307)
Date Let: 03-22-13 Call: 104 County: Hickman District: 01
NBI Structure Number: 053B00014N Bridge Area: 2,813 ft^2 (261.3 m^2)

	Total Removal Items, $	Unit Cost, $/ft^2 ($/m^2)
Bidder 1	80,000.00	28.44 (306.12)
Bidder 2	500,000.00	177.77 (1,913.49) *

Bridge with Grade, Drain & Surface Fulton-Fulgham Road (KY 307)
Date Let: 03-22-13 Call: 104 County: Hickman District: 01
NBI Structure Number: 053B00015N Bridge Area: 3,519 ft^2 (326.9 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	70,000.00	19.89 (214.09)
Bidder 2	500,000.00	142.08 (1,529.33) *

Bridge with Grade, Drain & Surface Fulton-Fulgham Road (KY 307)
Date Let: 03-22-13 Call: 104 County: Hickman District: 01
NBI Structure Number: 053B00016N Bridge Area: 2,540 ft^2 (236.0 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	60,000.00	23.62 (254.24)
Bidder 2	500,000.00	196.87 (2,119.08) *

Bridge with Grade, Drain & Surface Huddy-McVeigh Road (KY 199)
Date Let: 08-16-13 Call: 103 County: Pike District: 12
NBI Structure Number: 098B00033N Bridge Area: 1,151 ft^2 (106.9 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	10,000.00	8.69 (93.54)
Bidder 2	20,000.00	17.38 (187.08)
Bidder 3	55,000.00	47.79 (514.41)
Bidder 4	15,000.00	13.03 (140.25)

Bridge with Grade, Drain & Surface Wilson Creek Bridge (KY 945)
Date Let: 09-27-13 Call: 101 County: Graves District: 01
NBI Structure Number: 042B00187N Bridge Area: 2,503 ft^2 (232.5 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	48,203.50	19.26 (207.31)
Bidder 2	30,000.00	11.99 (129.06)
Bidder 3	100,000.00	39.96 (430.12)
Bidder 4	95,000.00	37.96 (408.60)

Bridge with Grade, Drain & Surface KY 476
Date Let: 09-27-13 Call: 105 County: Perry District: 10
NBI Structure Number: 097B00008N Bridge Area: 3,446 ft^2 (320.1 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	35,000.00	10.16 (109.36)
Bidder 2	90,000.00	26.12 (281.15)
Bidder 3	89,000.00	25.83 (278.03)
Bidder 4	50,000.00	14.51 (156.18)
Bidder 5	130,000.00	37.73 (406.12)

Bridge Replacement Anthoston-Niagara Road (KY-136)
Date Let: 10-25-13 Call: 109 County: Henderson District: 02
NBI Structure Number: 051B00024N Bridge Area: 556 ft^2 (51.7 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	29,500.00	53.05 (571.02)
Bidder 2	38,000.00	68.34 (735.60)
Bidder 3	20,000.00	35.97 (387.18)
Bidder 4	42,500.00	76.43 (822.68)
Bidder 5	33,000.00	59.35 (638.84)

Bridge Replacement Stanton-Slade Road (KY 11)
Date Let: 11-22-13 Call: 104 County: Powell District: 10
NBI Structure Number: 099B00039N Bridge Area: 1,385 ft^2 (128.7 m^2)

	Total Removal Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	15,000.00	10.83 (116.57)
Bidder 2	9,400.00	6.79 (73.09)
Bidder 3	43,000.00	31.04 (334.11)
Bidder 4	35,000.00	25.27 (272.00)

Bridge with Grade, Drain & Surface Beaver Dam - Leitchfield Road (US 62)
Date Let: 11-22-13 Call: 106 County: Ohio District: 02
NBI Structure Number: 092B00034N Bridge Area: 2,575 ft^2 (239.2 m^2)

	Total Removal Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	39,500.00	15.34 (165.12)
Bidder 2	66,000.00	25.63 (275.88)
Bidder 3	60,000.00	23.30 (250.80)
Bidder 4	15,000.00	5.83 (62.75)
Bidder 5	40,000.00	15.54 (167.27)

Bridge with Grade, Drain & Surface Sedalia to Mayfield Road (KY 79)
Date Let: 11-22-13 Call: 107 County: Graves District: 01
NBI Structure Number: 042B00046N Bridge Area: 1,612 ft^2 (149.8 m^2)

	Total Removal Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	33,000.00	20.47 (220.34)
Bidder 2	49,010.82	30.40 (327.22)
Bidder 3	40,000.00	24.81 (267.05)

Grade, Drain & Surface with Bridge Gratz-Moxley Road (KY-355)
Date Let: 12-13-13 Call: 106 County: Owen District: 06
NBI Structure Number: 094B00009N Bridge Area: 4,924 ft^2 (457.5 m^2)

	Total Removal Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	100,000.00	20.31 (218.61)
Bidder 2	55,087.89	11.19 (120.45)
Bidder 3	50,000.00	10.16 (109.36)
Bidder 4	163,860.00	33.28 (358.22)
Bidder 5	143,000.00	29.04 (312.58)
Bidder 6	140,500.00	28.54 (307.20)
Bidder 7	200,000.00	40.62 (437.23)
Bidder 8	133,000.00	27.01 (290.73)
Bidder 9	155,000.00	31.48 (338.85)

Grade, Drain & Surface with Bridge Morgantown Road (KY 79)
Date Let: 01-24-14 Call: 313 County: Logan District: 03
NBI Structure Number: 071B00009N Bridge Area: 2,049 ft^2 (190.4 m^2)

	Total Removal Items, $	Unit Cost, $/ft² ($/m²)
Bidder 1	22,000.00	10.74 (115.60)
Bidder 2	20,000.00	9.76 (105.06)
Bidder 3	32,000.00	15.62 (168.13)

Bridge Replacement Bloomfield Road (US 62)
Date Let: 04-25-14 Call: 105 County: Nelson District: 04
NBI Structure Number: 090B00023N Bridge Area: 1,072 ft^2 (99.6 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	25,000.00	23.33 (251.12)
Bidder 2	34,000.00	31.73 (341.54)
Bidder 3	24,000.00	22.40 (241.11)
Bidder 4	34,000.00	31.73 (341.54)

Bridge with Grade, Drain & Surface Frenchburg to Owingsville Road (KY 36)
Date Let: 06-27-14 Call: 109 County: Menifee District: 10
NBI Structure Number: 083B00001N Bridge Area: 2,795 ft^2 (259.7 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	50,000.00	17.89 (192.57)
Bidder 2	100,000.00	35.77 (385.02)
Bidder 3	180,000.00	64.39 (693.09)
Bidder 4	90,000.00	32.20 (346.60)
Bidder 5	125,000.00	44.72 (481.36)
Bidder 6	122,000.00	43.64 (469.74)
Bidder 7	39,100.00	13.99 (150.59)

Bridge with Grade, Drain & Surface KY 32 over Seas Branch
Date Let: 06-27-14 Call: 110 County: Rowan District: 09
NBI Structure Number: 103B00013N Bridge Area: 739 ft^2 (68.7 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	19,000.00	25.72 (276.85)
Bidder 2	4,600.00	6.23 (67.06)
Bidder 3	10,000.00	13.53 (145.64)
Bidder 4	10,000.00	13.53 (145.64)
Bidder 5	63,000.00	85.27 (917.84) *
Bidder 6	27,500.00	37.22 (400.63)
Bidder 7	32,500.00	43.99 (473.50)
Bidder 8	25,000.00	33.84 (364.25)

Bridge with Grade, Drain & Surface Morehead-Grayson Road (US-60)
Date Let: 08-22-14 Call: 106 County: Rowan District: 09
NBI Structure Number: 103B00006N
Bridge Area: 851 ft^2 (79.1 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	55,000.00	64.60 (695.35)
Bidder 2	25,000.00	29.36 (316.03)
Bidder 3	25,000.00	29.36 (316.03)
Bidder 4	29,500.00	34.65 (372.97)

Continuous Concrete Tee Beam Bridges (NBI Item 43=204)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
NBI Structure Number: 050B00006N Bridge Area: 8,447 ft^2 (784.8 m^2)

	Total Removal Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	100,000.00	11.84 (127.44)
Bidder 2	160,000.00	18.94 (203.87)
Bidder 3	200,000.00	23.68 (254.89)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
NBI Structure Number: 050B00027L Bridge Area: 5,620 ft^2 (522.1 m^2)

	Total Removal Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	62,500.00	11.12 (119.69)
Bidder 2	95,000.00	16.90 (181.91)
Bidder 3	110,837.70	19.72 (212.26)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
NBI Structure Number: 050B00027R Bridge Area: 5,620 ft^2 (522.1 m^2)

	Total Removal Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	62,500.00	11.12 (119.69)
Bidder 2	95,000.00	16.90 (181.91)
Bidder 3	110,837.70	19.72 (212.26)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
NBI Structure Number: 062B00016N Bridge Area: 7,400 ft^2 (687.5 m^2)

	Total Removal Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	120,000.00	16.22 (174.59)
Bidder 2	80,000.00	10.81 (116.36)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
NBI Structure Number: 050B00030L Bridge Area: 7,225 ft^2 (671.2 m^2)

	Total Removal Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	82,500.00	11.42 (122.92)
Bidder 2	100,000.00	13.84 (148.97)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
NBI Structure Number: 050B00030R Bridge Area: 7,225 ft^2 (671.2 m^2)

	Total Removal Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	82,500.00	11.42 (122.92)
Bidder 2	100,000.00	13.84 (148.97)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
NBI Structure Number: 050B00008N Bridge Area: 9,612 ft^2 (874.6 m^2)

	Total Removal Items, $	Unit Cost, $\$/ft^2$ ($\$/m^2$)
Bidder 1	120,000.00	12.48 (134.33)
Bidder 2	100,000.00	10.40 (111.94)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
NBI Structure Number: 047B00042N Bridge Area: 9,414 ft^2 (874.6 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	140,000.00	14.87 (160.06)
Bidder 2	100,000.00	10.62 (114.31)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
NBI Structure Number: 047B00064N Bridge Area: 7,332 ft^2 (681.2 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	140,000.00	19.10 (205.59)
Bidder 2	80,000.00	10.91 (117.43)

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04
NBI Structure Number: 047B00029N Bridge Area: 12,563 ft^2 (1,167.1 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	140,000.00	11.14 (119.91)
Bidder 2	100,000.00	7.96 (85.68)

Concrete Culvert (NBI Item 43=119)

Bridge with Grade, Drain & Surface Low Water Drive (CR 1336)
Date Let: 05-24-13 Call: 352 County: Harlan District: 11
NBI Structure Number: 048B00135N Bridge Area: 2,640 ft^2 (245.3 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	25,000.00	9.47 (101.93)
Bidder 2	20,000.00	7.58 (81.59)
Bidder 3	15,000.00	5.68 (61.14)
Bidder 4	52,500.00	19.89 (214.09)

Concrete Channel Beam Bridges (NBI Item 43=122)

Bridge with Grade, Drain & Surface Outland School Road (KY-1536)
Date Let: 05-30-14 Call: 103 County: Calloway District: 01
NBI Structure Number: 018B00108N Bridge Area: 1,314 ft^2 (122.1 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	34,600.00	26.33 (283.41)
Bidder 2	18,500.00	14.08 (151.56)
Bidder 3	40,000.00	30.44 (327.65)

Grade, Drain & Surface with Bridge Kenneth Barrett Road (KY 30)
Date Let: 09-26-14 Call: 112 County: Owsley District: 10
NBI Structure Number: 095B00013N Bridge Area: 1,556 ft^2 (144.6 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	11,000.00	7.07 (76.10)
Bidder 2	15,000.00	9.64 (103.76)
Bidder 3	12,000.00	7.71 (82.99)
Bidder 4	30,000.00	19.28 (207.53
Bidder 5	15,000.00	9.64 (103.76)

Grade & Drain with Bridge KY 343
Date Let: 09-26-14 Call: 119 County: Letcher District: 12
NBI Structure Number: 067B00015N Bridge Area: 656 ft^2 (60.9 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	32,500.00	49.52 (533.03)
Bidder 2	20,000.00	30.48 (328.08)
Bidder 3	20,000.00	30.48 (328.08)

Bridge Replacement Pryorsburg to Dublin Road (KY 1748)
Date Let: 10-24-14 Call: 108 County: Graves District: 01
NBI Structure Number: 042B00236N Bridge Area: 1,300 ft^2 (120.8 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	27,000.00	20.77 (223.57)
Bidder 2	17,500.00	13.46 (144.88)
Bidder 3	45,318.00	34.86 (375.23)
Bidder 4	38,000.00	29.23 (314.63)

Steel Stringer/multi-beam or Girder Bridges (NBI Item 43=302)

Bridge with Grade, Drain & Surface Dahl Road (KY 1677)
Date Let: 08-16-13 Call: 106 County: Pulaski District: 08
NBI Structure Number: 100B00023N Bridge Area: 1,168 ft^2 (108.5 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	20,000.00	17.12 (184.28)
Bidder 2	7,500.00	6.42 (69.10)
Bidder 3	20,000.00	17.12 (184.28)
Bidder 4	25,000.00	21.41 (230.45)
Bidder 5	25,000.00	21.41 (230.45)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
NBI Structure Number: 050B00029L Bridge Area: 4,698 ft^2 (436.5 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	75,000.00	15.96 (171.79)
Bidder 2	112,500.00	23.95 (257.79)
Bidder 3	150,901.11	32.12 (345.74)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
NBI Structure Number: 050B00029R Bridge Area: 4,698 ft^2 (436.5 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	75,000.00	15.96 (171.79)
Bidder 2	112,500.00	23.95 (257.79)
Bidder 3	150,901.11	32.12 (345.74)

Bridge with Grade, Drain & Surface Buffalo Branch Road (CR-1327)
Date Let: 11-22-13 Call: 111 County: Bell District: 11
NBI Structure Number: 007C00048N Bridge Area: 681 ft^2 (63.3 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	10,000.00	14.68 (158.01)
Bidder 2	6,000.00	8.81 (94.83)
Bidder 3	10,000.00	14.68 (158.01)
Bidder 4	47,500.00	69.75 (750.78) *

Bridge Replacement Pacies Branch Road (CR 1245)
Date Let: 03-28-14 Call: 112 County: Letcher District: 12
NBI Structure Number: 067C00027N Bridge Area: 332 ft^2 (30.8 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	30,000.00	90.49 (974.02) *
Bidder 2	7,700.00	23.23 (250.04)

Bridge Replacement Hacker Branch Road (CR-1136)
Date Let: 07-11-14 Call: 107 County: Owsley District: 10
NBI Structure Number: 095C00007N Bridge Area: 1,565 ft^2 (145.4 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	10,000.00	6.39 (68.78)
Bidder 2	25,000.00	15.97 (171.90)
Bidder 3	27,000.00	17.25 (185.68)

Bridge Replacement Rye Branch Road (CR 1756)
Date Let: 07-11-14 Call: 108 County: Magoffin District: 10
NBI Structure Number: 077C00048N Bridge Area: 638 ft^2 (59.3 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	9,500.00	14.89 (160.27)
Bidder 2	5,000.00	7.84 (84.39)
Bidder 3	22,500.00	35.26 (379.53)

Bridge with Grade & Drain Stinson Road (CR-1700)
Date Let: 07-11-14 Call: 115 County: Wayne District: 08
NBI Structure Number: 116C00040N Bridge Area: 609 ft^2 (56.6 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	11,100.00	18.21 (196.01)
Bidder 2	77,000.00	126.34 (1,359.91) *
Bidder 3	50,000.00	82.04 (883.07) *

Bridge with Grade & Drain Curtis Road (CR 1226)
Date Let: 08-22-14 Call: 111 County: Boyle District: 07
NBI Structure Number: 011C00042N Bridge Area: 860 ft^2 (79.9 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	15,000.00	17.44 (187.72)
Bidder 2	30,000.00	34.87 (375.34)

Bridge with Grade, Drain & Surface Oscar Bowling Road (CR 1113A)
Date Let: 09-26-14 Call: 104 County: Clay District: 11
NBI Structure Number: 026C00063N Bridge Area: 1,373 ft^2 (127.6 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	30,000.00	21.84 (235.08)
Bidder 2	20,000.00	14.56 (156.72)

Bridge Replacement Hade Bell Road (CR 1167)
Date Let: 09-26-14 Call: 116 County: Allen District: 03
NBI Structure Number: 002C00012N Bridge Area: 506 ft^2 (47.0 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	20,000.00	39.50 (425.17)
Bidder 2	19,000.00	37.52 (403.86)

Bridge Replacement Hemp Patch Branch Road (CR-1002)
Date Let: 10-24-14 Call: 302 County: Knott District: 12
NBI Structure Number: 060C00001N Bridge Area: 1,004 ft^2 (93.3 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	10,000.00	9.96 (107.21)
Bidder 2	5,000.00	4.98 (53.60)
Bidder 3	14,500.00	14.45 (155.54)
Bidder 4	22,500.00	22.42 (241.33)

Continuous Steel Stringer/multi-beam or Girder Bridges (NBI Item 43=402)

Bridge Replacement Elk Lick Creek Road (CR 1224)
Date Let: 05-30-14 Call: 110 County: Lee District: 10
NBI Structure Number: 065C00023N Bridge Area: 495 ft^2 (46.0 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	2,000.00	4.04 (43.49)
Bidder 2	16,300.00	32.91 (354.24)
Bidder 3	7,500.00	15.14 (162.96)
Bidder 4	24,000.00	48.46 (521.62)

Bridge Replacement Mobley Mill Road (CR 1327)
Date Let: 08-22-14 Call: 108 County: Nelson District: 04
NBI Structure Number: 090C00039N Bridge Area: 1,742 ft^2 (161.8 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	10,000.00	5.74 (61.78)
Bidder 2	31,000.00	17.80 (191.60)
Bidder 3	11,000.00	6.31 (67.92)
Bidder 4	25,000.00	14.35 (154.46)

Bridge with Grade, Drain & Surface KG Estates Road (CR 1162)
Date Let: 09-26-14 Call: 118 County: Lawrence District: 12
NBI Structure Number: 064C00078N Bridge Area: 996 ft^2 (92.5 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	48,500.00	48.71 (524.31)
Bidder 2	40,000.00	40.17 (432.38)

Continuous Steel Girder and Floorbeam System Bridges (NBI Item 43=403)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
NBI Structure Number: 050B00031L Bridge Area: 24,158 ft^2 (2,244.4 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	400,000.00	16.56 (178.25)
Bidder 2	625,000.00	25.87 (278.46)
Bidder 3	815,000.00	33.74 (363.17)

Bridge with Grade, Drain & Surface Tennessee State Line to E-Town Road (I-65)
Date Let: 11-22-13 Call: 109 County: Hart District: 04
NBI Structure Number: 050B00031R Bridge Area: 24,158 ft^2 (2,244.4 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	400,000.00	16.56 (178.25)
Bidder 2	625,000.00	25.87 (278.46)
Bidder 3	815,000.00	33.74 (363.17)

Bridge with Grade, Drain & Surface Patty Loveless Drive (KY 80)
Date Let: 12-13-13 Call: 105 County: Pike District: 12
NBI Structure Number: 098B00137N Bridge Area: 28,356 ft^2 (2,634.4 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	45,000.00	1.59 (17.11) *
Bidder 2	1,000.00	0.04 (0.43) *

Steel Thru Truss Bridges (NBI Item 43=310)

Bridge with Grade, Drain & Surface Ray Road (CR 1060)
Date Let: 07-12-13 Call: 200 County: Daviess District: 02
NBI Structure Number: 030C00018N Bridge Area: 1,296 ft^2 (120.4 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	20,000.00	15.43 (166.09)
Bidder 2	8,000.00	6.17 (66.41)
Bidder 3	23,000.00	17.75 (191.06)
Bidder 4	35,000.00	27.01 (290.73)
Bidder 5	25,000.00	19.29 (207.64)

Bridge with Grade, Drain & Surface Glomawr to Hazard Road (KY 451)
Date Let: 11-22-13 Call: 108 County: Perry District: 10
NBI Structure Number: 097B00016N Bridge Area: 8,247 ft^2 (766.2 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	109,426.97	13.27 (142.84)
Bidder 2	120,000.00	14.55 (156.61)
Bidder 3	209,000.00	25.34 (272.76)
Bidder 4	265,000.00	32.13 (345.84)

Bridge with Grade, Drain & Surface Hazard-Hyden Road (KY-80)
Date Let: 07-11-14 Call: 113 County: Perry District: 10
NBI Structure Number: 097B00029N Bridge Area: 9,576 ft^2 (889.6 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	180,000.00	18.80 (202.36)
Bidder 2	165,000.00	17.23 (185.46)
Bidder 3	185,365.00	19.36 (208.39)
Bidder 4	1,050,000.00	109.65 (1,180.26) *

Bridge Replacement Glasgow Street (CS 1053)
Date Let: 08-22-14 Call: 107 County: Metcalfe District: 03
NBI Structure Number: 085C00007N Bridge Area: 1,255 ft^2 (116.6 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	24,000.00	19.12 (205.81)
Bidder 2	15,000.00	11.95 (128.63)
Bidder 3	30,000.00	23.90 (257.26)
Bidder 4	25,000.00	19.92 (214.42)

Bridge with Grade, Drain & Surface Booneville-Jackson Road (KY 30)
Date Let: 09-26-14 Call: 113 County: Breathitt District: 10
NBI Structure Number: 013B00017N Bridge Area: 6,951 ft^2 (645.8 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	150,000.00	21.58 (232.28)
Bidder 2	115,000.00	16.54 (178.03)
Bidder 3	335,000.00	48.20 (518.82)
Bidder 4	485,000.00	69.78 (751.10) *

Prestressed Concrete Box Beam or Girders – Multiple Bridges (NBI Item 43=505)

Bridge Replacement Bridge over Little Goose Creek
Date Let: 05-24-13 Call: 368 County: Clay District: 11
NBI Structure Number: 026B00041N Bridge Area: 1,320 ft^2 (122.6 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	13,000.00	9.85 (106.02)
Bidder 2	22,000.00	16.67 (179.43)
Bidder 3	13,500.00	10.23 (110.11)

Bridge with Grade, Drain & Surface Woodbine-Barbourville Road (KY 6)
Date Let: 08-16-13 Call: 202 County: Knox District: 11
NBI Structure Number: 061B00042N Bridge Area: 1,430 ft^2 (132.9 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	20,000.00	13.99 (150.59)
Bidder 2	200,000.00	139.87 (1,505.54) *

Bridge with Grade, Drain & Surface Woodbine-Barbourville Road (KY 6)
Date Let: 08-16-13 Call: 202 County: Knox District: 11
NBI Structure Number: 061B00043N Bridge Area: 1,183 ft^2 (109.9 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	20,000.00	16.91 (182.02)
Bidder 2	200,000.00	169.10 (1,820.17) *

Bridge Replacement KY-502
Date Let: 09-27-13 Call: 111 County: Hopkins District: 02
NBI Structure Number: 054B00125N Bridge Area: 3,887 ft^2 (361.1 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	200,000.00	51.45 (553.80)
Bidder 2	405,000.00	104.19 (1,121.49) *
Bidder 3	250,000.00	64.32 (692.33)

Bridge with Grade, Drain & Surface Gray-Indian Creek Road (KY 3437)
Date Let: 11-22-13 Call: 105 County: Knox District: 11
NBI Structure Number: 061B00086N Bridge Area: 503 ft^2 (46.7 m^2)

	Total Removal Items, $	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	7,000.00	13.92 (149.83)
Bidder 2	10,000.00	19.89 (214.09)
Bidder 3	10,000.00	19.89 (214.09)

Bridge with Grade, Drain & Surface Lower Johns Creek Road (KY-194)
Date Let: 06-27-14 Call: 207 County: Floyd District: 12
NBI Structure Number: 036B00065N Bridge Area: 946 ft^2 (87.9 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	10,000.00	10.58 (113.88)

Bridge with Grade, Drain & Surface KY-49
Date Let: 08-22-14 Call: 313 County: Marion District: 04
NBI Structure Number: 078B00066N Bridge Area: 1,509 ft^2 (140.2 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	18,000.00	11.93 (128.41)
Bidder 2	29,950.00	19.85 (213.66)
Bidder 3	18,000.00	11.93 (128.41)

Bridge with Grade, Drain & Surface Upper Wolf Creek Road (CR 1134)
Date Let: 10-24-14 Call: 110 County: Owsley District: 10
NBI Structure Number: 095C00018N Bridge Area: 2,174 ft^2 (202.0 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	15,000.00	6.90 (74.27)
Bidder 2	62,000.00	28.52 (306.99)
Bidder 3	75,000.00	34.50 (371.35)
Bidder 4	72,000.00	33.12 (356.50)
Bidder 5	155,000.00	71.31 (767.57)

Timber Stringer/multi-beam or Girder Bridge (NBI Item 43=702)

Bridge with Grade, Drain & Surface Brown Badgett Loop (CR 1092)
Date Let: 01-25-13 Call: 103 County: Hopkins District: 02
NBI Structure Number: 054C00004N Bridge Area: 1,681 ft^2 (156.2 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	53,000.00	31.53 (339.38)
Bidder 2	60,500.00	35.99 (387.39)
Bidder 3	50,000.00	29.75 (320.23)
Bidder 4	60,000.00	35.70 (384.27)
Bidder 5	29,000.00	17.25 (185.68)
Bidder 6	15,000.00	8.92 (96.01)

Although the following project only called for the removal of the existing superstructure and abutment, the existing bridge was a single span steel thru truss.

Bridge Replacement Tebb's Bend (CR-1236)
Date Let: 09-26-14 Call: 103 County: Taylor District: 04
NBI Structure Number: 109C00015N Bridge Area: 2,669 ft^2 (248.0 m^2)

	Total Removal Items, $	Unit Cost, $/$ft^2$ ($/$m^2$)
Bidder 1	50,000.00	18.73 (201.61)
Bidder 2	150,000.00	56.20 (604.93)
Bidder 3	135,561.56	50.79 (546.70)
Bidder 4	100,000.00	37.47 (403.32)

Bridge Deck Removals

The cost analysis for deck removal included the following bid item:

- Remove existing deck

The calculated unit costs are summarized in Table C.5.

Table C.5-Bridge deck removal costs summary

Structure Type	n	Unit Costs, \$/ft^2 (\$/m^2)	
		Mean	Standard Deviation
402	3	4.87 (52.42)	2.61 (28.09)
505	7	12.69 (136.59)	5.77 (62.11)

The following is a summary of unit costs for the project used in the analysis.

Asphalt Rehab with Bridge (s) Martha Layne Collins Parkway (BG 9002)
Date Let: 04-19-13 Call: 425 County: Various District: 04
NBI Structure Number: 115B00041L and 115B00041R
Existing structure type-main: continuous steel stringer/multi-beam or girder (NBI Item 43=402)
Area each bridge: 18,123 ft^2 (1,683.7 m^2)

	Total Removal Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	250,000.00	6.90 (74.27)
Bidder 2	210,000.00	5.79 (62.32)
Bidder 3	70,000.00	1.93 (20.77)

The following project was not used in the cost analysis for deck removal because the structure type is adjacent prestressed concrete box beams. The different structural configuration results in removal conditions that are different than a slab on beam structure. Therefore these costs were not considered to be appropriate for this study.

Bridge Deck Restoration & Waterproofing Robertson County KY 165 and KY 616
Date Let: 08-16-13 Call: 410 County: Robertson District: 06
NBI Structure Number: 101B00018N
Existing structure type-main: prestressed concrete box beam or girders - multiple (NBI Item 43=505)
Area: 5,910 ft^2 (549.1 m^2)

	Total Removal Items, \$	Unit Cost, \$/ft^2 (\$/m^2)
Bidder 1	20,000.00	3.38 (36.36)
Bidder 2	55,000.00	9.31 (100.21)
Bidder 3	50,000.00	8.46 (91.06)
Bidder 4	86,000.00	14.55 (156.61)
Bidder 5	100,000.00	16.92 (182.12)
Bidder 6	115,000.00	19.46 (209.46)
Bidder 7	99,168.81	16.78 (177.39)

Bridge Rail Retrofits

The cost analysis for bridge rail retrofit with thrie beam included the following bid items:

- Guardrail Thrie Beam
- Thrie Beam to W Beam Connector

The calculated unit costs are summarized in Table C.6.

Table C.6-Thrie beam retrofit costs summary

Cost Analysis Case	n	Unit Costs, $/ft ($/m)	
		Mean	Standard Deviation
Excluding $180.00/ft ($590.55/m) unit cost	5	76.99 (252.59)	14.52 (47.64)
All costs included	6	94.16 (308.92)	44.01 (144.39)

The following are summaries of unit costs for the projects used in the analysis.

Guardrail Russell - Greenup (US 23)
Date Let: 06-14-13 Call: 202 County: Greenup District: 09

Unit Cost-Thrie Beam Retrofit		
Item	Bidder 1	Bidder 2
Guardrail Thrie Beam, $/ft ($/m)	28.75 (94.32)	100.00 (328.08)
Thrie Beam to W Beam Connector, $/each	400.00	500.00

Divide the cost of one connector by its length, 6.25 feet (1.91 m) to get an equivalent cost per length and add to the thrie beam cost. These costs were used in the analysis.

Unit Cost-Thrie Beam Retrofit, $/ft ($/m)	
Bidder 1	Bidder 2
100.75 (330.54)	180.00 (590.55)

Asphalt Rehab with Bridge(s) Louisville-Cincinnati Road (1-71)
Date Let: 09-27-13 Call: 200 County: Henry District: 05

Unit Cost-Thrie Beam Retrofit, $/ft ($/m)*			
Bidder 1	Bidder 2	Bidder 3	Bidder 4
65.00 (213.25)	80.71 (264.80)	70.00 (229.66)	68.50 (224.74)

*Includes connectors to W beam rail

APPENDIX D: MAINTENANCE OF TRAFFIC COSTS

Appendix D contains summaries of bid items and costs for maintenance of traffic (MOT) during the following:

- Bridge construction
- Bridge deck restoration

Maintenance of Traffic-Bridge Construction

The analysis of maintenance of traffic (MOT) costs calculated the percentage of the total contract amount that was bid for MOT items. The analysis included the following MOT bid items:

- Arrow Panel
- Barricade-Type III
- Concrete Median Barrier Type 9C2
- Concrete Barrier Wall Type 9T
- Crash Cushion TY VI Class B TL2
- Crash Cushion TY VI Class B TL3
- Crash Cushion TY VI Class BT TL2
- Crash Cushion TY VI Class BT TL3
- Crash Cushion Type IX-A
- Creek Crossing
- Diversions (By-Pass Detours)
- Install Temp Concrete Med Barrier
- Lane Closure
- Law Enforcement Officer
- Maintain & Control Traffic
- Pave Mark Temp Paint Stop Bar-24 in
- Pave Striping-Temp Paint-12 in
- Pave Striping-Temp Paint-4 in
- Pave Striping-Temp Paint-6 in
- Pave Striping-Temp Rem Tape-B
- Pave Striping-Temp Rem Tape-W
- Pave Striping-Temp Rem Tape-Y
- Pavement Marker Type IVA-BY Temp
- Pavement Marker Type IVA-MY Temp
- Portable Changeable Message Sign
- Relocate Concrete Barrier Wall
- Relocate Crash Cushion
- Relocate Temp Concrete Barrier
- Signs
- Temp Concrete Med Barrier
- Temp Crash Cushion
- Temp Guardrail
- Temp Median Crossover
- Temp Signal
- Temp Signal 2 Phase
- Temporary Signs
- Tubular Markers

Not all items were used on every project. The results of the analysis are summarized in Table D1.

Table D1-Maintenance of traffic analysis summary bridge replacement

Analysis Case	n	Mean	Standard Deviation
Precast PC I beams	114	3.41%	2.77%
Precast PC box beams	133	3.12%	3.55%
RC culvert	3	16.27%	2.23%
All types	250	3.41%	3.50%

The following are summaries of MOT percentages for each project used in the analysis.

Bridge with Grade, Drain & Surface Brown Badgett Loop (CR 1092)
Date Let: 01-25-13 Call: 103 County: Hopkins District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	9,543.62	1,805,945.22	0.53
Bidder 2	7,601.00	1,899,850.23	0.40
Bidder 3	12,684.00	1,944,512.77	0.65
Bidder 4	12,453.00	1,988,759.09	0.63
Bidder 5	12,684.00	2,146,221.90	0.59
Bidder 6	111,060.00	2,656,235.33	4.18

Grade, Drain & Surface with Bridge Georgetown Northwest Bypass
Date Let: 04-19-13 Call: 101 County: Scott District: 07

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	153,547.81	12,989,572.70	1.18
Bidder 2	221,160.49	13,527,266.37	1.63
Bidder 3	177,774.40	13,566,463.38	1.31
Bidder 4	186,733.20	13,665,008.63	1.37
Bidder 5	177,984.10	13,782,220.09	1.29
Bidder 6	133,770.00	14,225,780.57	0.94

Grade, Drain & Surface with Bridge Hooker Branch Road (CR 1276)
Date Let: 07-12-13 Call: 366 County: Clay District: 11

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	32,661.60	1,905,366.71	1.71
Bidder 2	26,871.20	2,021,640.81	1.33
Bidder 3	20,575.20	2,068,642.54	0.99
Bidder 4	40,527.20	2,238,985.14	1.81
Bidder 5	80,670.00	2,822,095.55	2.86

Bridge with Grade, Drain & Surface Dahl Road (KY 1677)
Date Let: 08-16-13 Call: 106 County: Pulaski District: 08

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	9,044.00	796,767.60	1.14
Bidder 2	9,908.00	839,199.35	1.18
Bidder 3	38,568.00	875,900.00	4.40
Bidder 4	12,552.00	909,134.52	1.38
Bidder 5	6,650.00	932,078.86	0.71

Bridge with Grade, Drain & Surface KY 476
Date Let: 09-27-13 Call: 105 County: Perry District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	100,277.50	1,422,535.50	7.05
Bidder 2	53,736.50	1,575,056.78	3.41
Bidder 3	173,204.50	1,854,347.34	9.34
Bidder 4	149,230.50	1,915,908.17	7.79
Bidder 5	189,861.71	1,952,550.75	9.72

Grade, Drain & Surface with Bridge Kuttawa-Princeton Road (US 62)
Date Let: 09-27-13 Call: 317 County: Lyon District: 01

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	301,754.84	14,869,588.01	2.03
Bidder 2	389,724.40	17,448,243.17	2.23

Bridge Replacement Stanton-Slade Road (KY 11)
Date Let: 11-22-13 Call: 104 County: Powell District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	75,300.80	895,095.49	8.41
Bidder 2	72,917.00	982,594.15	7.42
Bidder 3	92,366.80	997,701.81	9.26
Bidder 4	188,700.80	1,332,867.48	14.16

Bridge with Grade, Drain & Surface Beaver Dam - Leitchfield Road (US 62)
Date Let: 11-22-13 Call: 106 County: Ohio District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	2,724.00	849,506.11	0.32
Bidder 2	4,724.00	979,852.08	0.48
Bidder 3	2,116.00	986,670.88	0.21
Bidder 4	2,944.00	998,489.59	0.29
Bidder 5	10,344.00	1,071,853.80	0.97

Bridge with Grade, Drain & Surface Glomawr to Hazard Road (KY 451)
Date Let: 11-22-13 Call: 108 County: Perry District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	23,360.62	2,535,118.11	0.92
Bidder 2	23,142.70	2,670,259.63	0.87
Bidder 3	28,673.50	3,005,043.64	0.95
Bidder 4	50,820.70	3,775,000.00	1.35

Bridge with Grade, Drain & Surface Buffalo Branch Road (CR-1327)
Date Let: 11-22-13 Call: 111 County: Bell District: 11

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	15,100.00	475,850.00	3.17
Bidder 2	8,500.00	504,497.78	1.68
Bidder 3	7,600.00	534,380.10	1.42
Bidder 4	33,300.00	613,600.97	5.43

Grade, Drain & Surface with Bridge Gratz-Moxley Road (KY-355)
Date Let: 12-13-13 Call: 106 County: Owen District: 06

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	89,514.50	1,546,652.16	5.79
Bidder 2	94,190.50	1,623,700.00	5.80
Bidder 3	87,014.50	1,625,648.35	5.35
Bidder 4	111,085.50	1,750,662.02	6.35
Bidder 5	154,514.50	1,769,334.22	8.73
Bidder 6	120,926.50	1,839,724.00	6.57
Bidder 7	110,006.56	1,860,657.00	5.91
Bidder 8	189,014.50	1,870,341.94	10.11
Bidder 9	185,400.00	2,045,723.25	9.06

Grade & Drain with Bridge Partridge to Oven Fork Road (US 119, Section 3B)
Date Let: 12-13-13 Call: 113 County: Letcher District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	4,420.00	7,578,221.53	0.06
Bidder 2	3,294.00	7,754,235.24	0.04
Bidder 3	9,548.96	7,880,422.72	0.12
Bidder 4	12,780.00	9,192,686.00	0.14

Grade, Drain & Surface with Bridge US-68 and Louie B. Nunn Parkway
Date Let: 12-13-13 Call: 306 County: Metcalfe District: 03

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	391,503.25	9,682,936.69	4.04
Bidder 2	358,121.89	10,053,930.28	3.56
Bidder 3	614,784.71	10,074,064.58	6.10

Grade, Drain & Surface with Bridge New Moody Lane-Commerce Parkway (New Route)
Date Let: 12-13-13 Call: 307 County: Oldham District: 05

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	62,870.56	9,129,000.00	0.69
Bidder 2	142,196.00	9,484,979.49	1.50
Bidder 3	191,239.56	9,500,000.00	2.01
Bidder 4	152,561.80	9,550,564.42	1.60
Bidder 5	135,333.60	9,569,595.94	1.41
Bidder 6	120,497.35	9,916,269.92	1.22
Bidder 7	198,691.03	10,272,238.97	1.93
Bidder 8	188,126.78	10,838,290.31	1.74

Grade, Drain & Surface with Bridge Morgantown Road (KY 79)
Date Let: 01-24-14 Call: 313 County: Logan District: 03

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	226,205.00	3,698,030.22	6.12
Bidder 2	242,151.00	4,129,147.14	5.86
Bidder 3	251,134.56	4,184,763.00	6.00

Bridge with Grade, Drain & Surface Frenchburg to Owingsville Road (KY 36)
Date Let: 06-27-14 Call: 109 County: Menifee District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	37,210.00	1,030,975.29	3.61
Bidder 2	54,188.00	1,135,135.26	4.77
Bidder 3	38,613.00	1,252,303.33	3.08
Bidder 4	78,624.14	1,261,739.43	6.23
Bidder 5	49,520.00	1,269,226.50	3.90
Bidder 6	122,342.00	1,296,794.87	9.43
Bidder 7	70,970.00	1,556,668.07	4.56

Bridge Replacement Rye Branch Road (CR 1756)
Date Let: 07-11-14 Call: 108 County: Magoffin District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	11,960.00	353,862.26	3.38
Bidder 2	13,424.00	360,631.06	3.72
Bidder 3	13,080.00	401,434.99	3.26

Bridge with Grade, Drain & Surface Hazard-Hyden Road (KY-80)
Date Let: 07-11-14 Call: 113 County: Perry District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	135,085.80	4,277,564.72	3.16
Bidder 2	219,865.80	4,863,809.42	4.52
Bidder 3	134,235.80	5,457,242.25	2.46
Bidder 4	188,169.80	5,509,665.31	3.42

Bridge with Grade, Drain & Surface Tennessee State Line-Elizabethtown Road (I-65)
Date Let: 08-22-14 Call: 200 County: Hart District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	5,022,849.79	138,485,749.39	3.63
Bidder 2	7,612,965.54	144,700,000.00	5.26

Bridge with Grade, Drain & Surface KY-49
Date Let: 08-22-14 Call: 313 County: Marion District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	253,032.00	6,563,341.37	3.86
Bidder 2	227,647.00	7,142,390.72	3.19
Bidder 3	227,212.00	7,625,000.00	2.98

The following prestressed I-beam projects were included in the analysis of MOT costs but not in the analysis of replacement costs because bridge area data was not available.

Grade, Drain & Surface with Bridge Morgantown Road (KY 79)
Date Let: 12-13-13 Call: 300 County: Logan District: 03

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	272,151.00	4,198,460.80	6.48
Bidder 2	303,197.00	4,240,001.19	7.15

Bridge with Grade, Drain & Surface Oscar Bowling Road (CR 1113A)
Date Let: 09-26-14 Call: 104 County: Clay District: 11

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	90,225.00	1,345,000.00	6.71
Bidder 2	90,534.86	1,429,391.95	6.33

Grade, Drain & Surface with Bridge Kenneth Barrett Road (KY 30)
Date Let: 09-26-14 Call: 112 County: Owsley District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	70,995.84	3,916,594.89	1.81
Bidder 2	51,745.84	4,103,166.10	1.26
Bidder 3	112,645.84	4,359,000.00	2.58
Bidder 4	67,090.12	4,363,986.66	1.54
Bidder 5	108,455.74	4,553,738.21	2.38

Bridge with Grade, Drain & Surface Booneville-Jackson Road (KY 30)
Date Let: 09-26-14 Call: 113 County: Breathitt District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	100,055.30	3,141,110.54	3.19
Bidder 2	117,229.20	3,898,353.71	3.01
Bidder 3	182,311.30	4,373,538.22	4.17
Bidder 4	257,401.30	5,045,000.00	5.10

Grade & Drain with Bridge Simpsonville - Buck Creek Road (KY 1848)
Date Let: 10-24-14 Call: 118 County: Shelby District: 05

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	145,595.72	7,964,000.00	1.83
Bidder 2	135,013.72	8,193,500.00	1.65
Bidder 3	203,235.72	8,400,000.00	2.42
Bidder 4	90,504.82	8,443,035.77	1.07
Bidder 5	159,505.72	8,982,600.00	1.78

Bridge Replacement Hemp Patch Branch Road (CR-1002)
Date Let: 10-24-14 Call: 302 County: Knott District: 12
Proposal Description: FD04 SPP 060 1002 000-001

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	13,876.00	578,922.34	2.40
Bidder 2	19,232.50	582,948.64	3.30
Bidder 3	19,311.00	652,000.00	2.96
Bidder 4	13,826.00	687,400.70	2.01

The following projects were included in the analysis of MOT costs but not in the analysis of replacement costs because the bridge type was prestressed concrete box beam.

Bridge with Grade, Drain & Surface Fulton-Fulgham Road (KY 307)
Date Let: 03-22-13 Call: 104 County: Hickman District: 01

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	180,652.00	4,785,770.00	3.77
Bidder 2	675,325.10	7,999,354.11	8.44

Asphalt Rehab with Bridge(s) Martha Layne Collins Parkway (BG 9002)
Date Let: 04-19-13 Call: 425 County: Various District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	1,052,014.43	15,274,318.78	6.89
Bidder 2	870,315.75	16,440,000.00	5.29
Bidder 3	562,969.98	16,645,000.00	3.38

Bridge with Grade, Drain & Surface Low Water Drive (CR 1336)
Date Let: 05-24-13 Call: 352 County: Harlan District: 11

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	23,529.00	1,099,520.97	2.14
Bidder 2	25,453.00	1,115,808.16	2.28
Bidder 3	26,786.00	1,303,490.78	2.05
Bidder 4	37,464.00	1,393,334.07	2.69

Bridge with Grade, Drain & Surface Ray Road (CR 1060)
Date Let: 07-12-13 Call: 200 County: Daviess District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	4,332.00	506,417.49	0.86
Bidder 2	7,232.00	510,474.97	1.42
Bidder 3	9,199.20	585,581.00	1.57
Bidder 4	13,322.50	651,335.09	2.05
Bidder 5	14,732.00	679,247.20	2.17

Bridge with Grade, Drain & Surface Huddy-Mcveigh Road (KY 199)
Date Let: 08-16-13 Call: 103 County: Pike District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	4,063.00	921,425.55	0.44
Bidder 2	17,963.00	1,071,105.92	1.68
Bidder 3	37,467.80	1,197,516.40	3.13
Bidder 4	34,954.50	1,302,471.50	2.68

Bridge with Grade & Drain Bridge Connector
Date Let: 08-16-13 Call: 344 County: Martin District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	3,228.00	803,709.59	0.40
Bidder 2	10,535.00	881,765.54	1.19
Bidder 3	7,785.00	892,137.20	0.87

Bridge with Grade, Drain & Surface Wilson Creek Bridge (KY 945)
Date Let: 09-27-13 Call: 101 County: Graves District: 01

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	13,966.72	1,061,739.37	1.32
Bidder 2	12,320.00	1,181,273.31	1.04
Bidder 3	10,648.80	1,283,145.52	0.83
Bidder 4	9,049.00	1,298,504.00	0.70

Bridge Replacement East Union-Carlisle Road (KY-1285)
Date Let: 09-27-13 Call: 102 County: Nicholas District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	10,160.00	844,352.00	1.20
Bidder 2	10,236.00	851,117.74	1.20
Bidder 3	12,993.00	908,062.62	1.43
Bidder 4	15,532.00	982,293.27	1.58
Bidder 5	13,312.80	999,561.89	1.33
Bidder 6	13,936.00	1,027,542.18	1.36

Bridge Replacement KY-502
Date Let: 09-27-13 Call: 111 County: Hopkins District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	37,617.53	1,496,471.40	2.51
Bidder 2	4,252.00	1,534,048.98	0.28
Bidder 3	8,352.00	1,819,794.55	0.46

Bridge Replacement Anthoston-Niagara Road (KY-136)
Date Let: 10-25-13 Call: 109 County: Henderson District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	3,120.00	644,680.18	0.48
Bidder 2	2,920.00	695,836.16	0.42
Bidder 3	4,480.00	705,464.54	0.64
Bidder 4	7,100.00	713,383.91	1.00
Bidder 5	12,220.00	835,597.95	1.46

Bridge with Grade, Drain & Surface Gray-Indian Creek Road (KY 3437)
Date Let: 11-22-13 Call: 105 County: Knox District: 11

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	5,600.00	629,053.34	0.89
Bidder 2	7,790.00	630,903.09	1.23
Bidder 3	21,850.00	729,500.00	3.00

Bridge with Grade, Drain & Surface Sedalia to Mayfield Road (KY 79)
Date Let: 11-22-13 Call: 107 County: Graves District: 01

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	4,015.25	903,300.00	0.44
Bidder 2	12,027.85	906,572.53	1.33
Bidder 3	12,442.75	958,903.34	1.30

Bridge with Grade, Drain & Surface Baizetown-Windy Hill Road (KY 505 over Western KY Parkway)
Date Let: 12-13-13 Call: 402 County: Ohio District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	37,696.40	1,297,816.47	2.90
Bidder 2	25,000.40	1,326,690.97	1.88
Bidder 3	45,856.40	1,374,382.90	3.34
Bidder 4	166,762.40	1,758,287.84	9.48

Bridge with Grade, Drain & Surface KY 1505
Date Let: 01-24-14 Call: 101 County: Rockcastle District: 08

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	31,500.00	540,750.00	5.83
Bidder 2	36,125.00	555,019.67	6.51
Bidder 3	52,500.00	598,439.48	8.77
Bidder 4	24,332.50	620,293.57	3.92
Bidder 5	38,967.37	630,366.97	6.18
Bidder 6	41,958.33	741,746.41	5.66

Bridge Replacement Daniel Boone Drive (KY-11)
Date Let: 01-24-14 Call: 301 County: Knox District: 11

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	35,173.00	2,649,044.01	1.33
Bidder 2	31,068.00	2,658,452.65	1.17
Bidder 3	68,001.50	3,412,908.31	1.99

Bridge Replacement Pacies Branch Road (CR 1245)
Date Let: 03-28-14 Call: 112 County: Letcher District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	8,484.00	437,088.88	1.94
Bidder 2	5,304.52	530,009.43	1.00

Bridge Replacement Bloomfield Road (US 62)
Date Let: 04-25-14 Call: 105 County: Nelson District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	8,039.98	410,219.97	1.96
Bidder 2	10,170.00	473,997.78	2.15
Bidder 3	5,066.00	499,559.32	1.01
Bidder 4	8,866.00	558,843.58	1.59

Bridge with Grade, Drain & Surface Outland School Road (KY-1536)
Date Let: 05-30-14 Call: 103 County: Calloway District: 01

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	7,933.05	564,752.04	1.40
Bidder 2	2,292.00	589,089.00	0.39
Bidder 3	8,728.00	704,451.63	1.24

Bridge Replacement Tousey Road (CR 1872) over Spring Fork
Date Let: 05-30-14 Call: 108 County: Grayson District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	1,500.00	247,414.14	0.61
Bidder 2	2,500.00	259,974.76	0.96
Bidder 3	6,000.00	395,717.51	1.52

Bridge with Grade & Drain Stinson Road (CR-1700)
Date Let: 05-30-14 Call: 109 County: Wayne District: 08

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	52,220.00	584,268.40	8.94

Bridge Replacement Elk Lick Creek Road (CR 1224)
Date Let: 05-30-14 Call: 110 County: Lee District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	8,200.00	189,220.42	4.33
Bidder 2	41,500.00	224,848.10	18.46
Bidder 3	43,500.00	227,910.54	19.09
Bidder 4	1,000.00	243,728.50	0.41

Bridge with Grade, Drain & Surface KY 32 over Seas Branch
Date Let: 06-27-14 Call: 110 County: Rowan District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	53,455.00	907,243.52	5.89
Bidder 2	75,786.00	996,876.68	7.60
Bidder 3	82,792.00	1,112,225.48	7.44
Bidder 4	78,021.83	1,168,146.31	6.68
Bidder 5	173,902.00	1,218,490.41	14.27
Bidder 6	115,602.00	1,219,772.95	9.48
Bidder 7	191,902.75	1,222,250.96	15.70
Bidder 8	237,593.00	1,379,104.73	17.23

Bridge with Grade, Drain & Surface Lower Johns Creek Road (KY-194)
Date Let: 06-27-14 Call: 207 County: Floyd District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	22,350.00	798,175.52	2.80

Bridge Replacement Hacker Branch Road (CR-1136)
Date Let: 07-11-14 Call: 107 County: Owsley District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	10,000.00	908,735.60	1.10
Bidder 2	1,000.00	931,183.89	0.11
Bidder 3	32,500.00	1,104,653.07	2.94

Bridge with Grade, Drain & Surface Kg Estates Road (CR 1162)
Date Let: 07-11-14 Call: 109 County: Lawrence District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	28,145.00	697,491.87	4.04
Bidder 2	16,430.00	720,475.28	2.28

Bridge with Grade & Drain Stinson Road (CR-1700)
Date Let: 07-11-14 Call: 115 County: Wayne District: 08

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	28,915.00	366,965.44	7.88
Bidder 2	25,636.00	381,161.00	6.73
Bidder 3	22,020.00	498,981.95	4.41

Bridge with Grade, Drain & Surface Morehead-Grayson Road (US-60)
Date Let: 08-22-14 Call: 106 County: Rowan District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	82,033.96	1,777,455.92	4.62
Bidder 2	104,643.84	1,958,099.72	5.34
Bidder 3	100,088.80	2,040,112.57	4.91
Bidder 4	170,591.96	2,054,367.03	8.30

Bridge Replacement Glasgow Street (CS 1053)
Date Let: 08-22-14 Call: 107 County: Metcalfe District: 03

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	1,975.00	889,251.56	0.22
Bidder 2	1,735.00	935,417.89	0.19
Bidder 3	22,995.00	1,046,509.65	2.20
Bidder 4	6,626.57	1,162,102.31	0.57

Bridge Replacement Mobley Mill Road (CR 1327)
Date Let: 08-22-14 Call: 108 County: Nelson District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	3,422.00	326,336.65	1.05
Bidder 2	1,684.00	379,489.78	0.44
Bidder 3	3,186.00	385,347.04	0.83
Bidder 4	3,642.74	401,845.35	0.91

Bridge with Grade, Drain & Surface Upper Wolf Creek Road (CR 1134)
Date Let: 08-22-14 Call: 109 County: Owsley District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	6,172.50	688,250.58	0.90
Bidder 2	8,030.00	727,788.73	1.10
Bidder 3	9,222.50	746,698.10	1.24

Bridge with Grade & Drain Curtis Road (CR 1226)
Date Let: 08-22-14 Call: 111 County: Boyle District: 07

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	4,286.00	503,216.38	0.85
Bidder 2	5,522.12	592,950.97	0.93

Bridge Replacement Hade Bell Road (CR 1167)
Date Let: 09-26-14 Call: 116 County: Allen District: 03

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	2,270.00	356,355.71	0.64
Bidder 2	2,988.50	385,855.52	0.77

Bridge with Grade, Drain & Surface Wildie Road (CR-1071)
Date Let: 09-26-14 Call: 117 County: Rockcastle District: 08

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	17,750.00	543,590.31	3.27
Bidder 2	14,308.75	556,335.00	2.57
Bidder 3	9,985.89	567,949.77	1.76

Bridge with Grade, Drain & Surface Kg Estates Road (CR 1162)
Date Let: 09-26-14 Call: 118 County: Lawrence District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	35,262.00	718,909.19	4.90
Bidder 2	16,430.00	720,817.89	2.28

Bridge with Grade, Drain & Surface 10th Street (KY-2386)
Date Let: 09-26-14 Call: 306 County: Whitley District: 11

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	60,899.00	2,568,000.00	2.37
Bidder 2	21,053.00	2,717,624.63	0.77

Bridge Replacement Pryorsburg to Dublin Road (KY 1748)
Date Let: 10-24-14 Call: 108 County: Graves District: 01

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	3,960.00	499,248.06	0.79
Bidder 2	3,748.00	593,808.00	0.63
Bidder 3	14,916.00	628,858.68	2.37
Bidder 4	12,912.00	774,376.54	1.67

Bridge with Grade, Drain & Surface Upper Wolf Creek Road (CR 1134)
Date Let: 10-24-14 Call: 110 County: Owsley District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	17,822.50	560,100.00	3.18
Bidder 2	16,172.50	688,781.91	2.35
Bidder 3	17,522.50	696,905.94	2.51
Bidder 4	20,130.00	721,464.81	2.79
Bidder 5	25,964.00	909,200.91	2.86

Bridge Replacement Wildie Road (CR 1071)
Date Let: 10-24-14 Call: 111 County: Rockcastle District: 08

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	12,697.50	472,350.00	2.69
Bidder 2	12,457.00	500,851.70	2.49
Bidder 3	17,047.50	504,868.57	3.38
Bidder 4	9,097.50	543,018.80	1.68
Bidder 5	15,956.97	577,334.24	2.76

Grade & Drain with Asphalt Surface Chalybeate School Road (KY 743)
Date Let: 10-24-14 Call: 304 County: Edmonson District: 03

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	96,199.09	3,297,310.97	2.92

The following project was included in the analysis of MOT costs but not in the analysis of replacement costs because the bridge type was reinforced concrete box culvert.

Grade & Drain with Bridge KY 343
Date Let: 09-26-14 Call: 119 County: Letcher District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	70,714.00	504,849.77	14.01
Bidder 2	85,769.00	524,724.15	16.35
Bidder 3	110,456.00	598,309.85	18.46

Maintenance of Traffic-Bridge Deck Restoration

The analysis of maintenance of traffic (MOT) costs calculated the percentage of the total contract amount that was bid for MOT items. The analysis included the following MOT bid items:

- Arrow Panel
- Barricade-Type III
- Concrete Barrier Wall Type 9T
- Crash Cushion Type VI Class B TL2
- Crash Cushion Type VI Class B TL3
- Crash Cushion Type VI Class BT TL3
- Install Temp Crash Cushion
- Lane Closure
- Law Enforcement Officer
- Maintain & Control Traffic
- Pave Striping-Temp Paint-4 in
- Pave Striping-Temp Paint -6 in
- Pave Striping-Temp Rem Tape -B
- Pave Striping-Temp Rem Tape -W
- Pave Striping-Temp Rem Tape-Y
- Pavement Marker Type IVA-MW Temp
- Pavement Marker Type IVA-MY Temp
- Pavement Marker Type V-B W/R
- Police Officer with Vehicle
- Portable Changeable Message Sign
- Relocate Crash Cushion
- Relocate Temp Concrete Barrier
- Relocate Water-Filled Barriers
- Remove Pavement Marker Type V
- Signs
- Temp Concrete Median Barrier
- Temp Crash Cushion
- Temp Signal 2 Phase
- Temp Signal Multi Phase
- Temporary Signs
- Truck Mounted Attenuator
- Water-Filled Barriers

Not all items were used on every project. The results of the analysis are summarized in Table D2.

Table D2-Maintenance of traffic analysis summary bridge deck restoration

Analysis Case	n	Mean	Standard Deviation
MOT < 30%	270	14.19%	6.10%
MOT < 35%	276	14.46%	6.46%
MOT < 40%	280	14.75%	6.87%
All	283	15.12%	7.73%

The following are summaries of MOT percentages for each project used in the analysis.

Bridge Deck Overlay Butler County (WN 9007)
Date Let: 01-25-13 Call: 317 County: Butler District: 03

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	64,760.00	342,714.00	18.90
Bidder 2	68,945.00	352,658.20	19.55
Bidder 3	61,800.00	359,799.24	17.18
Bidder 4	81,200.00	370,450.00	21.92
Bidder 5	55,700.00	394,259.03	14.13
Bidder 6	77,150.00	417,997.30	18.46
Bidder 7	73,900.00	497,065.00	14.87

Bridge Deck Restoration & Waterproofing Interstate 64
Date Let: 02-22-13 Call: 100 County: Jefferson District: 05

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	71,995.00	326,889.00	22.02
Bidder 2	101,995.00	348,000.00	29.31
Bidder 3	78,797.00	348,000.00	22.64
Bidder 4	99,245.00	372,488.52	26.64
Bidder 5	85,095.00	390,520.70	21.79
Bidder 6	127,682.00	411,888.53	31.00

Bridge Deck Restoration & Waterproofing Campbell County (KY 9)
Date Let: 02-22-13 Call: 311 County: Campbell District: 06

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	59,300.00	584,185.49	10.15
Bidder 2	62,050.00	608,000.00	10.21
Bidder 3	101,010.00	688,574.00	14.67
Bidder 4	56,800.00	693,950.26	8.19
Bidder 5	65,700.00	718,203.86	9.15
Bidder 6	108,950.00	749,910.42	14.53

Bridge Deck Restoration & Waterproofing Bridge over North Fork of Triplett Creek
Date Let: 03-22-13 Call: 332 County: Rowan District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	29,343.00	179,566.50	16.34
Bidder 2	21,746.00	195,140.54	11.14
Bidder 3	70,192.00	205,016.10	34.24
Bidder 4	53,540.00	246,550.62	21.72
Bidder 5	22,895.00	273,178.03	8.38

Bridge Deck Restoration & Waterproofing Wayne & McCreary Cos. Bridge Overlays and Joint Replacements
Date Let: 03-22-13 Call: 434 County: Various District: 08

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	60,990.00	384,878.62	15.85
Bidder 2	105,360.00	422,043.30	24.96
Bidder 3	134,060.00	465,063.70	28.83
Bidder 4	80,560.00	480,000.00	16.78
Bidder 5	106,020.00	504,400.09	21.02
Bidder 6	49,380.00	549,869.87	8.98

Bridge Deck Overlay Hancock County
Date Let: 04-19-13 Call: 406 County: Hancock District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	49,725.00	366,602.53	13.56
Bidder 2	49,607.50	373,503.52	13.28
Bidder 3	27,040.00	407,319.32	6.64
Bidder 4	82,140.00	444,000.00	18.50
Bidder 5	43,840.00	447,250.00	9.80

Bridge Deck Restoration & Waterproofing New Circle Road Bridges
Date Let: 04-19-13 Call: 426 County: Fayette District: 07

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	269,204.00	1,757,032.16	15.32
Bidder 2	245,660.00	1,893,755.14	12.97
Bidder 3	248,284.00	1,984,735.50	12.51
Bidder 4	261,120.00	2,124,203.61	12.29

Bridge Deck Restoration & Waterproofing Bridge over Levisa Fork of Big Sandy
Date Let: 05-24-13 Call: 369 County: Floyd District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	50,434.00	493,286.00	10.22
Bidder 2	95,450.00	526,038.00	18.15
Bidder 3	101,238.00	649,803.01	15.58
Bidder 4	87,280.00	669,866.57	13.03
Bidder 5	107,490.00	740,600.00	14.51
Bidder 6	97,990.00	757,058.15	12.94

Bridge Deck Overlay KY 838 Crittenden and Livingston Countys
Date Let: 05-24-13 Call: 406 County: Various District: 01

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	4,200.00	362,587.65	1.16
Bidder 2	50,400.00	390,826.36	12.90
Bidder 3	6,900.00	393,250.60	1.75
Bidder 4	10,500.00	398,000.00	2.64
Bidder 5	32,500.00	511,946.72	6.35

Bridge Deck Restoration & Waterproofing KY 80 over KY 9006
Date Let: 05-24-13 Call: 420 County: Clay District: 11

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	82,197.00	514,214.72	15.98
Bidder 2	108,944.00	597,925.53	18.22
Bidder 3	125,890.00	648,249.05	19.42
Bidder 4	130,410.00	718,400.00	18.15
Bidder 5	129,874.00	730,391.97	17.78
Bidder 6	160,660.00	739,593.00	21.72
Bidder 7	114,580.00	755,823.40	15.16

Bridge Deck Restoration & Waterproofing Bridges over I-64
Date Let: 06-14-13 Call: 201 County: Bath District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	58,310.00	478,001.00	12.20
Bidder 2	66,785.00	499,871.77	13.36
Bidder 3	57,609.50	594,395.18	9.69
Bidder 4	213,729.00	618,439.40	34.56
Bidder 5	59,629.00	621,015.58	9.60
Bidder 6	106,335.00	750,000.00	14.18
Bidder 7	82,599.50	767,220.22	10.77
Bidder 8	96,432.00	776,643.30	12.42
Bidder 9	58,029.00	808,691.81	7.18

Bridge Deck Restoration & Waterproofing I-64 Bridges
Date Let: 08-16-13 Call: 201 County: Franklin District: 05

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	75,589.50	1,006,341.07	7.51
Bidder 2	283,090.00	1,186,067.80	23.87
Bidder 3	198,945.00	1,194,260.00	16.66
Bidder 4	323,727.00	1,279,942.42	25.29
Bidder 5	761,285.00	1,394,080.95	54.61

Bridge Deck Restoration & Waterproofing Robertson County KY 165 and KY 616
Date Let: 08-16-13 Call: 410 County: Robertson District: 06

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	31,468.00	380,405.20	8.27
Bidder 2	22,900.80	397,488.53	5.76
Bidder 3	28,600.80	409,257.75	6.99
Bidder 4	62,867.20	435,829.24	14.42
Bidder 5	69,500.80	458,514.14	15.16
Bidder 6	17,584.20	529,140.17	3.32
Bidder 7	45,059.50	565,000.00	7.98

Bridge Deck Overlay Boone County KY 8 and KY 536--Gallatin County KY 35
Date Let: 08-16-13 Call: 430 County: Various District: 06

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	78,670.00	593,151.55	13.26
Bidder 2	87,635.00	597,553.40	14.67
Bidder 3	91,634.65	625,952.80	14.64
Bidder 4	75,882.00	697,251.99	10.88
Bidder 5	46,226.24	700,000.00	6.60
Bidder 6	36,549.50	808,905.05	4.52

Bridge Deck Overlay Outerloop (KY 1065)
Date Let: 09-27-13 Call: 311 County: Jefferson District: 05

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	81,790.00	679,109.50	12.04
Bidder 2	50,975.00	680,392.00	7.49
Bidder 3	68,590.00	717,403.00	9.56
Bidder 4	44,439.20	731,310.25	6.08
Bidder 5	37,789.75	743,211.00	5.08
Bidder 6	36,784.00	760,025.37	4.84
Bidder 7	68,516.00	775,242.80	8.84
Bidder 8	51,120.00	849,250.00	6.02

Bridge Deck Restoration & Waterproofing KY 1773 Bridge over Grassy Creek
Date Let: 09-27-13 Call: 320 County: Carter District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	8,891.00	242,283.77	3.67
Bidder 2	9,895.00	257,092.50	3.85
Bidder 3	29,235.00	344,865.61	8.48

Bridge Deck Restoration & Waterproofing KY 386 Bridge over McBride Creek
Date Let: 09-27-13 Call: 322 County: Nicholas District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	14,344.00	137,579.93	10.43
Bidder 2	27,493.00	224,740.15	12.23

Bridge Deck Restoration & Waterproofing KY 699 Bridge over Leatherwood Creek
Date Let: 09-27-13 Call: 323 County: Perry District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	19,437.00	243,985.70	7.97
Bidder 2	21,043.00	262,310.69	8.02
Bidder 3	100,960.00	350,782.80	28.78
Bidder 4	115,788.00	364,534.00	31.76

Bridge Deck Restoration & Waterproofing Henderson County KY 285
Date Let: 10-25-13 Call: 301 County: Henderson District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	23,682.00	170,577.14	13.88
Bidder 2	27,777.00	186,466.30	14.90
Bidder 3	17,358.80	197,666.79	8.78
Bidder 4	24,832.00	197,848.32	12.55
Bidder 5	44,338.80	213,857.79	20.73
Bidder 6	24,568.60	234,403.75	10.48

Bridge Deck Restoration & Waterproofing Ohio County KY 1245
Date Let: 10-25-13 Call: 304 County: Ohio District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	22,340.00	149,869.30	14.91
Bidder 2	31,060.00	193,124.60	16.08
Bidder 3	23,720.00	198,321.67	11.96
Bidder 4	27,740.00	209,830.30	13.22
Bidder 5	57,340.00	233,742.30	24.53
Bidder 6	38,480.00	256,924.17	14.98

Bridge Deck Restoration & Waterproofing Union County KY 359
Date Let: 10-25-13 Call: 321 County: Union District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	28,250.00	223,910.80	12.62
Bidder 2	25,885.00	235,092.39	11.01
Bidder 3	45,500.00	278,758.57	16.32
Bidder 4	20,445.00	297,790.24	6.87

Bridge Deck Restoration & Waterproofing Davies County KY 3143, KY 554 and US 431
Date Let: 10-25-13 Call: 400 County: Daviess District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	85,140.00	434,403.28	19.60
Bidder 2	71,228.00	442,867.10	16.08
Bidder 3	56,175.00	465,583.78	12.07
Bidder 4	94,740.00	528,500.61	17.93
Bidder 5	63,940.00	567,292.35	11.27
Bidder 6	93,000.00	593,835.42	15.66
Bidder 7	61,800.00	596,820.69	10.35
Bidder 8	81,580.00	598,420.52	13.63

Bridge Deck Restoration & Waterproofing Bridge Overlays in Powell County
Date Let: 10-25-13 Call: 404 County: Powell District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	56,525.00	375,316.50	15.06
Bidder 2	64,282.00	469,842.80	13.68
Bidder 3	87,476.00	524,175.97	16.69
Bidder 4	120,205.00	593,953.05	20.24
Bidder 5	107,470.00	594,711.55	18.07
Bidder 6	132,576.00	598,866.80	22.14
Bidder 7	103,326.00	659,431.33	15.67
Bidder 8	95,832.00	677,677.00	14.14

Bridge Deck Restoration & Waterproofing District 9 Bridge Overlays
Date Let: 10-25-13 Call: 406 County: Various District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	79,576.00	696,209.67	11.43
Bidder 2	89,866.00	758,915.86	11.84
Bidder 3	182,368.00	779,724.30	23.39
Bidder 4	72,168.00	788,291.30	9.15
Bidder 5	77,676.00	799,161.05	9.72
Bidder 6	145,960.00	864,007.03	16.89
Bidder 7	133,952.00	936,928.70	14.30

Bridge Deck Restoration & Waterproofing Bluegrass Parkway
Date Let: 11-22-13 Call: 304 County: Nelson District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	64,484.00	426,172.22	15.13
Bidder 2	109,692.00	436,411.00	25.14
Bidder 3	83,490.00	446,551.00	18.70
Bidder 4	73,088.00	447,446.00	16.33
Bidder 5	134,450.00	449,101.00	29.94
Bidder 6	72,185.00	468,019.56	15.42
Bidder 7	67,788.00	472,379.21	14.35
Bidder 8	54,980.00	488,396.69	11.26

Bridge Deck Restoration & Waterproofing District 10 Bridge Overlays
Date Let: 11-22-13 Call: 406 County: Various District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	74,460.00	541,924.72	13.74
Bidder 2	152,066.00	570,456.15	26.66
Bidder 3	86,976.00	581,077.16	14.97
Bidder 4	108,580.00	604,617.60	17.96
Bidder 5	76,664.00	645,743.80	11.87
Bidder 6	138,440.00	706,281.46	19.60

Bridge Deck Restoration & Waterproofing Warren County KY 185
Date Let: 12-13-13 Call: 303 County: Warren District: 03

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	79,650.00	669,947.00	11.89
Bidder 2	44,330.00	692,135.65	6.40
Bidder 3	36,300.00	763,848.41	4.75
Bidder 4	74,720.00	767,673.75	9.73
Bidder 5	33,363.00	849,415.39	3.93
Bidder 6	45,320.00	912,467.95	4.97
Bidder 7	44,794.00	1,000,000.00	4.48

Bridge Deck Restoration & Waterproofing District 4 Bridge Overlays
Date Let: 12-13-13 Call: 401 County: Various District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	59,235.00	368,839.00	16.06
Bidder 2	60,735.00	396,670.00	15.31
Bidder 3	62,682.00	399,302.03	15.70
Bidder 4	53,616.00	417,662.60	12.84
Bidder 5	208,425.00	430,319.00	48.43
Bidder 6	50,382.00	446,680.50	11.28
Bidder 7	63,129.00	449,898.19	14.03

Bridge Deck Restoration & Waterproofing Bridge Over Culp Creek Rd
Date Let: 04-25-14 Call: 328 County: Greenup District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	16,422.00	230,410.08	7.13
Bidder 2	17,070.00	233,366.27	7.31
Bidder 3	46,843.00	262,803.00	17.82
Bidder 4	29,480.00	283,913.27	10.38
Bidder 5	17,073.00	296,224.92	5.76

Bridge Deck Restoration & Waterproofing US 31E
Date Let: 04-25-14 Call: 329 County: Nelson District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	21,189.00	261,859.11	8.09
Bidder 2	30,569.00	284,864.23	10.73
Bidder 3	43,019.00	329,124.88	13.07
Bidder 4	27,945.00	333,770.40	8.37

Bridge Deck Restoration & Waterproofing Fleming County Bridge Overlays
Date Let: 04-25-14 Call: 403 County: Fleming District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	35,280.00	240,321.15	14.68
Bidder 2	37,480.00	247,784.25	15.13
Bidder 3	40,638.00	299,849.38	13.55
Bidder 4	36,890.00	356,713.01	10.34
Bidder 5	81,686.00	364,499.00	22.41

Bridge Deck Restoration & Waterproofing Davies County
Date Let: 05-30-14 Call: 352 County: Daviess District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	57,672.50	221,318.20	26.06
Bidder 2	48,150.00	270,483.50	17.80
Bidder 3	84,065.00	289,540.92	29.03
Bidder 4	48,490.00	292,049.93	16.60
Bidder 5	64,900.00	299,695.80	21.66
Bidder 6	73,812.50	301,141.90	24.51

Bridge Deck Restoration & Waterproofing Hopkins
Date Let: 05-30-14 Call: 353 County: Hopkins District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	162,360.00	452,638.55	35.87
Bidder 2	84,650.00	515,926.54	16.41
Bidder 3	98,848.00	523,038.38	18.90
Bidder 4	147,650.00	572,290.30	25.80
Bidder 5	95,400.00	593,655.34	16.07
Bidder 6	122,100.00	606,092.10	20.15

Bridge Deck Restoration & Waterproofing Bridge over Licking River
Date Let: 05-30-14 Call: 354 County: Morgan District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	23,337.00	254,117.63	9.18
Bidder 2	44,969.00	292,315.20	15.38
Bidder 3	19,945.00	310,682.38	6.42
Bidder 4	50,245.00	342,734.60	14.66
Bidder 5	15,245.00	347,619.36	4.39
Bidder 6	86,380.00	366,294.00	23.58

Bridge Deck Restoration & Waterproofing Bridge over Middle Fork of Red River
Date Let: 05-30-14 Call: 355 County: Powell District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	32,817.00	170,621.97	19.23
Bidder 2	38,215.00	190,517.70	20.06
Bidder 3	52,114.00	206,032.16	25.29
Bidder 4	74,470.00	207,388.30	35.91
Bidder 5	36,805.00	258,413.77	14.24

Bridge Deck Restoration & Waterproofing KY 114 Overlays
Date Let: 05-30-14 Call: 440 County: Floyd District: 12

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	55,658.50	366,242.27	15.20
Bidder 2	56,788.00	379,004.56	14.98
Bidder 3	85,488.00	384,729.20	22.22
Bidder 4	61,980.00	391,227.10	15.84
Bidder 5	59,788.00	392,574.19	15.23

Bridge Deck Restoration & Waterproofing Davies County US 231
Date Let: 05-30-14 Call: 444 County: Daviess District: 02

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	93,769.00	460,777.00	20.35
Bidder 2	40,818.00	489,121.41	8.35
Bidder 3	76,760.00	513,202.00	14.96
Bidder 4	115,185.00	529,931.75	21.74
Bidder 5	44,685.00	537,515.98	8.31
Bidder 6	76,276.50	560,926.31	13.60
Bidder 7	97,185.00	583,290.00	16.66

Bridge Deck Restoration & Waterproofing Ballard County
Date Let: 05-30-14 Call: 445 County: Ballard District: 01

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	69,238.00	432,024.60	16.03
Bidder 2	71,605.00	461,404.92	15.52
Bidder 3	81,715.00	493,644.71	16.55
Bidder 4	41,985.00	562,607.51	7.46
Bidder 5	85,747.00	640,602.31	13.39

Bridge Deck Restoration & Waterproofing Bridges over Mountain Parkway
Date Let: 05-30-14 Call: 446 County: Powell District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	55,776.00	487,248.51	11.45
Bidder 2	72,938.00	495,021.80	14.73
Bidder 3	38,138.00	498,217.18	7.65
Bidder 4	43,988.00	522,500.60	8.42
Bidder 5	85,790.00	528,787.40	16.22

Bridge Deck Restoration & Waterproofing Bridge over Wilson Creek
Date Let: 06-27-14 Call: 316 County: Nelson District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	16,925.00	117,467.50	14.41
Bidder 2	20,269.50	163,710.07	12.38
Bidder 3	30,995.00	174,611.50	17.75
Bidder 4	22,490.00	179,482.50	12.53
Bidder 5	19,245.00	209,588.91	9.18

Bridge Deck Restoration & Waterproofing Interstate 64
Date Let: 07-11-14 Call: 100 County: Franklin District: 05

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	189,066.00	787,836.00	24.00
Bidder 2	74,340.00	835,469.00	8.90
Bidder 3	39,533.60	890,676.31	4.44
Bidder 4	77,200.00	923,620.82	8.36
Bidder 5	133,080.00	1,082,629.46	12.29

Bridge Deck Restoration & Waterproofing Bridge Overlays in Harlan County
Date Let: 08-22-14 Call: 435 County: Harlan District: 11

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	85,176.00	791,855.41	10.76
Bidder 2	182,235.00	851,170.40	21.41
Bidder 3	95,826.00	857,545.16	11.17
Bidder 4	281,604.00	950,600.40	29.62

Bridge Deck Restoration & Waterproofing Bridge Overlays in Perry County
Date Let: 08-22-14 Call: 445 County: Perry District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	101,276.00	748,644.42	13.53
Bidder 2	69,788.00	751,375.08	9.29
Bidder 3	87,936.00	822,514.71	10.69
Bidder 4	161,986.00	891,011.70	18.18
Bidder 5	240,890.00	899,935.70	26.77

Bridge Deck Restoration & Waterproofing Bridge over Ohio River
Date Let: 09-26-14 Call: 100 County: Boone District: 06

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	1,059,290.00	6,725,000.00	15.75
Bidder 2	1,550,465.00	8,153,368.39	19.02
Bidder 3	1,059,298.00	8,772,892.82	12.07
Bidder 4	1,419,050.00	8,871,092.00	16.00
Bidder 5	1,770,505.00	9,596,222.00	18.45

Bridge Deck Restoration & Waterproofing Western Kentucky Parkway Bridge Overlays
Date Let: 09-26-14 Call: 404 County: Hardin District: 04

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	156,748.00	735,209.66	21.32
Bidder 2	238,900.00	751,373.00	31.80
Bidder 3	245,226.04	758,000.00	32.35
Bidder 4	151,380.00	795,459.68	19.03
Bidder 5	209,580.00	849,857.00	24.66
Bidder 6	159,584.00	851,503.81	18.74

Bridge Deck Restoration & Waterproofing Bridge over Tygarts Creek
Date Let: 10-24-14 Call: 319 County: Carter District: 09

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	47,300.00	459,533.45	10.29
Bidder 2	38,800.00	497,414.50	7.80
Bidder 3	1,200.00	509,889.52	0.24
Bidder 4	51,300.00	512,384.40	10.01
Bidder 5	4,000.00	562,184.75	0.71
Bidder 6	15,050.00	609,471.66	2.47
Bidder 7	8,300.00	662,378.40	1.25

Bridge Deck Restoration & Waterproofing Bridge Overlays in Wayne County
Date Let: 10-24-14 Call: 403 County: Wayne District: 08

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	87,705.00	389,939.80	22.49
Bidder 2	76,182.00	404,524.40	18.83
Bidder 3	96,049.95	505,884.71	18.99
Bidder 4	62,829.00	514,635.59	12.21
Bidder 5	108,435.00	533,264.15	20.33

The following projects were included in the analysis of MOT costs but not in the analysis of overlay costs because they did not include a latex-modified concrete overlay.

Bridge Deck Restoration & Waterproofing Bridges over Mountain Parkway
Date Let: 06-14-13 Call: 405 County: Wolfe District: 10

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	38,243.00	181,435.80	21.08
Bidder 2	12,245.00	188,366.34	6.50
Bidder 3	49,745.00	240,826.30	20.66
Bidder 4	21,543.00	253,716.31	8.49
Bidder 5	30,170.00	264,780.20	11.39
Bidder 6	32,537.00	313,454.13	10.38
Bidder 7	82,840.00	408,254.16	20.29

Bridge Deck Restoration & Waterproofing Bridge over Harrods Creek
Date Let: 03-28-14 Call: 300 County: Oldham District: 05

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	4,248.00	57,753.20	7.36
Bidder 2	7,246.80	62,622.76	11.57
Bidder 3	10,947.20	83,917.12	13.05

Bridge Deck Restoration & Waterproofing Anderson County US 62 Tyron Bridge
Date Let: 08-22-14 Call: 319 County: Anderson District: 07

	MOT Items ($)	Total Bid, $	MOT Percent
Bidder 1	19,500.00	42,500.00	45.88
Bidder 2	13,500.00	44,500.00	30.34
Bidder 3	9,950.00	53,755.00	18.51
Bidder 4	25,000.00	99,472.18	25.13

APPENDIX E: PROBABILISTIC ANALYSIS

Appendix E contains the risk profile statistics and ascending cumulative probability plots for the following probabilistic analyses:

- Bridge over highway
- Bridge over highway with modified bridge construction time and cost
- Bridge over highway with limited variables
- Bridge over waterway
- Bridge over waterway with modified bridge construction time and cost

Bridge over Highway

Table E.1-Risk profile statistics for highway bridge ADT case 1 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	97,438	1,045,382	794,935	341,131	1,340,918
Maximum	1,900,008	8,127,154	9,416,041	2,117,072	6,808,270	8,115,999
Mean	1,203,146	2,487,246	3,690,392	1,250,889	2,190,694	3,441,584
Std Dev	156,583	1,170,485	1,180,960	175,993	906,419	929,941
Percentile						
1%	872,316	432,429	1,593,222	918,427	612,292	1,782,069
5%	945,174	793,004	1,982,405	989,862	885,351	2,096,983
10%	998,059	1,064,676	2,256,335	1,035,656	1,093,040	2,316,965
15%	1,036,328	1,271,769	2,466,409	1,068,262	1,255,455	2,483,991
20%	1,067,022	1,454,059	2,649,745	1,095,750	1,390,624	2,623,876
25%	1,093,240	1,618,878	2,815,350	1,121,263	1,516,133	2,753,954
30%	1,117,539	1,770,534	2,970,703	1,145,099	1,635,395	2,878,401
35%	1,139,266	1,916,931	3,117,045	1,167,704	1,751,407	2,996,011
40%	1,160,427	2,061,895	3,262,952	1,190,012	1,863,082	3,111,579
45%	1,180,850	2,207,432	3,410,607	1,211,954	1,975,540	3,225,424
50%	1,201,069	2,356,742	3,560,778	1,235,173	2,088,005	3,340,833
55%	1,220,708	2,508,172	3,714,483	1,258,333	2,204,872	3,460,045
60%	1,241,683	2,664,206	3,871,521	1,282,448	2,326,519	3,580,577
65%	1,263,431	2,835,780	4,041,007	1,307,817	2,454,685	3,713,426
70%	1,285,744	3,017,088	4,228,912	1,335,014	2,597,707	3,861,338
75%	1,309,538	3,217,436	4,431,141	1,364,839	2,755,398	4,018,037
80%	1,336,254	3,450,674	4,663,438	1,398,495	2,931,534	4,199,411
85%	1,367,361	3,729,281	4,943,681	1,438,184	3,146,207	4,423,492
90%	1,407,025	4,091,371	5,302,833	1,489,869	3,426,181	4,708,994
95%	1,464,162	4,630,264	5,855,001	1,564,673	3,851,427	5,135,324
99%	1,576,306	5,649,521	6,853,068	1,708,231	4,638,987	5,959,375

Table E.2-Risk profile statistics for highway bridge ADT case 2 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	128,948	1,136,745	794,935	627,597	1,664,219
Maximum	1,900,008	15,913,872	17,202,760	2,117,072	13,417,366	14,725,095
Mean	1,203,146	4,805,013	6,008,159	1,250,889	4,265,064	5,515,954
Std Dev	156,583	2,320,482	2,325,747	175,993	1,798,822	1,813,805
Percentile						
1%	872,316	717,568	1,901,047	918,427	1,125,222	2,332,708
5%	945,174	1,443,603	2,642,581	989,862	1,671,524	2,898,109
10%	998,059	1,983,136	3,180,393	1,035,656	2,084,829	3,321,224
15%	1,036,328	2,396,570	3,596,632	1,068,262	2,406,865	3,643,361
20%	1,067,022	2,758,475	3,954,421	1,095,750	2,681,582	3,919,214
25%	1,093,240	3,084,803	4,282,127	1,121,263	2,926,514	4,168,648
30%	1,117,539	3,387,221	4,588,013	1,145,099	3,163,495	4,409,121
35%	1,139,266	3,676,889	4,879,458	1,167,704	3,393,788	4,639,750
40%	1,160,427	3,962,949	5,165,387	1,190,012	3,617,512	4,864,784
45%	1,180,850	4,251,826	5,453,012	1,211,954	3,838,843	5,088,789
50%	1,201,069	4,548,437	5,748,648	1,235,173	4,062,532	5,315,901
55%	1,220,708	4,846,878	6,052,732	1,258,333	4,294,361	5,541,791
60%	1,241,683	5,156,019	6,361,843	1,282,448	4,533,615	5,783,157
65%	1,263,431	5,495,789	6,697,248	1,307,817	4,789,563	6,041,907
70%	1,285,744	5,854,924	7,063,779	1,335,014	5,073,127	6,329,824
75%	1,309,538	6,249,841	7,462,974	1,364,839	5,385,349	6,640,381
80%	1,336,254	6,711,539	7,923,100	1,398,495	5,734,930	6,995,903
85%	1,367,361	7,267,546	8,474,759	1,438,184	6,161,103	7,429,282
90%	1,407,025	7,981,769	9,191,668	1,489,869	6,718,945	7,990,383
95%	1,464,162	9,050,651	10,266,998	1,564,673	7,559,273	8,831,245
99%	1,576,306	11,077,926	12,262,742	1,708,231	9,125,888	10,418,898

Table E.3-Risk profile statistics for highway bridge ADT case 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	206,437	1,270,059	794,935	1,439,719	2,535,401
Maximum	1,900,008	39,277,797	40,562,914	2,117,072	33,244,654	34,552,383
Mean	1,203,146	11,758,315	12,961,461	1,250,889	10,488,175	11,739,065
Std Dev	156,583	5,771,415	5,773,489	175,993	4,476,565	4,486,264
Percentile						
1%	872,316	1,585,982	2,783,652	918,427	2,666,615	3,888,973
5%	945,174	3,388,038	4,596,383	989,862	4,028,280	5,265,337
10%	998,059	4,738,215	5,943,565	1,035,656	5,062,315	6,312,043
15%	1,036,328	5,764,651	6,972,496	1,068,262	5,861,357	7,103,400
20%	1,067,022	6,673,058	7,878,844	1,095,750	6,550,163	7,791,140
25%	1,093,240	7,486,983	8,680,707	1,121,263	7,160,756	8,400,892
30%	1,117,539	8,239,355	9,437,390	1,145,099	7,749,965	9,001,345
35%	1,139,266	8,958,709	10,156,542	1,167,704	8,321,916	9,568,357
40%	1,160,427	9,664,707	10,869,362	1,190,012	8,876,822	10,121,179
45%	1,180,850	10,383,858	11,589,573	1,211,954	9,429,836	10,679,482
50%	1,201,069	11,119,865	12,320,279	1,235,173	9,985,899	11,237,070
55%	1,220,708	11,863,936	13,067,967	1,258,333	10,562,750	11,808,288
60%	1,241,683	12,631,063	13,832,748	1,282,448	11,155,603	12,406,793
65%	1,263,431	13,470,428	14,672,003	1,307,817	11,793,266	13,040,609
70%	1,285,744	14,373,610	15,569,892	1,335,014	12,496,336	13,756,259
75%	1,309,538	15,351,251	16,561,290	1,364,839	13,276,944	14,523,221
80%	1,336,254	16,498,176	17,708,920	1,398,495	14,145,345	15,395,228
85%	1,367,361	17,884,613	19,086,306	1,438,184	15,206,662	16,465,633
90%	1,407,025	19,656,498	20,859,854	1,489,869	16,592,100	17,853,154
95%	1,464,162	22,317,651	23,537,864	1,564,673	18,687,465	19,951,555
99%	1,576,306	27,340,546	28,539,746	1,708,231	22,573,882	23,859,671

Table E.4-Risk profile statistics for highway bridge ADT case 4 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	690,790	1,806,946	794,935	752,672	1,843,415
Maximum	1,900,008	11,191,076	12,479,963	2,117,072	8,600,840	9,908,569
Mean	1,203,146	4,012,556	5,215,702	1,250,889	3,237,609	4,488,499
Std Dev	156,583	1,410,766	1,420,371	175,993	1,065,127	1,090,539
Percentile						
1%	872,316	1,473,263	2,642,809	918,427	1,348,978	2,519,661
5%	945,174	1,963,911	3,147,135	989,862	1,705,022	2,910,677
10%	998,059	2,295,765	3,486,805	1,035,656	1,948,617	3,168,273
15%	1,036,328	2,543,648	3,744,644	1,068,262	2,136,639	3,365,706
20%	1,067,022	2,762,035	3,959,026	1,095,750	2,300,995	3,531,210
25%	1,093,240	2,963,393	4,161,854	1,121,263	2,444,304	3,682,957
30%	1,117,539	3,149,028	4,349,547	1,145,099	2,582,765	3,827,301
35%	1,139,266	3,332,802	4,529,285	1,167,704	2,720,820	3,964,214
40%	1,160,427	3,508,662	4,707,391	1,190,012	2,853,351	4,102,558
45%	1,180,850	3,683,235	4,886,617	1,211,954	2,986,072	4,236,305
50%	1,201,069	3,865,747	5,071,344	1,235,173	3,120,120	4,372,410
55%	1,220,708	4,052,585	5,257,421	1,258,333	3,257,939	4,511,289
60%	1,241,683	4,245,816	5,451,197	1,282,448	3,403,322	4,659,087
65%	1,263,431	4,447,270	5,651,355	1,307,817	3,556,245	4,817,323
70%	1,285,744	4,662,528	5,875,186	1,335,014	3,723,358	4,984,699
75%	1,309,538	4,904,348	6,116,437	1,364,839	3,902,246	5,170,453
80%	1,336,254	5,179,627	6,395,274	1,398,495	4,110,965	5,380,937
85%	1,367,361	5,512,845	6,723,508	1,438,184	4,363,050	5,639,359
90%	1,407,025	5,933,560	7,150,655	1,489,869	4,688,068	5,972,862
95%	1,464,162	6,573,928	7,787,315	1,564,673	5,177,528	6,461,485
99%	1,576,306	7,770,867	8,992,684	1,708,231	6,110,561	7,415,750

Table E.5-Risk profile statistics for highway bridge ADT case 5 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	722,300	1,930,294	794,935	1,063,635	2,256,461
Maximum	1,900,008	18,977,794	20,266,682	2,117,072	15,209,936	16,517,665
Mean	1,203,146	6,330,323	7,533,469	1,250,889	5,311,980	6,562,869
Std Dev	156,583	2,530,719	2,536,052	175,993	1,939,853	1,956,718
Percentile						
1%	872,316	1,868,151	3,054,626	918,427	1,938,273	3,133,485
5%	945,174	2,684,329	3,883,606	989,862	2,532,482	3,754,640
10%	998,059	3,258,857	4,453,017	1,035,656	2,967,113	4,199,130
15%	1,036,328	3,702,118	4,904,151	1,068,262	3,306,553	4,543,798
20%	1,067,022	4,086,513	5,283,927	1,095,750	3,598,788	4,838,617
25%	1,093,240	4,442,203	5,643,559	1,121,263	3,862,853	5,104,769
30%	1,117,539	4,768,723	5,972,237	1,145,099	4,112,247	5,362,583
35%	1,139,266	5,091,612	6,292,662	1,167,704	4,367,917	5,613,147
40%	1,160,427	5,412,614	6,608,427	1,190,012	4,611,938	5,857,963
45%	1,180,850	5,724,548	6,927,899	1,211,954	4,848,313	6,100,857
50%	1,201,069	6,043,843	7,250,388	1,235,173	5,085,968	6,339,431
55%	1,220,708	6,380,034	7,584,815	1,258,333	5,338,865	6,593,957
60%	1,241,683	6,728,621	7,927,645	1,282,448	5,604,887	6,857,818
65%	1,263,431	7,088,269	8,295,244	1,307,817	5,882,195	7,142,829
70%	1,285,744	7,481,278	8,688,812	1,335,014	6,186,605	7,442,035
75%	1,309,538	7,918,934	9,127,494	1,364,839	6,519,861	7,781,507
80%	1,336,254	8,419,858	9,634,028	1,398,495	6,900,388	8,157,432
85%	1,367,361	9,019,055	10,232,593	1,438,184	7,362,019	8,631,906
90%	1,407,025	9,793,609	11,007,341	1,489,869	7,962,515	9,233,089
95%	1,464,162	10,952,717	12,167,788	1,564,673	8,853,724	10,127,765
99%	1,576,306	13,126,231	14,352,181	1,708,231	10,550,036	11,853,870

Table E.6-Risk profile statistics for highway bridge ADT case 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	816,830	2,022,003	794,935	1,978,980	3,144,649
Maximum	1,900,008	42,337,949	43,626,836	2,117,072	35,037,224	36,344,953
Mean	1,203,146	13,283,624	14,486,770	1,250,889	11,535,090	12,785,980
Std Dev	156,583	5,960,550	5,962,774	175,993	4,605,433	4,616,116
Percentile						
1%	872,316	2,844,264	4,031,257	918,427	3,536,571	4,768,463
5%	945,174	4,673,734	5,882,916	989,862	4,924,719	6,153,751
10%	998,059	6,044,544	7,246,086	1,035,656	5,956,079	7,205,100
15%	1,036,328	7,094,535	8,292,717	1,068,262	6,778,933	8,021,078
20%	1,067,022	8,012,264	9,213,564	1,095,750	7,459,721	8,709,063
25%	1,093,240	8,848,828	10,049,529	1,121,263	8,103,906	9,346,338
30%	1,117,539	9,620,709	10,828,172	1,145,099	8,700,974	9,956,863
35%	1,139,266	10,371,884	11,575,932	1,167,704	9,298,056	10,547,840
40%	1,160,427	11,113,571	12,308,718	1,190,012	9,871,473	11,121,189
45%	1,180,850	11,848,500	13,054,503	1,211,954	10,431,269	11,684,579
50%	1,201,069	12,609,807	13,817,945	1,235,173	11,002,411	12,255,098
55%	1,220,708	13,384,215	14,592,372	1,258,333	11,602,847	12,850,894
60%	1,241,683	14,203,659	15,399,410	1,282,448	12,221,115	13,466,766
65%	1,263,431	15,058,098	16,257,046	1,307,817	12,883,263	14,124,088
70%	1,285,744	15,977,979	17,181,878	1,335,014	13,607,587	14,859,684
75%	1,309,538	17,019,257	18,217,440	1,364,839	14,403,007	15,654,613
80%	1,336,254	18,186,446	19,402,790	1,398,495	15,295,393	16,555,744
85%	1,367,361	19,609,346	20,818,148	1,438,184	16,398,183	17,660,386
90%	1,407,025	21,461,131	22,660,891	1,489,869	17,817,470	19,087,773
95%	1,464,162	24,201,168	25,398,514	1,564,673	19,980,314	21,243,462
99%	1,576,306	29,395,091	30,608,721	1,708,231	23,970,207	25,252,243

Table E.7-Risk profile statistics for highway bridge ADT case 7 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	3,103,685	4,187,213	794,935	2,519,511	3,688,107
Maximum	1,900,008	26,190,632	27,554,763	2,117,072	19,710,031	20,858,993
Mean	1,203,146	10,791,710	11,994,856	1,250,889	7,890,566	9,141,455
Std Dev	156,583	3,018,819	3,025,201	175,993	2,115,615	2,140,584
Percentile						
1%	872,316	5,027,835	6,221,604	918,427	3,897,325	5,091,288
5%	945,174	6,201,260	7,399,223	989,862	4,730,081	5,940,267
10%	998,059	7,013,774	8,214,189	1,035,656	5,282,830	6,499,107
15%	1,036,328	7,612,451	8,818,029	1,068,262	5,696,640	6,927,315
20%	1,067,022	8,134,123	9,330,228	1,095,750	6,049,030	7,277,027
25%	1,093,240	8,595,871	9,795,708	1,121,263	6,354,480	7,589,744
30%	1,117,539	9,018,702	10,218,745	1,145,099	6,634,018	7,876,496
35%	1,139,266	9,424,442	10,623,052	1,167,704	6,904,079	8,143,975
40%	1,160,427	9,815,643	11,020,702	1,190,012	7,173,156	8,413,454
45%	1,180,850	10,191,980	11,393,374	1,211,954	7,450,134	8,691,982
50%	1,201,069	10,575,930	11,778,008	1,235,173	7,713,306	8,963,475
55%	1,220,708	10,963,323	12,170,565	1,258,333	7,981,474	9,238,719
60%	1,241,683	11,368,995	12,569,962	1,282,448	8,262,548	9,524,291
65%	1,263,431	11,800,112	13,004,798	1,307,817	8,565,452	9,824,245
70%	1,285,744	12,244,283	13,450,291	1,335,014	8,891,201	10,152,254
75%	1,309,538	12,731,325	13,937,650	1,364,839	9,236,565	10,500,609
80%	1,336,254	13,303,645	14,510,059	1,398,495	9,636,490	10,906,040
85%	1,367,361	13,964,300	15,175,338	1,438,184	10,112,248	11,387,842
90%	1,407,025	14,827,998	16,043,020	1,489,869	10,727,542	12,001,726
95%	1,464,162	16,123,374	17,337,248	1,564,673	11,644,613	12,944,882
99%	1,576,306	18,613,419	19,834,669	1,708,231	13,479,517	14,810,886

Table E.8-Risk profile statistics for highway bridge ADT case 8 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	3,232,036	4,315,564	794,935	2,830,474	4,023,300
Maximum	1,900,008	32,595,226	33,884,113	2,117,072	24,381,753	25,792,195
Mean	1,203,146	13,109,477	14,312,623	1,250,889	9,964,936	11,215,825
Std Dev	156,583	3,912,018	3,916,923	175,993	2,838,506	2,859,078
Percentile						
1%	872,316	5,765,631	6,944,840	918,427	4,719,163	5,914,247
5%	945,174	7,261,582	8,451,320	989,862	5,785,638	7,010,177
10%	998,059	8,258,649	9,456,711	1,035,656	6,487,893	7,715,102
15%	1,036,328	9,010,194	10,214,434	1,068,262	7,027,472	8,261,945
20%	1,067,022	9,659,422	10,855,600	1,095,750	7,475,790	8,711,570
25%	1,093,240	10,235,657	11,434,677	1,121,263	7,877,929	9,116,576
30%	1,117,539	10,773,734	11,976,009	1,145,099	8,259,585	9,498,858
35%	1,139,266	11,293,176	12,494,324	1,167,704	8,620,164	9,868,757
40%	1,160,427	11,790,615	12,991,105	1,190,012	8,983,124	10,231,507
45%	1,180,850	12,299,784	13,497,592	1,211,954	9,338,929	10,585,944
50%	1,201,069	12,798,769	14,002,997	1,235,173	9,697,881	10,945,213
55%	1,220,708	13,300,534	14,508,335	1,258,333	10,071,011	11,320,860
60%	1,241,683	13,828,191	15,033,865	1,282,448	10,455,931	11,713,893
65%	1,263,431	14,378,431	15,585,063	1,307,817	10,855,367	12,113,554
70%	1,285,744	14,976,863	16,183,398	1,335,014	11,279,906	12,542,013
75%	1,309,538	15,636,306	16,846,852	1,364,839	11,755,003	13,021,092
80%	1,336,254	16,362,041	17,574,146	1,398,495	12,304,093	13,567,844
85%	1,367,361	17,238,853	18,458,417	1,438,184	12,952,737	14,228,861
90%	1,407,025	18,369,728	19,580,654	1,489,869	13,796,960	15,074,705
95%	1,464,162	20,083,625	21,300,864	1,564,673	15,041,135	16,315,401
99%	1,576,306	23,291,785	24,504,388	1,708,231	17,536,966	18,840,269

Table E.9-Risk profile statistics for highway bridge ADT case 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	3,453,948	4,700,618	794,935	3,763,362	4,956,188
Maximum	1,900,008	55,955,380	57,244,268	2,117,072	43,004,201	44,311,930
Mean	1,203,146	20,062,778	21,265,924	1,250,889	16,188,047	17,438,936
Std Dev	156,583	7,053,829	7,056,515	175,993	5,325,634	5,339,699
Percentile						
1%	872,316	7,366,316	8,549,296	918,427	6,744,891	7,957,381
5%	945,174	9,819,553	11,016,051	989,862	8,525,108	9,759,652
10%	998,059	11,478,824	12,678,868	1,035,656	9,743,086	10,982,568
15%	1,036,328	12,718,239	13,924,777	1,068,262	10,683,195	11,924,305
20%	1,067,022	13,810,174	15,004,406	1,095,750	11,504,973	12,742,123
25%	1,093,240	14,816,966	16,017,933	1,121,263	12,221,519	13,465,542
30%	1,117,539	15,745,138	16,944,935	1,145,099	12,913,827	14,161,331
35%	1,139,266	16,664,011	17,858,390	1,167,704	13,604,101	14,853,101
40%	1,160,427	17,543,312	18,740,592	1,190,012	14,266,757	15,519,694
45%	1,180,850	18,416,174	19,624,725	1,211,954	14,930,360	16,186,149
50%	1,201,069	19,328,734	20,532,299	1,235,173	15,600,600	16,847,351
55%	1,220,708	20,262,925	21,467,226	1,258,333	16,289,696	17,541,123
60%	1,241,683	21,229,080	22,433,723	1,282,448	17,016,609	18,272,260
65%	1,263,431	22,236,350	23,439,542	1,307,817	17,781,227	19,029,834
70%	1,285,744	23,312,638	24,518,997	1,335,014	18,616,790	19,874,615
75%	1,309,538	24,521,739	25,730,166	1,364,839	19,511,231	20,769,732
80%	1,336,254	25,898,133	27,101,973	1,398,495	20,554,824	21,821,332
85%	1,367,361	27,564,227	28,773,031	1,438,184	21,815,248	23,077,053
90%	1,407,025	29,667,802	30,866,754	1,489,869	23,440,341	24,708,865
95%	1,464,162	32,869,642	34,066,445	1,564,673	25,887,641	27,141,899
99%	1,576,306	38,854,335	40,071,905	1,708,231	30,552,805	31,812,369

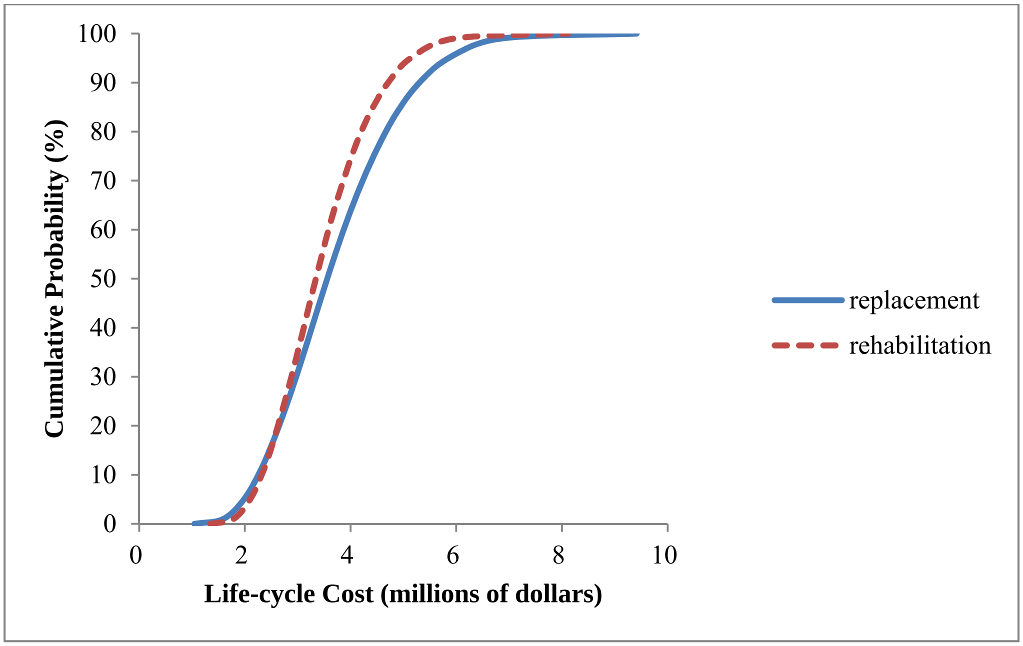


Figure E.1-Ascending cumulative probability distributions for highway bridge ADT case 1 (Table 3.6)

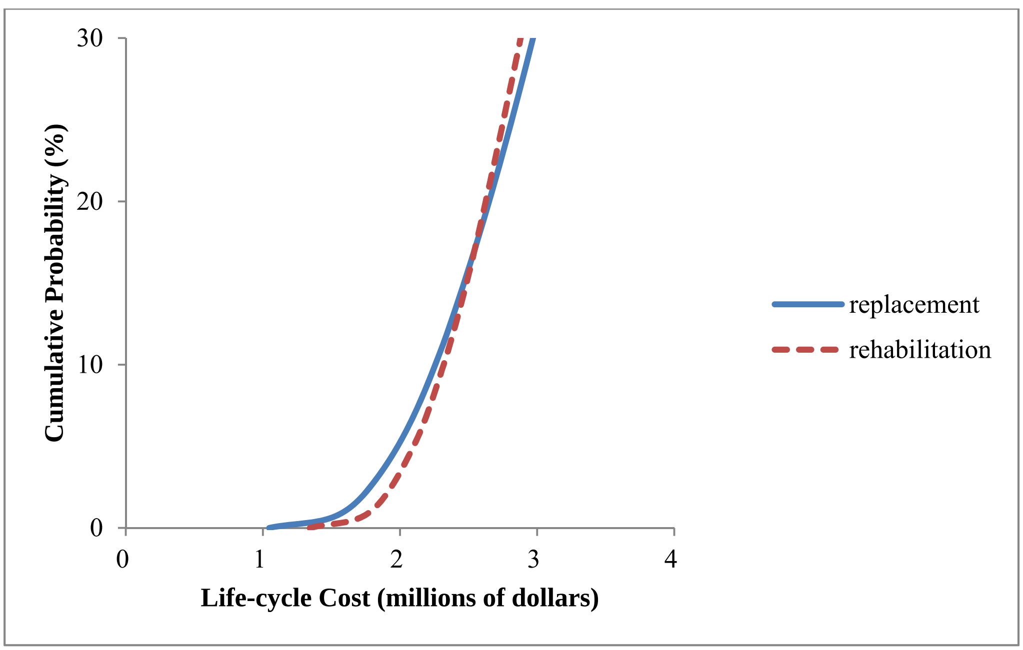


Figure E.2-Ascending cumulative probability distributions for highway bridge ADT case 1 (Table 3.6)

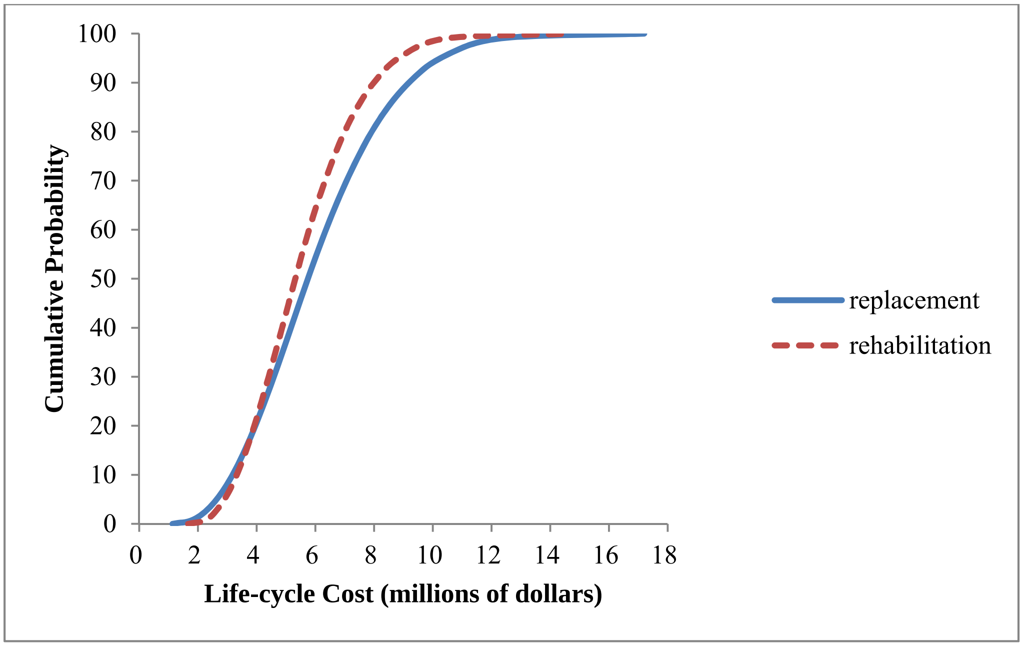


Figure E.3-Ascending cumulative probability distributions for highway bridge ADT case 2 (Table 3.6)

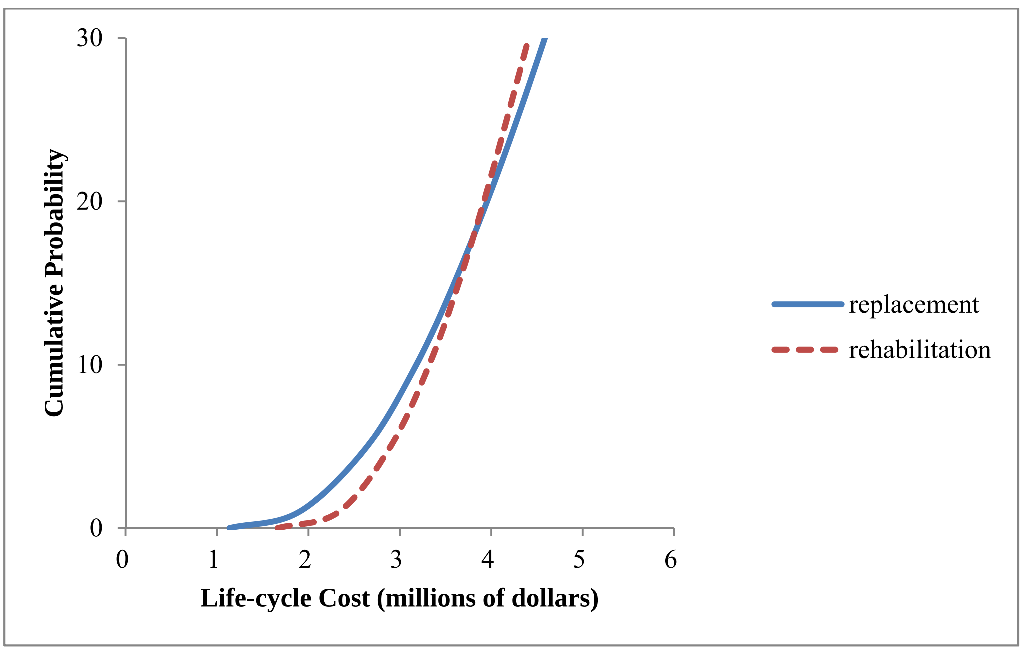


Figure E.4-Ascending cumulative probability distributions for highway bridge ADT case 2 (Table 3.6)

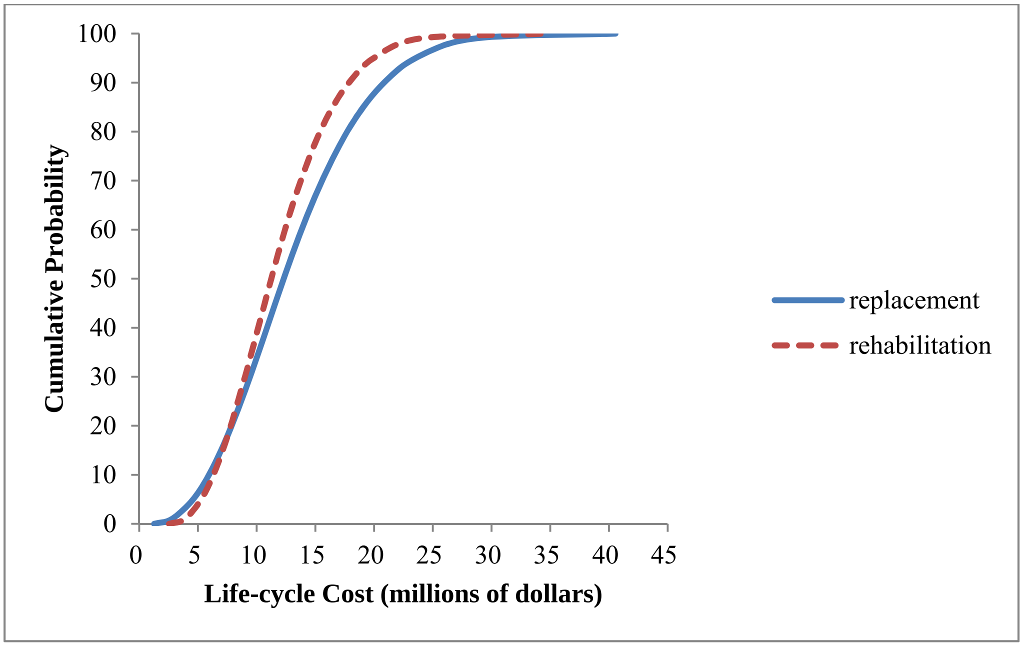


Figure E.5-Ascending cumulative probability distributions for highway bridge ADT case 3 (Table 3.6)

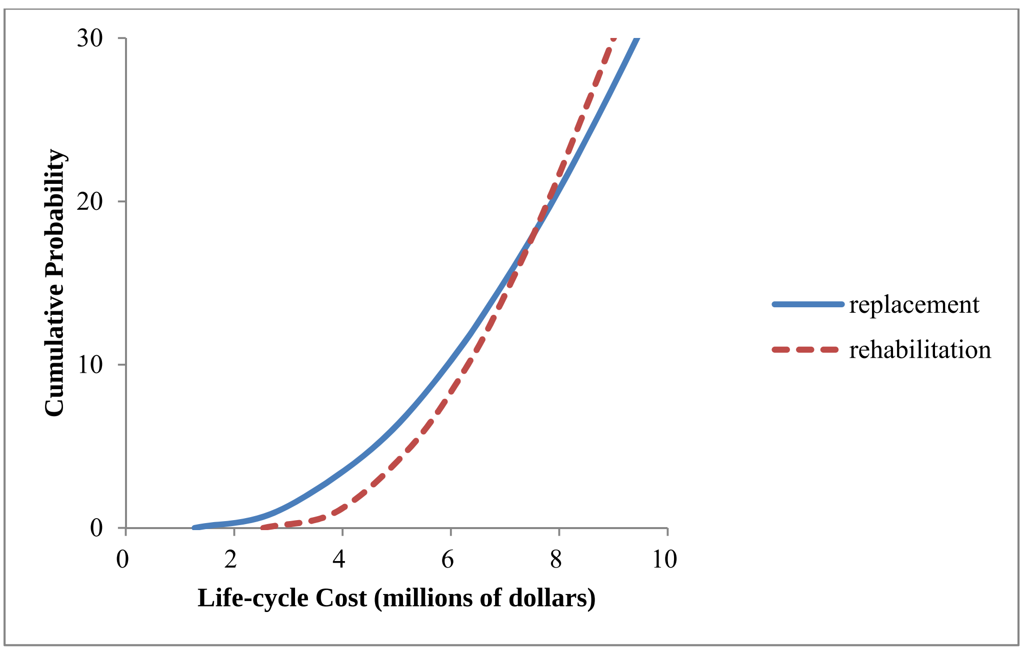


Figure E.6-Ascending cumulative probability distributions for highway bridge ADT case 3 (Table 3.6)

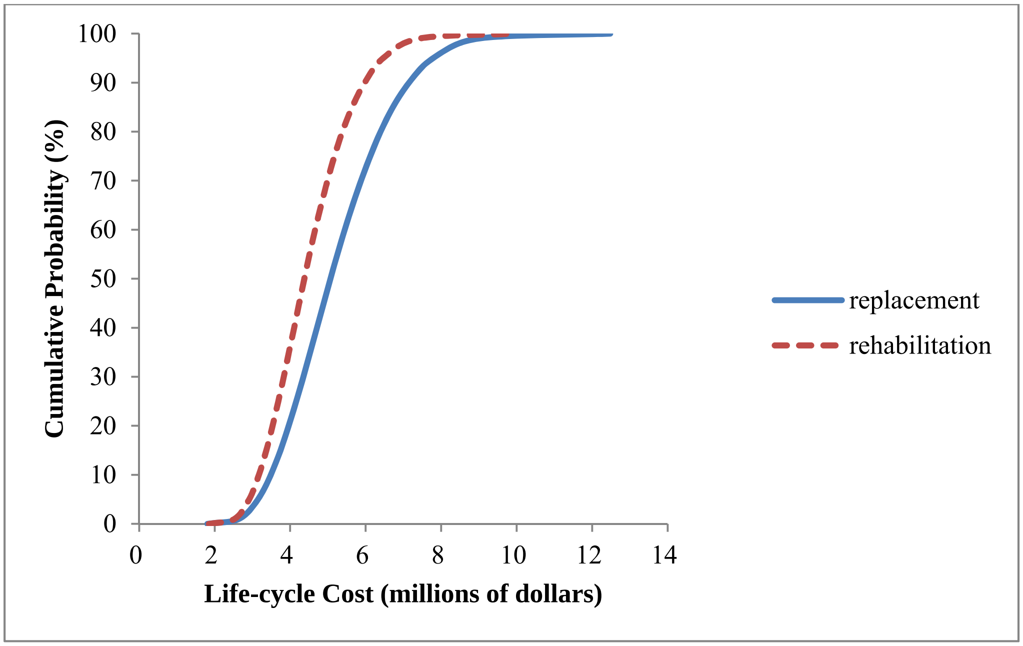


Figure E.7-Ascending cumulative probability distributions for highway bridge ADT case 4 (Table 3.6)

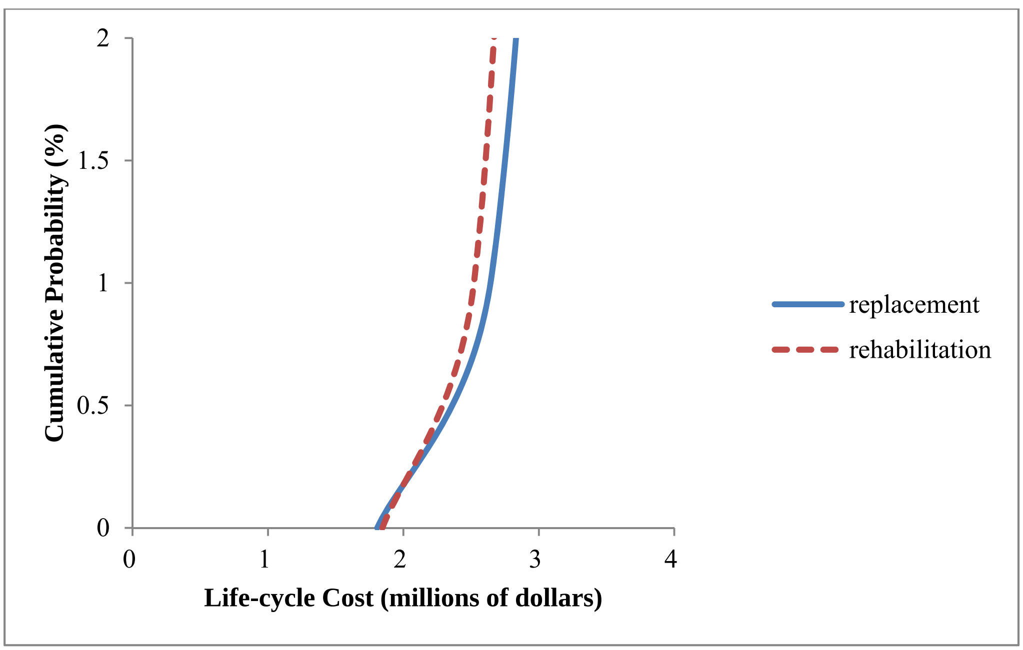


Figure E.8-Ascending cumulative probability distributions for highway bridge ADT case 4 (Table 3.6)

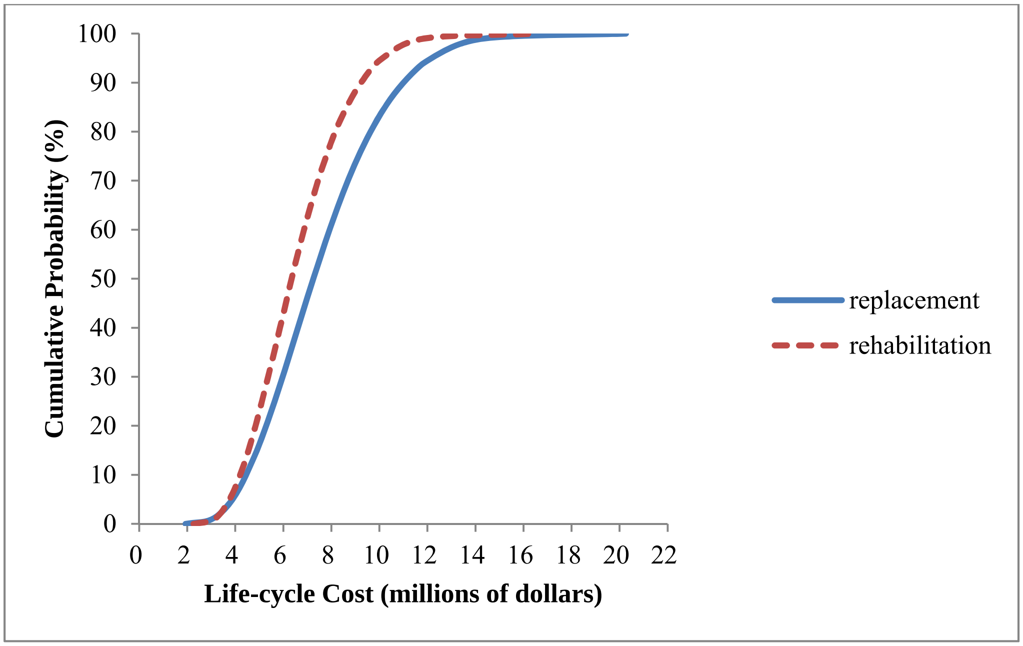


Figure E.9-Ascending cumulative probability distributions for highway bridge ADT case 5 (Table 3.6)

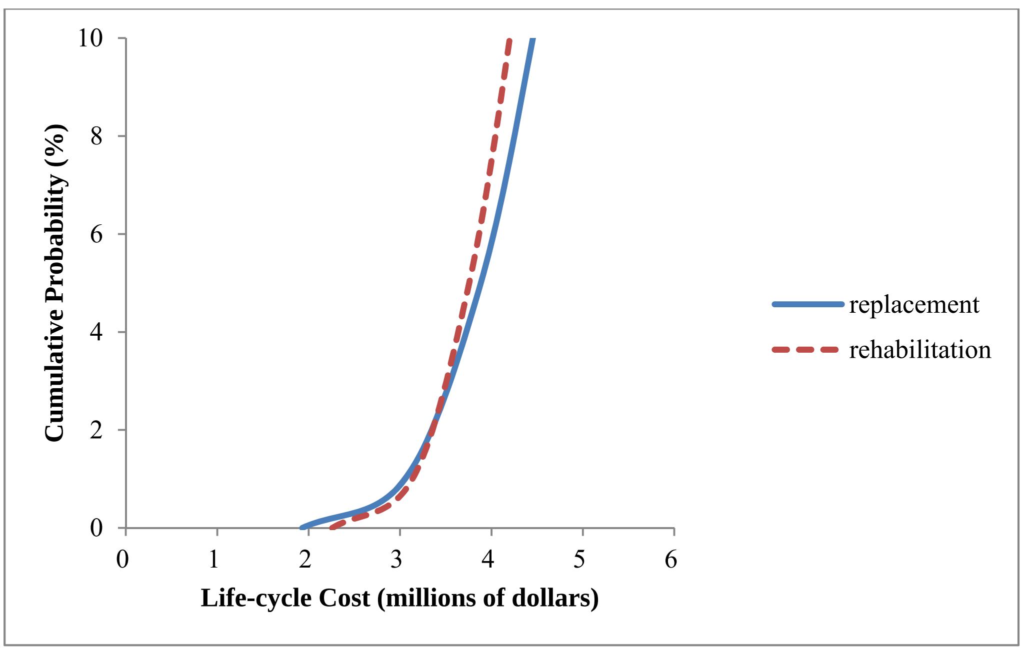


Figure E.10-Ascending cumulative probability distributions for highway bridge ADT case 5 (Table 3.6)

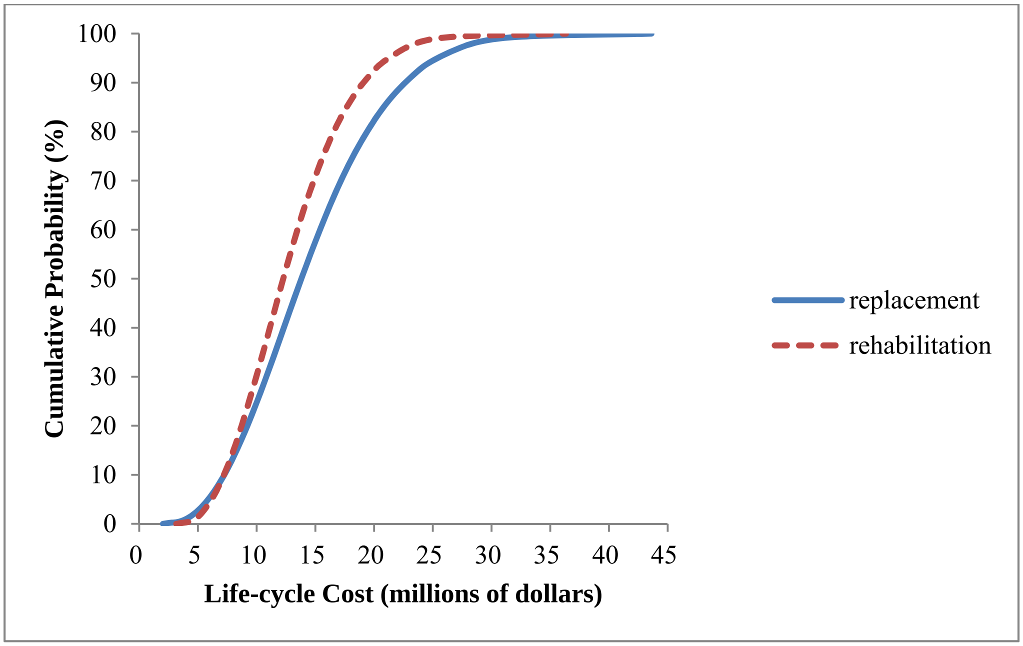


Figure E.11-Ascending cumulative probability distributions for highway bridge ADT case 6 (Table 3.6)

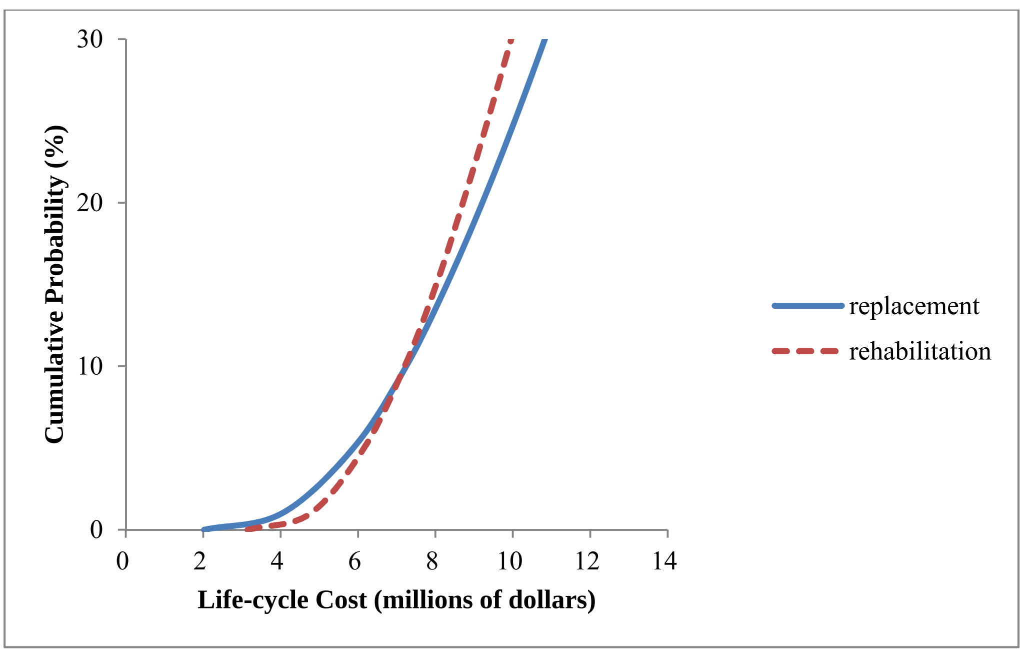


Figure E.12-Ascending cumulative probability distributions for highway bridge ADT case 6 (Table 3.6)

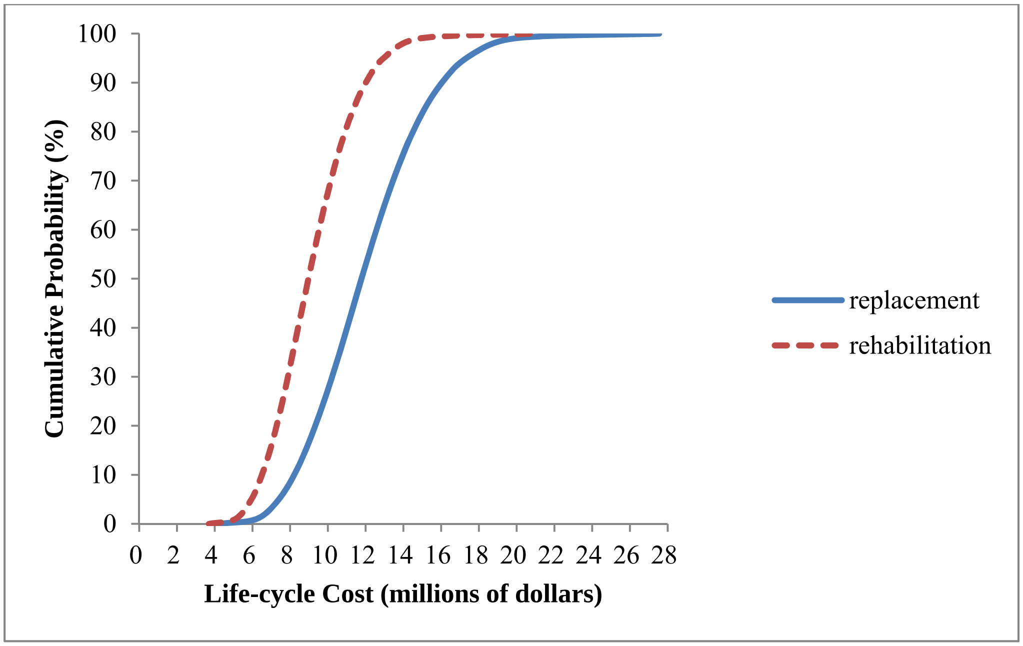


Figure E.13-Ascending cumulative probability distributions for highway bridge ADT case 7 (Table 3.6)

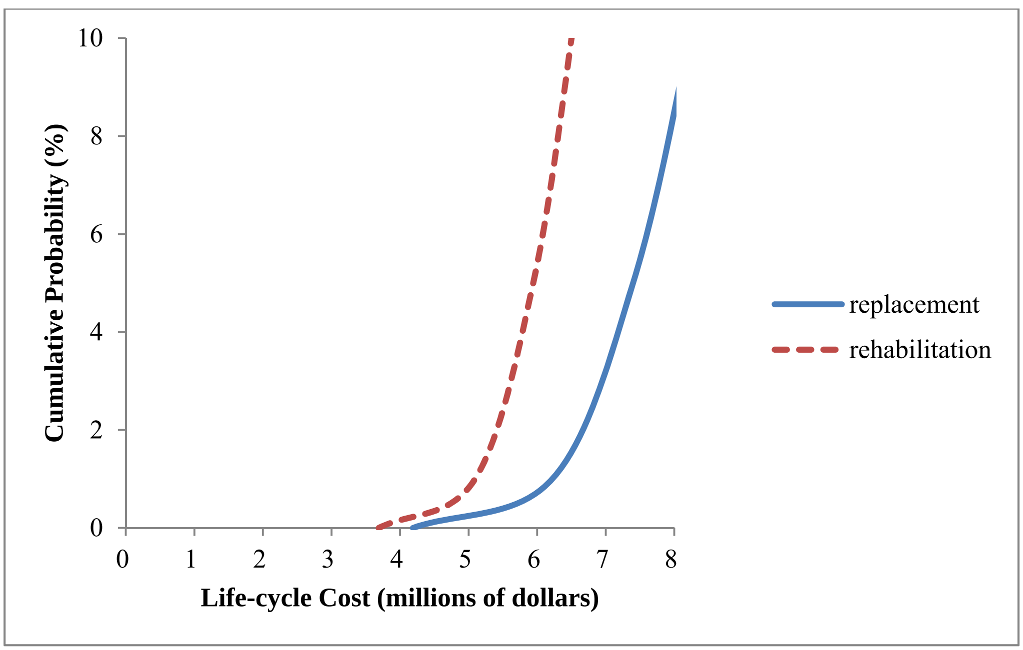


Figure E.14-Ascending cumulative probability distributions for highway bridge ADT case 7 (Table 3.6)

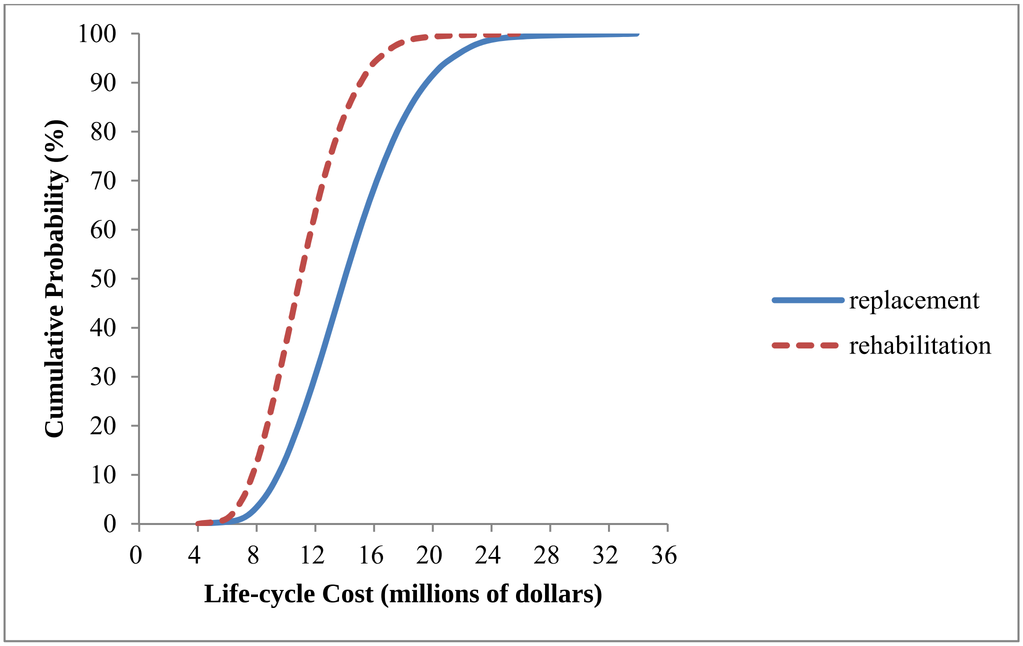


Figure E.15-Ascending cumulative probability distributions for highway bridge ADT case 8 (Table 3.6)

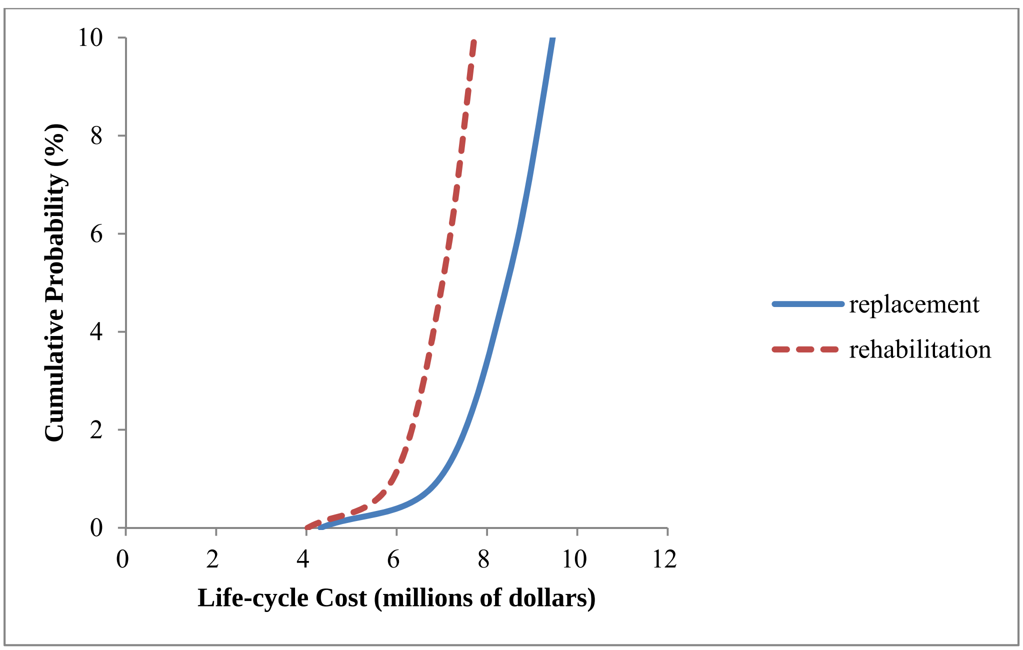


Figure E.16-Ascending cumulative probability distributions for highway bridge ADT case 8 (Table 3.6)

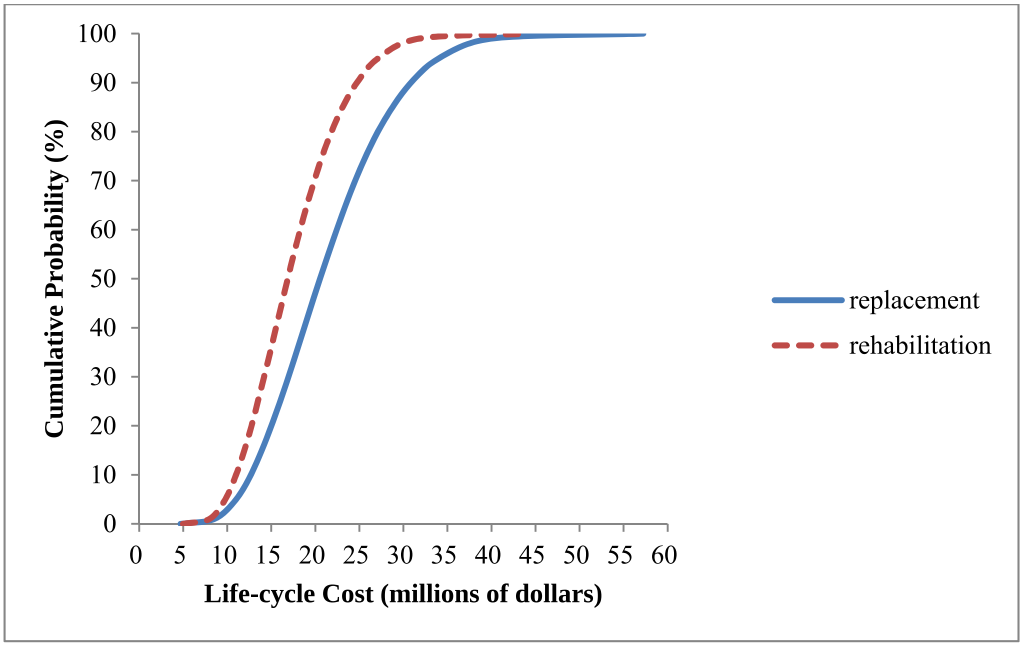


Figure E.17-Ascending cumulative probability distributions for highway bridge ADT case 9 (Table 3.6)

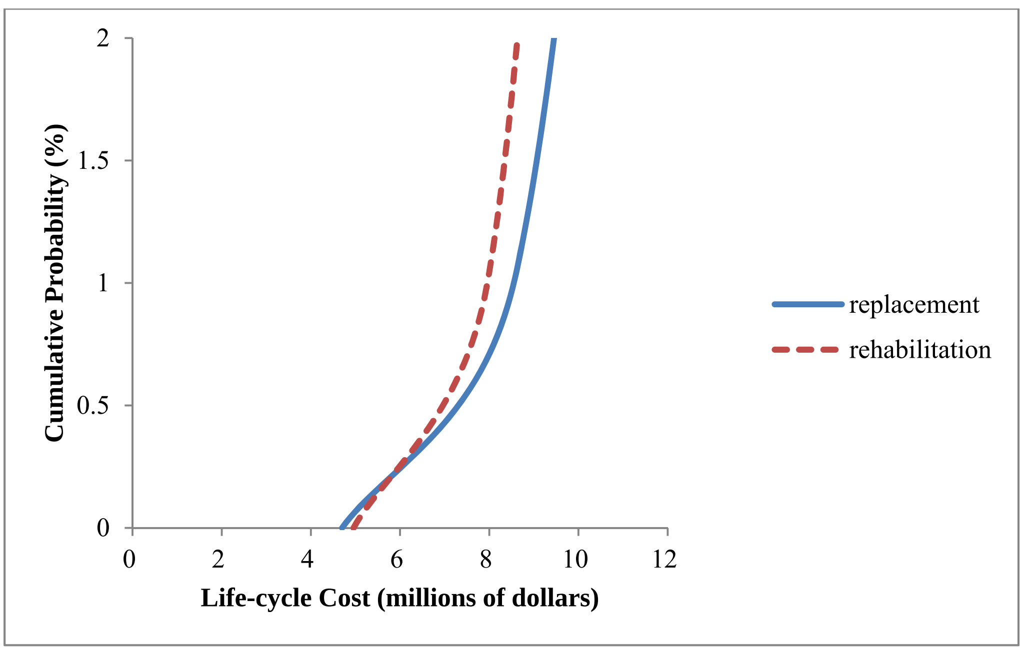


Figure E.18-Ascending cumulative probability distributions for highway bridge ADT case 9 (Table 3.6)

Bridge over Highway with Limited Variables

Table E.10-Risk profile statistics for highway bridge with limited variables limited ADT case 1 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	1,191,515	102,185	1,293,699	1,172,788	331,508	1,504,296
Maximum	1,191,515	8,278,948	9,470,463	1,172,788	6,519,239	7,692,027
Mean	1,191,515	2,468,495	3,660,009	1,172,788	2,129,102	3,301,889
Std Dev	0	1,175,057	1,175,057	0	876,721	876,721
Percentile						
1%	1,191,515	411,795	1,603,309	1,172,788	597,000	1,769,788
5%	1,191,515	771,918	1,963,433	1,172,788	860,283	2,033,071
10%	1,191,515	1,039,411	2,230,926	1,172,788	1,064,298	2,237,086
15%	1,191,515	1,248,972	2,440,487	1,172,788	1,219,474	2,392,262
20%	1,191,515	1,427,619	2,619,134	1,172,788	1,352,763	2,525,551
25%	1,191,515	1,592,421	2,783,936	1,172,788	1,474,569	2,647,357
30%	1,191,515	1,748,940	2,940,455	1,172,788	1,591,160	2,763,948
35%	1,191,515	1,896,125	3,087,640	1,172,788	1,702,694	2,875,482
40%	1,191,515	2,046,552	3,238,067	1,172,788	1,811,710	2,984,498
45%	1,191,515	2,189,612	3,381,126	1,172,788	1,921,860	3,094,648
50%	1,191,515	2,337,238	3,528,753	1,172,788	2,034,332	3,207,120
55%	1,191,515	2,491,621	3,683,135	1,172,788	2,148,200	3,320,987
60%	1,191,515	2,652,264	3,843,779	1,172,788	2,267,214	3,440,002
65%	1,191,515	2,817,281	4,008,796	1,172,788	2,391,910	3,564,697
70%	1,191,515	3,001,447	4,192,961	1,172,788	2,527,825	3,700,612
75%	1,191,515	3,203,006	4,394,521	1,172,788	2,677,812	3,850,600
80%	1,191,515	3,431,298	4,622,813	1,172,788	2,851,324	4,024,112
85%	1,191,515	3,711,538	4,903,053	1,172,788	3,056,992	4,229,780
90%	1,191,515	4,076,121	5,267,635	1,172,788	3,318,860	4,491,648
95%	1,191,515	4,605,957	5,797,472	1,172,788	3,727,382	4,900,170
99%	1,191,515	5,644,347	6,835,861	1,172,788	4,508,790	5,681,578

Table E.11-Risk profile statistics for highway bridge with limited variables limited ADT case 2 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	1,191,515	123,784	1,315,299	1,172,788	587,671	1,760,459
Maximum	1,191,515	16,327,092	17,518,607	1,172,788	12,886,251	14,059,039
Mean	1,191,515	4,790,065	5,981,580	1,172,788	4,158,914	5,331,702
Std Dev	0	2,332,461	2,332,461	0	1,742,661	1,742,661
Percentile						
1%	1,191,515	699,344	1,890,859	1,172,788	1,105,370	2,278,158
5%	1,191,515	1,416,765	2,608,279	1,172,788	1,633,029	2,805,817
10%	1,191,515	1,951,161	3,142,675	1,172,788	2,042,178	3,214,966
15%	1,191,515	2,371,272	3,562,787	1,172,788	2,353,193	3,525,981
20%	1,191,515	2,725,045	3,916,560	1,172,788	2,617,119	3,789,907
25%	1,191,515	3,055,272	4,246,787	1,172,788	2,860,320	4,033,107
30%	1,191,515	3,365,017	4,556,531	1,172,788	3,091,169	4,263,956
35%	1,191,515	3,656,520	4,848,034	1,172,788	3,311,994	4,484,782
40%	1,191,515	3,952,722	5,144,236	1,172,788	3,529,821	4,702,609
45%	1,191,515	4,237,852	5,429,367	1,172,788	3,749,267	4,922,054
50%	1,191,515	4,529,065	5,720,580	1,172,788	3,971,580	5,144,368
55%	1,191,515	4,836,252	6,027,767	1,172,788	4,196,943	5,369,730
60%	1,191,515	5,154,928	6,346,442	1,172,788	4,433,437	5,606,225
65%	1,191,515	5,482,301	6,673,816	1,172,788	4,682,179	5,854,967
70%	1,191,515	5,846,515	7,038,030	1,172,788	4,950,081	6,122,869
75%	1,191,515	6,247,103	7,438,618	1,172,788	5,248,507	6,421,295
80%	1,191,515	6,702,656	7,894,171	1,172,788	5,593,621	6,766,409
85%	1,191,515	7,253,934	8,445,449	1,172,788	6,003,695	7,176,483
90%	1,191,515	7,982,758	9,174,273	1,172,788	6,523,102	7,695,890
95%	1,191,515	9,030,446	10,221,961	1,172,788	7,337,277	8,510,065
99%	1,191,515	11,086,970	12,278,485	1,172,788	8,891,219	10,064,006

Table E.12-Risk profile statistics for highway bridge with limited variables limited ADT case 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	1,191,515	175,055	1,366,570	1,172,788	1,356,159	2,528,947
Maximum	1,191,515	40,471,525	41,663,039	1,172,788	31,987,287	33,160,075
Mean	1,191,515	11,754,776	12,946,291	1,172,788	10,248,350	11,421,138
Std Dev	0	5,805,077	5,805,077	0	4,340,689	4,340,689
Percentile						
1%	1,191,515	1,561,066	2,752,580	1,172,788	2,630,928	3,803,716
5%	1,191,515	3,351,052	4,542,567	1,172,788	3,957,354	5,130,142
10%	1,191,515	4,692,040	5,883,555	1,172,788	4,977,191	6,149,978
15%	1,191,515	5,738,923	6,930,437	1,172,788	5,747,438	6,920,226
20%	1,191,515	6,619,931	7,811,445	1,172,788	6,409,518	7,582,306
25%	1,191,515	7,439,862	8,631,377	1,172,788	7,015,978	8,188,766
30%	1,191,515	8,211,125	9,402,639	1,172,788	7,593,160	8,765,947
35%	1,191,515	8,937,950	10,129,465	1,172,788	8,141,740	9,314,528
40%	1,191,515	9,668,102	10,859,617	1,172,788	8,683,334	9,856,122
45%	1,191,515	10,387,479	11,578,994	1,172,788	9,228,952	10,401,740
50%	1,191,515	11,105,824	12,297,338	1,172,788	9,781,240	10,954,028
55%	1,191,515	11,869,891	13,061,405	1,172,788	10,344,170	11,516,958
60%	1,191,515	12,663,127	13,854,641	1,172,788	10,930,109	12,102,897
65%	1,191,515	13,476,119	14,667,634	1,172,788	11,551,618	12,724,406
70%	1,191,515	14,379,985	15,571,500	1,172,788	12,217,994	13,390,782
75%	1,191,515	15,382,029	16,573,544	1,172,788	12,958,380	14,131,168
80%	1,191,515	16,511,068	17,702,583	1,172,788	13,822,822	14,995,610
85%	1,191,515	17,887,238	19,078,753	1,172,788	14,840,953	16,013,741
90%	1,191,515	19,696,462	20,887,977	1,172,788	16,131,048	17,303,836
95%	1,191,515	22,311,022	23,502,537	1,172,788	18,165,398	19,338,186
99%	1,191,515	27,429,629	28,621,144	1,172,788	22,036,760	23,209,548

Table E.13-Risk profile statistics for highway bridge with limited variables limited ADT case 4 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	1,191,515	726,164	1,917,679	1,172,788	812,589	1,985,377
Maximum	1,191,515	10,356,181	11,547,696	1,172,788	7,889,286	9,062,074
Mean	1,191,515	3,790,812	4,982,327	1,172,788	3,022,707	4,195,495
Std Dev	0	1,358,784	1,358,784	0	986,888	986,888
Percentile						
1%	1,191,515	1,358,085	2,549,600	1,172,788	1,283,434	2,456,222
5%	1,191,515	1,821,355	3,012,870	1,172,788	1,600,765	2,773,553
10%	1,191,515	2,138,005	3,329,520	1,172,788	1,823,645	2,996,432
15%	1,191,515	2,380,754	3,572,269	1,172,788	1,994,474	3,167,262
20%	1,191,515	2,585,736	3,777,251	1,172,788	2,143,878	3,316,666
25%	1,191,515	2,771,363	3,962,877	1,172,788	2,282,683	3,455,471
30%	1,191,515	2,954,989	4,146,504	1,172,788	2,413,357	3,586,145
35%	1,191,515	3,130,625	4,322,140	1,172,788	2,538,264	3,711,052
40%	1,191,515	3,303,225	4,494,739	1,172,788	2,665,977	3,838,765
45%	1,191,515	3,477,625	4,669,140	1,172,788	2,790,166	3,962,954
50%	1,191,515	3,648,470	4,839,985	1,172,788	2,914,969	4,087,757
55%	1,191,515	3,827,485	5,019,000	1,172,788	3,045,740	4,218,528
60%	1,191,515	4,012,908	5,204,423	1,172,788	3,184,460	4,357,248
65%	1,191,515	4,208,457	5,399,972	1,172,788	3,328,913	4,501,701
70%	1,191,515	4,417,437	5,608,952	1,172,788	3,480,055	4,652,843
75%	1,191,515	4,652,335	5,843,850	1,172,788	3,650,269	4,823,056
80%	1,191,515	4,915,272	6,106,787	1,172,788	3,839,951	5,012,739
85%	1,191,515	5,231,492	6,423,007	1,172,788	4,067,409	5,240,196
90%	1,191,515	5,643,025	6,834,540	1,172,788	4,362,092	5,534,880
95%	1,191,515	6,252,406	7,443,920	1,172,788	4,812,734	5,985,522
99%	1,191,515	7,427,124	8,618,638	1,172,788	5,673,693	6,846,481

Table E.14-Risk profile statistics for highway bridge with limited variables limited ADT case 5 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	1,191,515	773,470	1,964,985	1,172,788	1,126,410	2,299,198
Maximum	1,191,515	18,404,325	19,595,840	1,172,788	14,256,298	15,429,086
Mean	1,191,515	6,112,382	7,303,897	1,172,788	5,052,519	6,225,307
Std Dev	0	2,502,624	2,502,624	0	1,845,573	1,845,573
Percentile						
1%	1,191,515	1,726,387	2,917,902	1,172,788	1,838,739	3,011,527
5%	1,191,515	2,511,094	3,702,609	1,172,788	2,391,797	3,564,584
10%	1,191,515	3,084,061	4,275,576	1,172,788	2,812,891	3,985,679
15%	1,191,515	3,509,859	4,701,374	1,172,788	3,131,071	4,303,859
20%	1,191,515	3,891,312	5,082,827	1,172,788	3,409,240	4,582,028
25%	1,191,515	4,233,857	5,425,372	1,172,788	3,669,116	4,841,904
30%	1,191,515	4,564,802	5,756,317	1,172,788	3,912,545	5,085,333
35%	1,191,515	4,891,326	6,082,841	1,172,788	4,145,316	5,318,103
40%	1,191,515	5,203,239	6,394,754	1,172,788	4,379,830	5,552,618
45%	1,191,515	5,515,812	6,707,327	1,172,788	4,613,353	5,786,141
50%	1,191,515	5,838,469	7,029,984	1,172,788	4,847,678	6,020,466
55%	1,191,515	6,162,360	7,353,874	1,172,788	5,092,138	6,264,926
60%	1,191,515	6,506,199	7,697,714	1,172,788	5,347,394	6,520,182
65%	1,191,515	6,863,217	8,054,732	1,172,788	5,609,658	6,782,446
70%	1,191,515	7,254,455	8,445,970	1,172,788	5,896,505	7,069,293
75%	1,191,515	7,685,217	8,876,732	1,172,788	6,217,986	7,390,774
80%	1,191,515	8,172,800	9,364,315	1,172,788	6,575,100	7,747,888
85%	1,191,515	8,765,507	9,957,022	1,172,788	7,008,203	8,180,991
90%	1,191,515	9,538,859	10,730,374	1,172,788	7,559,492	8,732,279
95%	1,191,515	10,656,167	11,847,682	1,172,788	8,410,348	9,583,136
99%	1,191,515	12,857,536	14,049,050	1,172,788	10,046,797	11,219,585

Table E.15-Risk profile statistics for highway bridge with limited variables limited ADT case 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	1,191,515	868,788	2,060,302	1,172,788	2,034,268	3,207,056
Maximum	1,191,515	42,548,758	43,740,272	1,172,788	33,357,333	34,530,121
Mean	1,191,515	13,077,093	14,268,608	1,172,788	11,141,955	12,314,743
Std Dev	0	5,966,015	5,966,015	0	4,438,778	4,438,778
Percentile						
1%	1,191,515	2,670,125	3,861,640	1,172,788	3,417,695	4,590,483
5%	1,191,515	4,475,235	5,666,750	1,172,788	4,726,569	5,899,357
10%	1,191,515	5,842,020	7,033,535	1,172,788	5,755,841	6,928,629
15%	1,191,515	6,878,046	8,069,561	1,172,788	6,528,011	7,700,799
20%	1,191,515	7,795,964	8,987,479	1,172,788	7,209,116	8,381,903
25%	1,191,515	8,613,794	9,805,308	1,172,788	7,821,386	8,994,174
30%	1,191,515	9,411,155	10,602,670	1,172,788	8,406,472	9,579,260
35%	1,191,515	10,168,164	11,359,679	1,172,788	8,976,957	10,149,744
40%	1,191,515	10,920,454	12,111,969	1,172,788	9,530,456	10,703,244
45%	1,191,515	11,653,470	12,844,985	1,172,788	10,090,824	11,263,612
50%	1,191,515	12,415,774	13,607,289	1,172,788	10,657,966	11,830,754
55%	1,191,515	13,190,705	14,382,220	1,172,788	11,238,229	12,411,017
60%	1,191,515	14,008,282	15,199,797	1,172,788	11,839,889	13,012,677
65%	1,191,515	14,848,134	16,039,649	1,172,788	12,476,761	13,649,549
70%	1,191,515	15,782,649	16,974,163	1,172,788	13,160,193	14,332,981
75%	1,191,515	16,807,591	17,999,106	1,172,788	13,924,297	15,097,085
80%	1,191,515	17,970,435	19,161,949	1,172,788	14,797,740	15,970,528
85%	1,191,515	19,387,940	20,579,455	1,172,788	15,836,817	17,009,604
90%	1,191,515	21,241,235	22,432,750	1,172,788	17,175,942	18,348,730
95%	1,191,515	23,929,326	25,120,841	1,172,788	19,236,486	20,409,274
99%	1,191,515	29,189,550	30,381,065	1,172,788	23,180,495	24,353,283

Table E.16-Risk profile statistics for highway bridge with limited variables limited ADT case 7 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	1,191,515	3,373,496	4,565,011	1,172,788	2,694,755	3,867,543
Maximum	1,191,515	19,588,328	20,779,843	1,172,788	13,978,382	15,151,170
Mean	1,191,515	9,667,779	10,859,294	1,172,788	6,994,286	8,167,074
Std Dev	0	2,461,665	2,461,665	0	1,644,666	1,644,666
Percentile						
1%	1,191,515	4,731,149	5,922,664	1,172,788	3,733,878	4,906,665
5%	1,191,515	5,733,299	6,924,814	1,172,788	4,413,269	5,586,057
10%	1,191,515	6,467,978	7,659,493	1,172,788	4,879,545	6,052,333
15%	1,191,515	7,015,998	8,207,513	1,172,788	5,239,891	6,412,678
20%	1,191,515	7,487,756	8,679,271	1,172,788	5,535,574	6,708,362
25%	1,191,515	7,896,591	9,088,105	1,172,788	5,796,275	6,969,063
30%	1,191,515	8,271,917	9,463,431	1,172,788	6,046,476	7,219,263
35%	1,191,515	8,618,133	9,809,647	1,172,788	6,270,223	7,443,011
40%	1,191,515	8,948,275	10,139,790	1,172,788	6,491,342	7,664,130
45%	1,191,515	9,269,422	10,460,937	1,172,788	6,707,213	7,880,000
50%	1,191,515	9,589,226	10,780,740	1,172,788	6,919,394	8,092,182
55%	1,191,515	9,902,402	11,093,916	1,172,788	7,134,320	8,307,108
60%	1,191,515	10,228,812	11,420,326	1,172,788	7,354,171	8,526,958
65%	1,191,515	10,557,640	11,749,154	1,172,788	7,583,200	8,755,988
70%	1,191,515	10,923,833	12,115,348	1,172,788	7,826,016	8,998,804
75%	1,191,515	11,324,993	12,516,508	1,172,788	8,091,285	9,264,073
80%	1,191,515	11,770,499	12,962,013	1,172,788	8,393,265	9,566,052
85%	1,191,515	12,288,647	13,480,162	1,172,788	8,738,895	9,911,682
90%	1,191,515	12,935,064	14,126,579	1,172,788	9,181,902	10,354,690
95%	1,191,515	13,905,755	15,097,269	1,172,788	9,845,735	11,018,522
99%	1,191,515	15,636,758	16,828,273	1,172,788	11,049,437	12,222,225

Table E.17-Risk profile statistics for highway bridge with limited variables limited ADT case 8 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	1,191,515	3,488,900	4,680,415	1,172,788	3,060,108	4,232,895
Maximum	1,191,515	27,636,472	28,827,987	1,172,788	20,345,394	21,518,181
Mean	1,191,515	11,989,349	13,180,864	1,172,788	9,024,098	10,196,886
Std Dev	0	3,473,365	3,473,365	0	2,421,953	2,421,953
Percentile						
1%	1,191,515	5,384,054	6,575,569	1,172,788	4,486,421	5,659,209
5%	1,191,515	6,706,593	7,898,108	1,172,788	5,406,352	6,579,140
10%	1,191,515	7,652,641	8,844,155	1,172,788	6,025,962	7,198,750
15%	1,191,515	8,338,803	9,530,318	1,172,788	6,478,906	7,651,694
20%	1,191,515	8,919,687	10,111,202	1,172,788	6,881,858	8,054,646
25%	1,191,515	9,448,204	10,639,718	1,172,788	7,238,945	8,411,733
30%	1,191,515	9,931,268	11,122,783	1,172,788	7,562,605	8,735,393
35%	1,191,515	10,398,922	11,590,436	1,172,788	7,887,019	9,059,807
40%	1,191,515	10,855,889	12,047,404	1,172,788	8,206,671	9,379,459
45%	1,191,515	11,297,276	12,488,790	1,172,788	8,511,519	9,684,307
50%	1,191,515	11,740,662	12,932,177	1,172,788	8,816,965	9,989,753
55%	1,191,515	12,189,214	13,380,729	1,172,788	9,138,664	10,311,452
60%	1,191,515	12,646,677	13,838,192	1,172,788	9,468,412	10,641,200
65%	1,191,515	13,134,232	14,325,747	1,172,788	9,820,868	10,993,656
70%	1,191,515	13,654,760	14,846,275	1,172,788	10,194,262	11,367,050
75%	1,191,515	14,237,127	15,428,642	1,172,788	10,596,077	11,768,865
80%	1,191,515	14,908,121	16,099,636	1,172,788	11,053,464	12,226,252
85%	1,191,515	15,680,733	16,872,248	1,172,788	11,587,226	12,760,014
90%	1,191,515	16,644,790	17,836,305	1,172,788	12,281,173	13,453,961
95%	1,191,515	18,141,488	19,333,002	1,172,788	13,342,370	14,515,158
99%	1,191,515	20,905,082	22,096,597	1,172,788	15,310,909	16,483,697

Table E.18-Risk profile statistics for highway bridge with limited variables limited ADT case 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	1,191,515	3,630,819	4,822,334	1,172,788	4,062,945	5,235,732
Maximum	1,191,515	51,780,905	52,972,419	1,172,788	39,446,429	40,619,217
Mean	1,191,515	18,954,060	20,145,575	1,172,788	15,113,535	16,286,323
Std Dev	0	6,793,922	6,793,922	0	4,934,438	4,934,438
Percentile						
1%	1,191,515	6,790,427	7,981,942	1,172,788	6,417,171	7,589,959
5%	1,191,515	9,106,776	10,298,290	1,172,788	8,003,825	9,176,613
10%	1,191,515	10,690,025	11,881,540	1,172,788	9,118,223	10,291,010
15%	1,191,515	11,903,771	13,095,285	1,172,788	9,972,371	11,145,159
20%	1,191,515	12,928,679	14,120,193	1,172,788	10,719,392	11,892,180
25%	1,191,515	13,856,813	15,048,328	1,172,788	11,413,417	12,586,205
30%	1,191,515	14,774,944	15,966,459	1,172,788	12,066,786	13,239,573
35%	1,191,515	15,653,127	16,844,642	1,172,788	12,691,319	13,864,107
40%	1,191,515	16,516,123	17,707,637	1,172,788	13,329,887	14,502,675
45%	1,191,515	17,388,127	18,579,642	1,172,788	13,950,831	15,123,619
50%	1,191,515	18,242,351	19,433,866	1,172,788	14,574,847	15,747,635
55%	1,191,515	19,137,425	20,328,940	1,172,788	15,228,700	16,401,488
60%	1,191,515	20,064,542	21,256,057	1,172,788	15,922,301	17,095,089
65%	1,191,515	21,042,285	22,233,800	1,172,788	16,644,567	17,817,354
70%	1,191,515	22,087,186	23,278,701	1,172,788	17,400,277	18,573,064
75%	1,191,515	23,261,676	24,453,191	1,172,788	18,251,343	19,424,131
80%	1,191,515	24,576,359	25,767,874	1,172,788	19,199,757	20,372,545
85%	1,191,515	26,157,461	27,348,976	1,172,788	20,337,043	21,509,831
90%	1,191,515	28,215,126	29,406,641	1,172,788	21,810,461	22,983,249
95%	1,191,515	31,262,028	32,453,542	1,172,788	24,063,670	25,236,457
99%	1,191,515	37,135,618	38,327,133	1,172,788	28,368,467	29,541,255

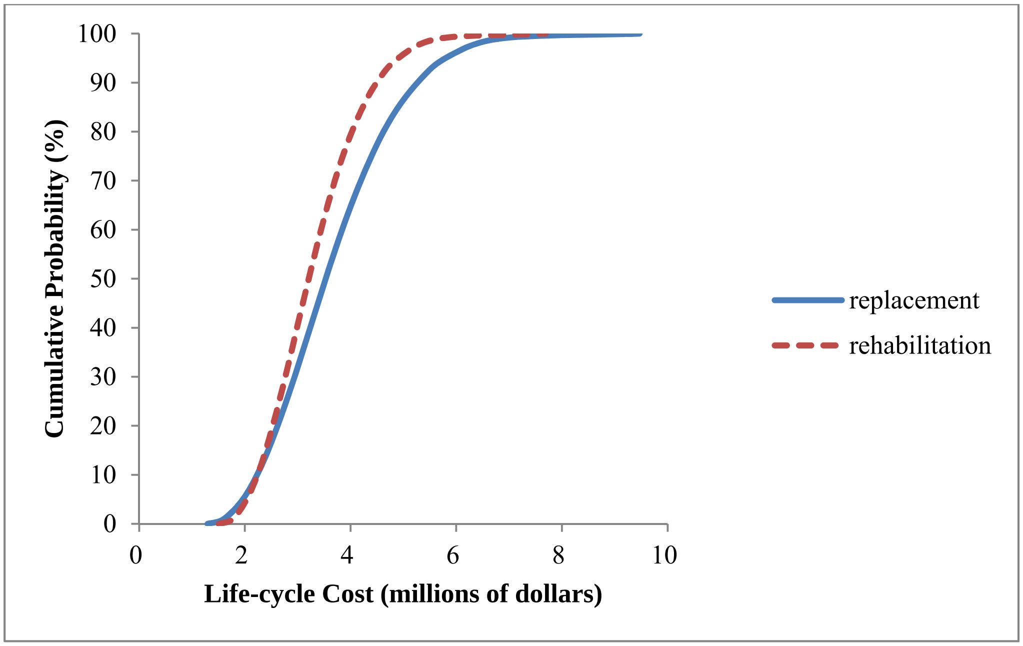


Figure E.19-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 1 (Table 3.6)

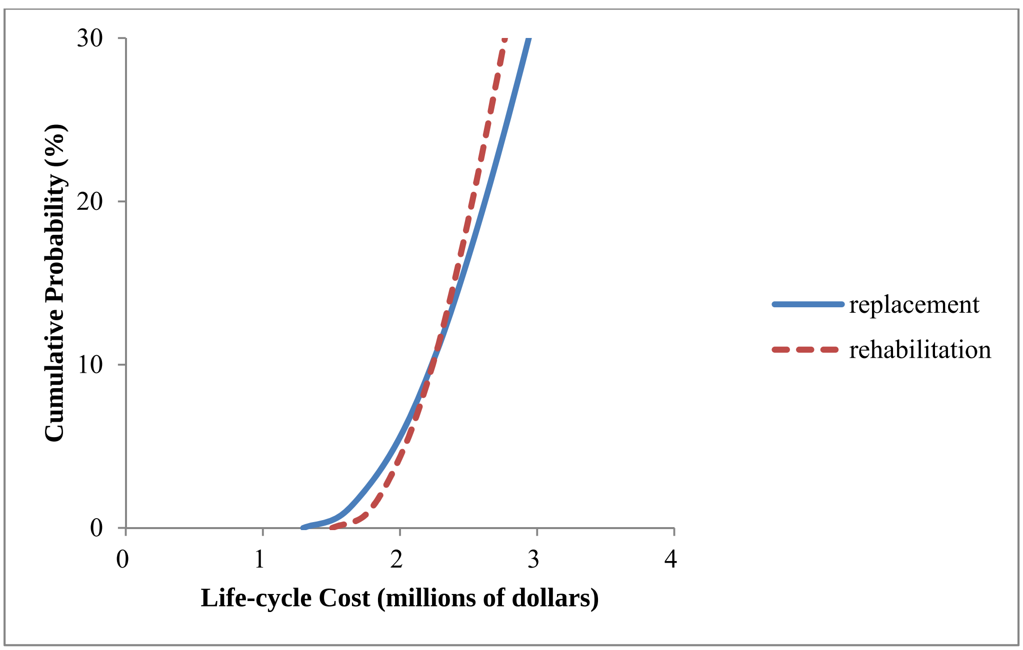


Figure E.20-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 1 (Table 3.6)

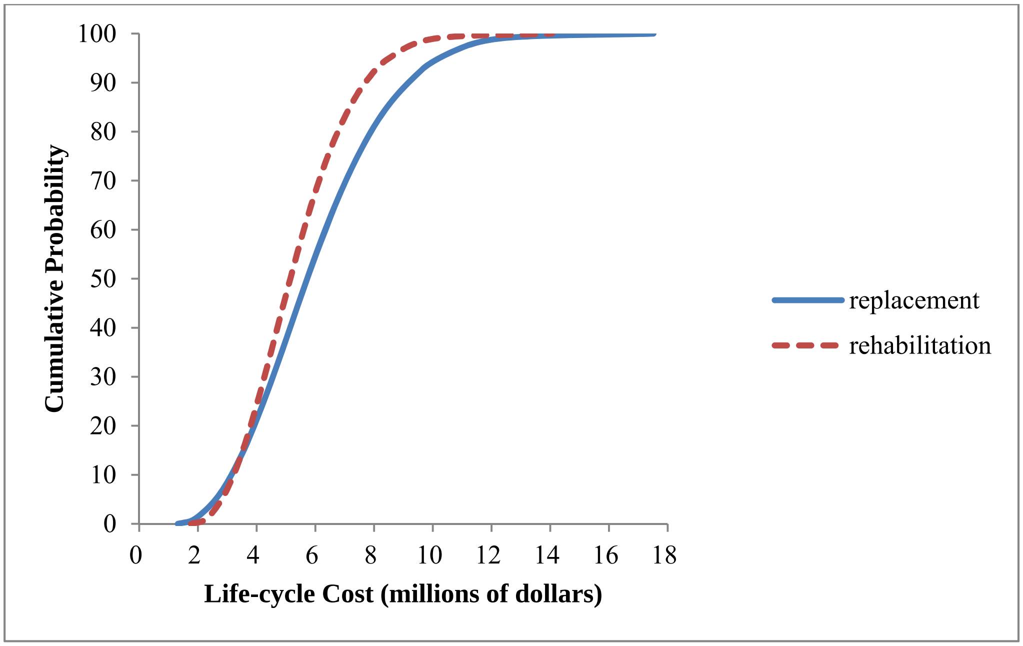


Figure E.21-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 2 (Table 3.6)

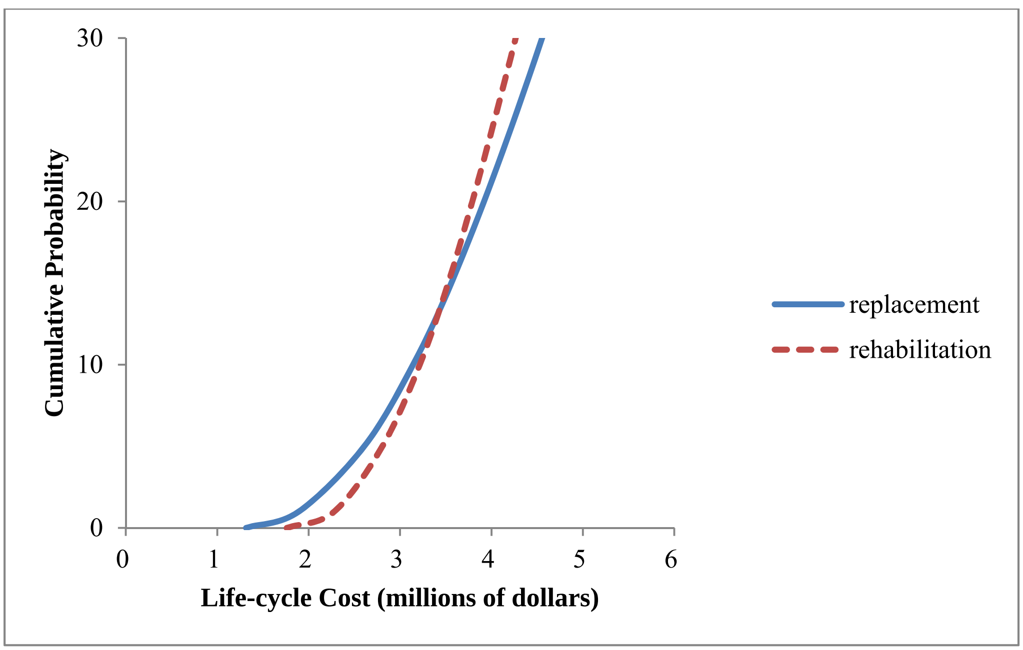


Figure E.22-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 2 (Table 3.6)

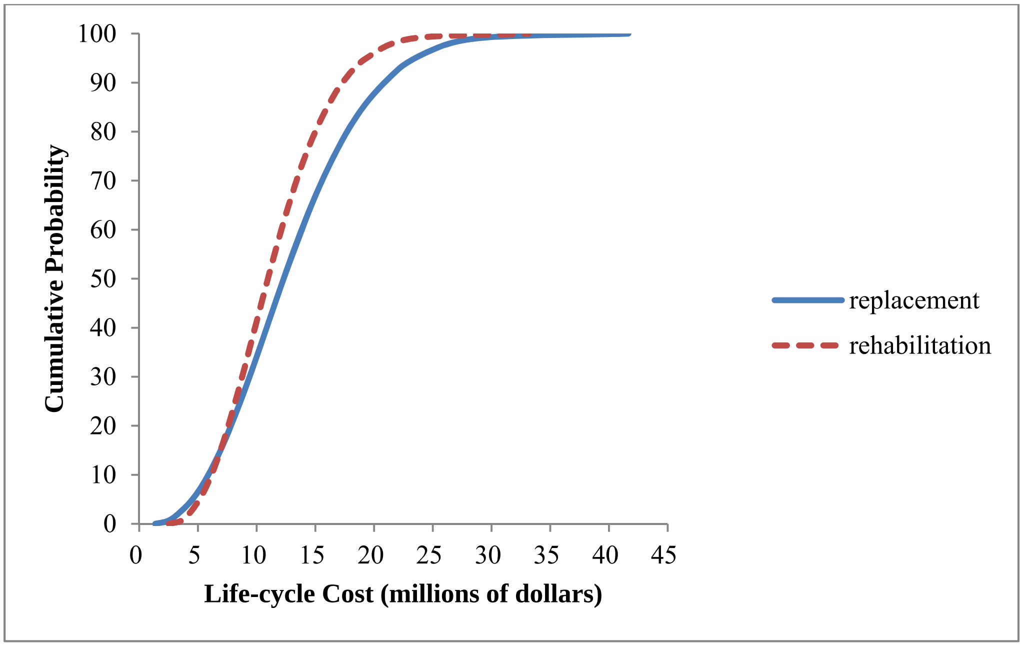


Figure E.23-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 3 (Table 3.6)

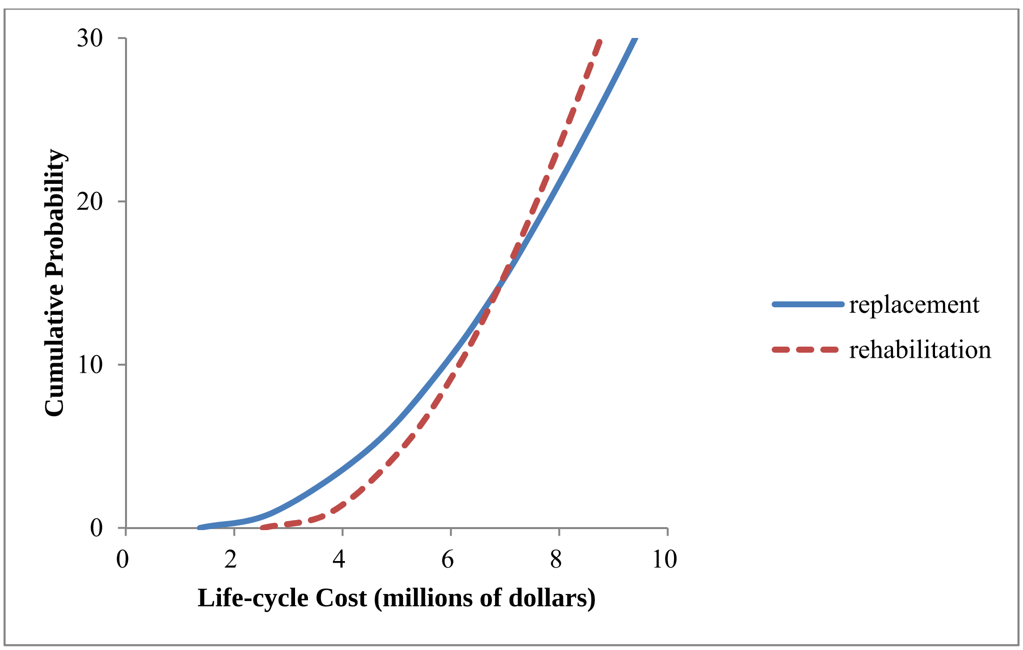


Figure E.24-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 3 (Table 3.6)

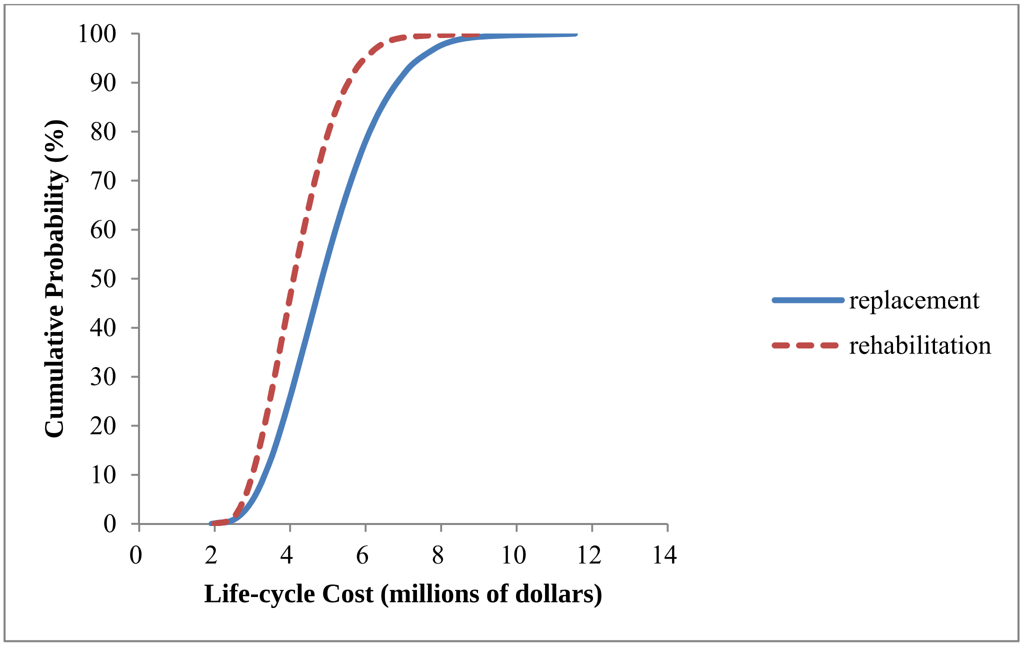


Figure E.25-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 4 (Table 3.6)

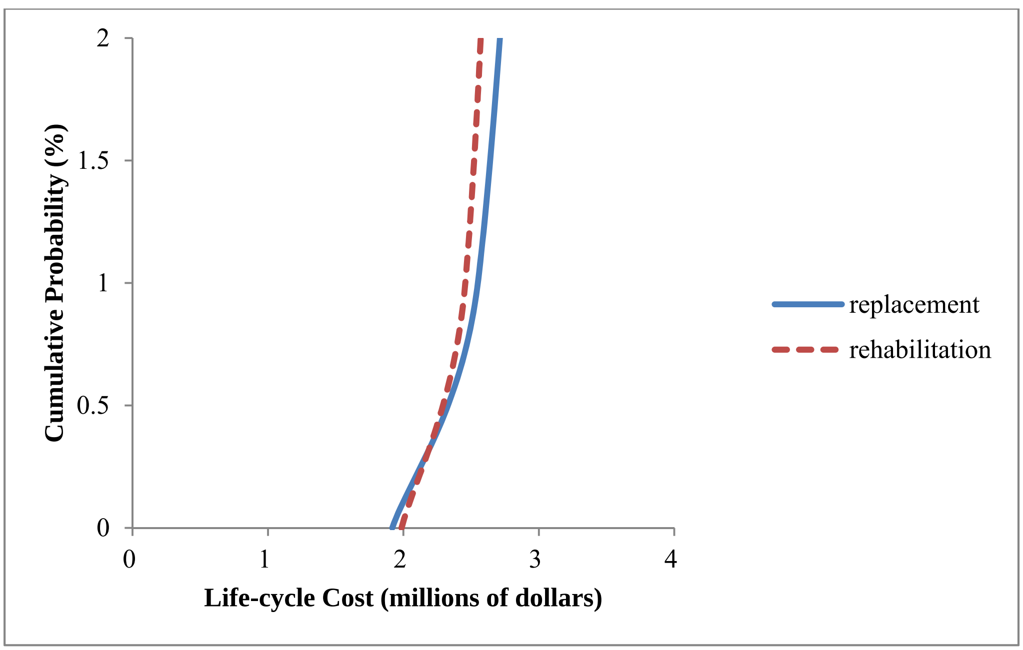


Figure E.26-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 4 (Table 3.6)

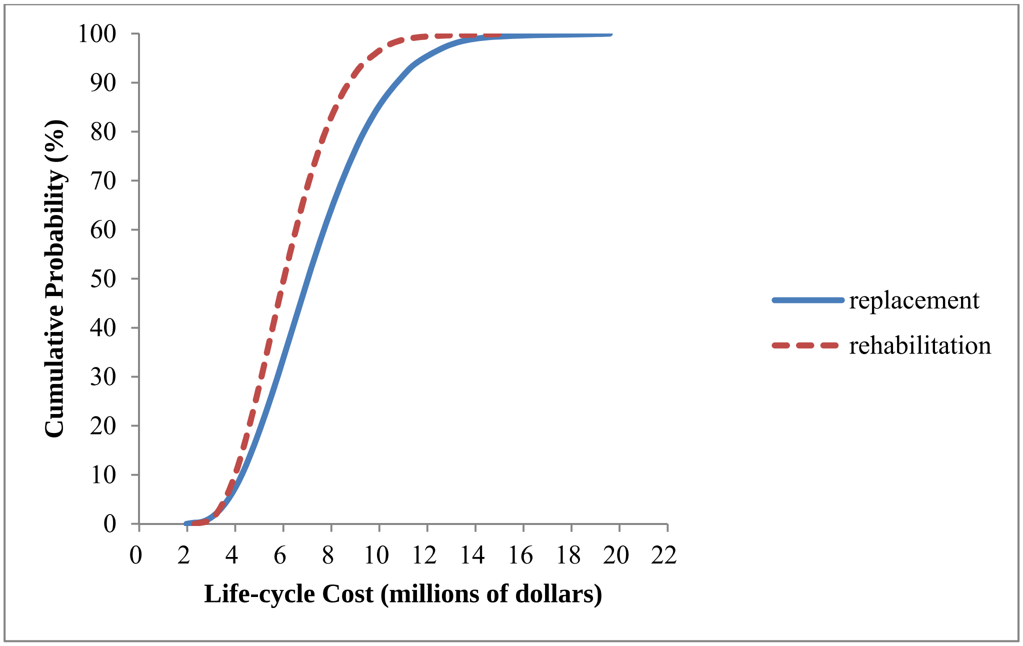


Figure E.27-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 5 (Table 3.6)

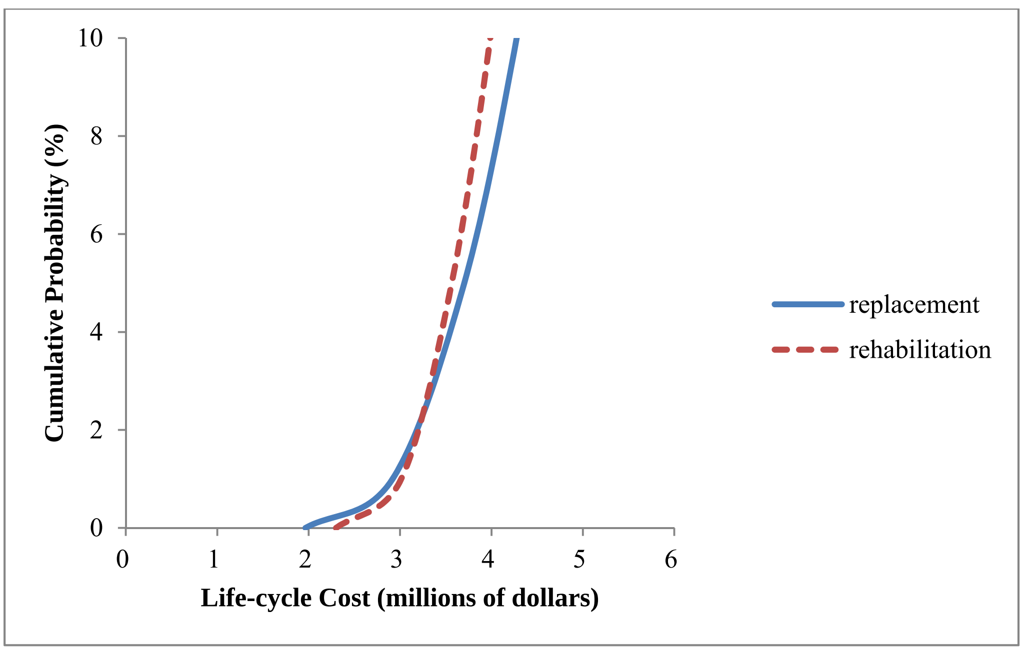


Figure E.28-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 5 (Table 3.6)

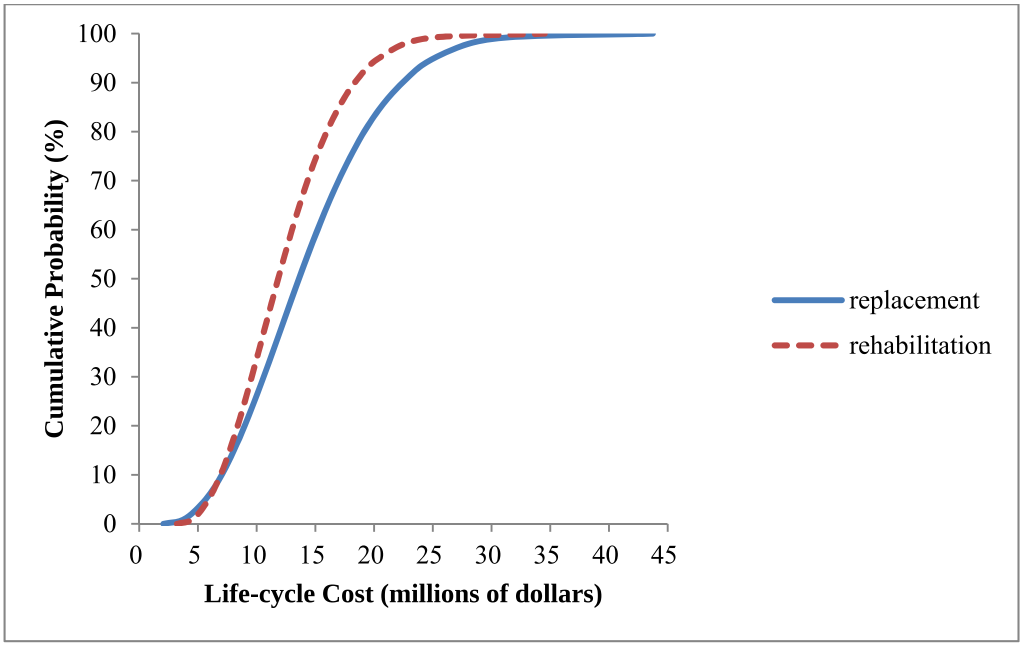


Figure E.29-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 6 (Table 3.6)

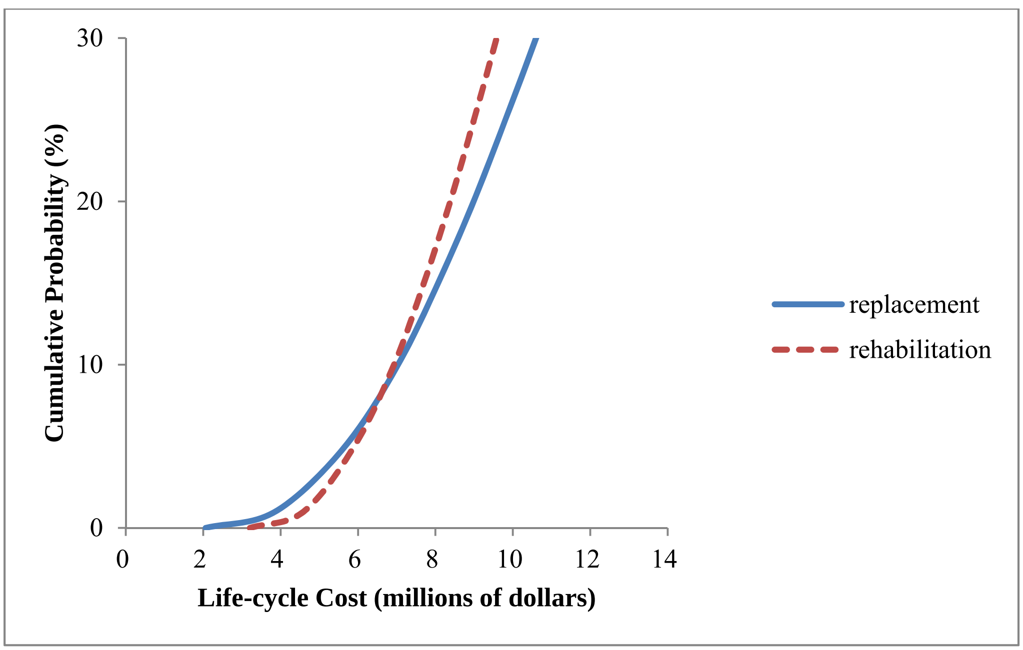


Figure E.30-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 6 (Table 3.6)

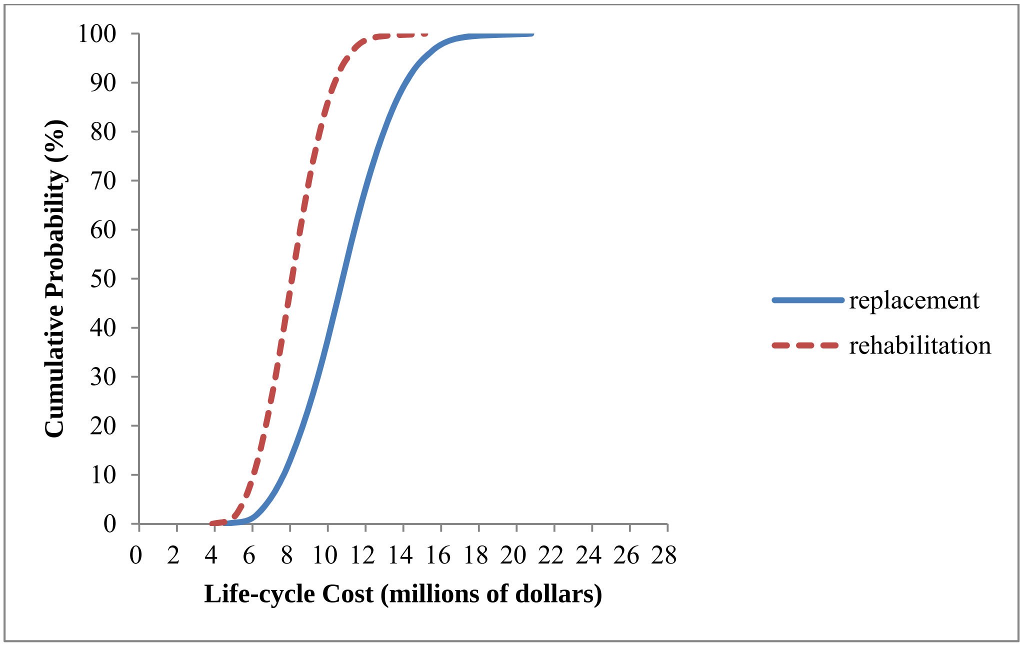


Figure E.31-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 7 (Table 3.6)

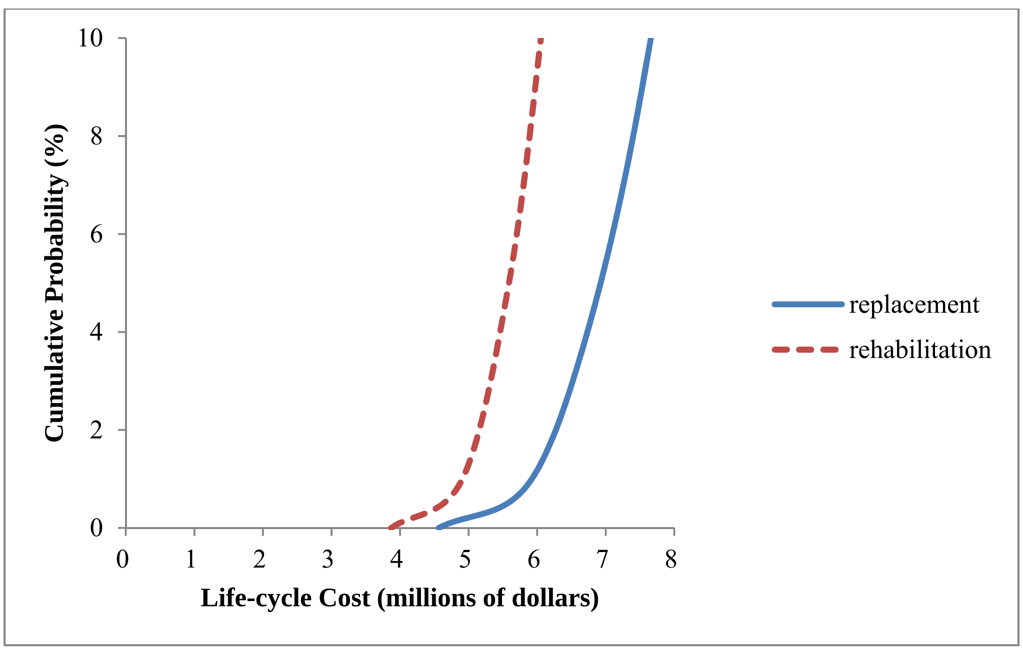


Figure E.32-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 7 (Table 3.6)

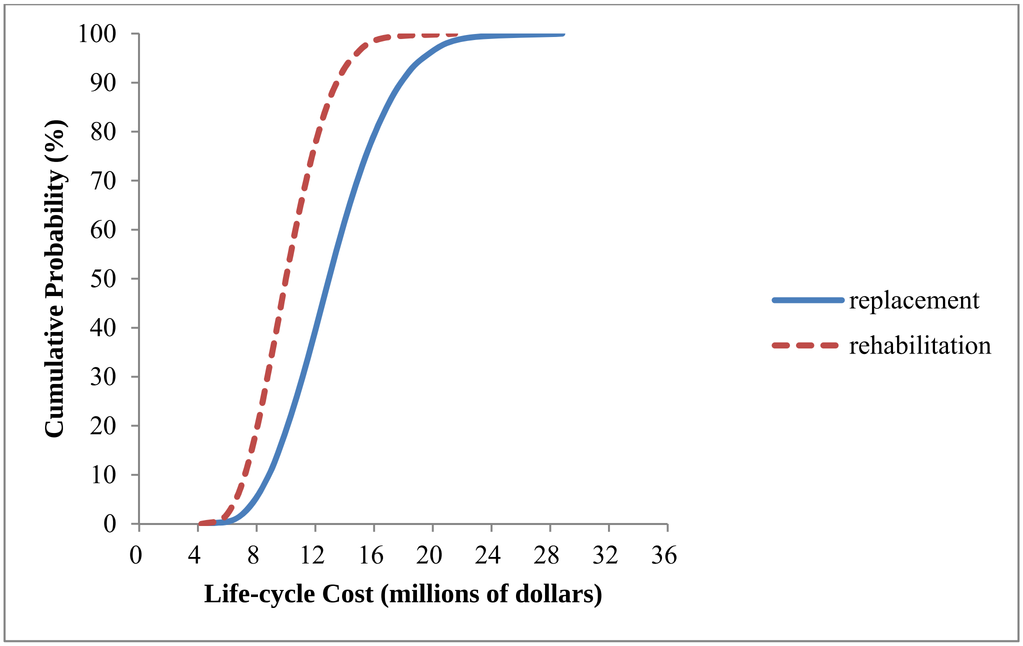


Figure E.33-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 8 (Table 3.6)

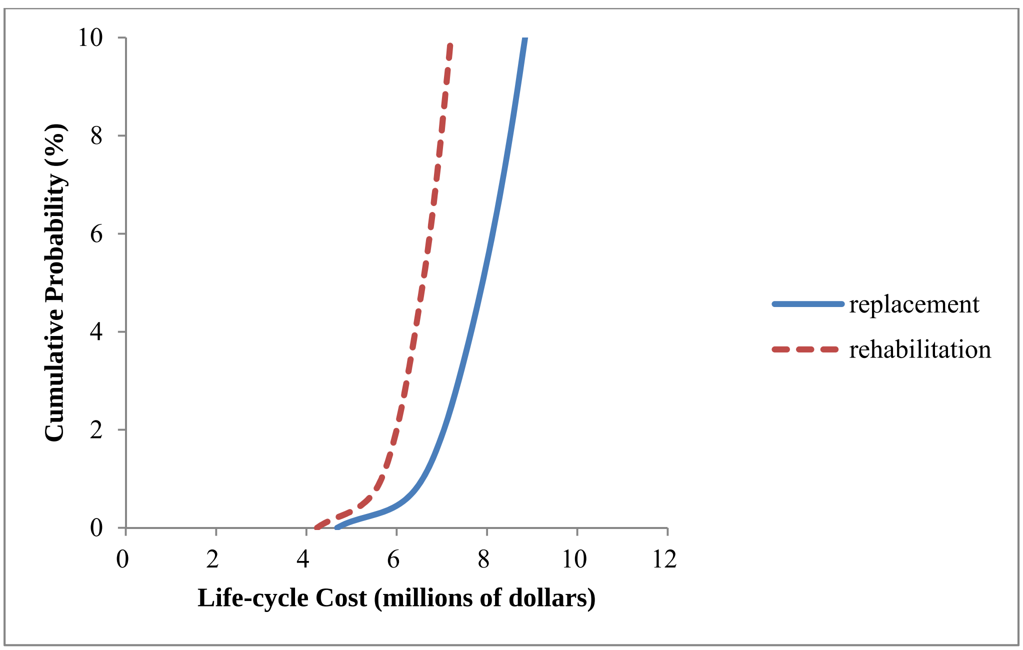


Figure E.34-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 8 (Table 3.6)

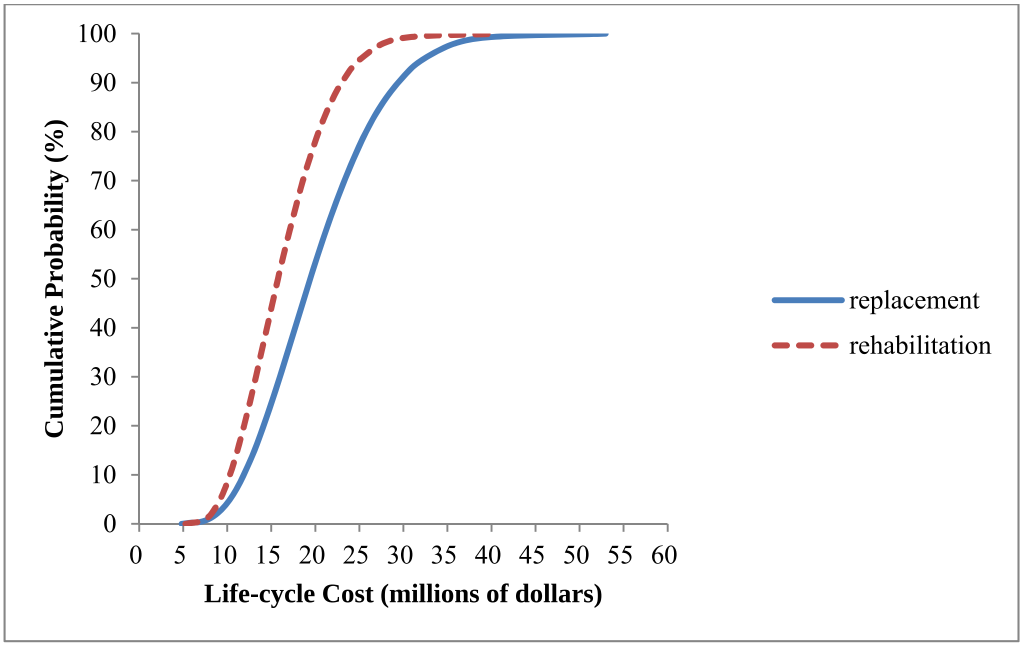


Figure E.35-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 9 (Table 3.6)

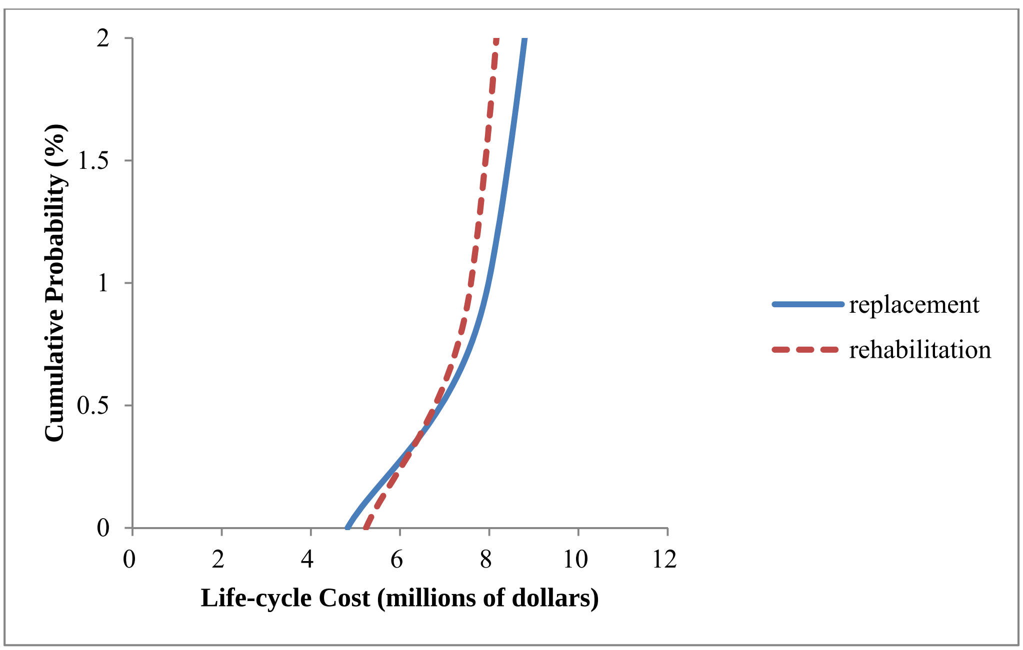


Figure E.36-Ascending cumulative probability distributions for highway bridge with limited variables limited ADT case 9 (Table 3.6)

Bridge over Highway with Modified Bridge Construction Time and Cost

Table E.19-Risk profile statistics for highway bridge with modification 1a ADT case 1 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	90,021	997,558	794,935	325,137	1,309,070
Maximum	1,900,008	6,169,989	7,458,877	2,117,072	5,257,288	6,584,774
Mean	1,203,146	1,940,574	3,143,720	1,250,889	1,775,886	3,026,776
Std Dev	156,583	882,656	896,516	175,993	685,605	714,611
Percentile						
1%	872,316	350,983	1,498,369	918,427	552,626	1,704,352
5%	945,174	641,569	1,824,990	989,862	772,733	1,976,453
10%	998,059	858,168	2,045,021	1,035,656	938,675	2,155,608
15%	1,036,328	1,022,892	2,212,653	1,068,262	1,065,372	2,289,334
20%	1,067,022	1,165,884	2,358,998	1,095,750	1,173,812	2,401,838
25%	1,093,240	1,293,179	2,487,584	1,121,263	1,270,432	2,504,710
30%	1,117,539	1,409,749	2,607,132	1,145,099	1,362,892	2,601,538
35%	1,139,266	1,520,568	2,719,292	1,167,704	1,451,651	2,691,652
40%	1,160,427	1,631,253	2,831,197	1,190,012	1,534,851	2,783,202
45%	1,180,850	1,738,344	2,942,311	1,211,954	1,619,499	2,870,397
50%	1,201,069	1,851,573	3,056,106	1,235,173	1,705,154	2,958,214
55%	1,220,708	1,964,694	3,171,178	1,258,333	1,793,216	3,048,399
60%	1,241,683	2,082,071	3,288,857	1,282,448	1,883,209	3,140,512
65%	1,263,431	2,205,917	3,418,629	1,307,817	1,979,547	3,241,550
70%	1,285,744	2,342,544	3,555,567	1,335,014	2,086,393	3,353,330
75%	1,309,538	2,492,286	3,707,100	1,364,839	2,201,981	3,474,252
80%	1,336,254	2,666,429	3,881,803	1,398,495	2,335,023	3,610,000
85%	1,367,361	2,874,579	4,089,979	1,438,184	2,496,929	3,775,584
90%	1,407,025	3,142,691	4,360,836	1,489,869	2,705,669	3,993,572
95%	1,464,162	3,547,200	4,774,802	1,564,673	3,024,648	4,314,100
99%	1,576,306	4,309,443	5,522,246	1,708,231	3,614,423	4,948,396

Table E.20-Risk profile statistics for highway bridge with modification 1a ADT case 2 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	118,709	1,068,418	794,935	601,470	1,629,127
Maximum	1,900,008	12,077,864	13,366,752	2,117,072	10,358,029	11,665,758
Mean	1,203,146	3,745,172	4,948,318	1,250,889	3,456,912	4,707,801
Std Dev	156,583	1,751,880	1,758,866	175,993	1,361,823	1,379,772
Percentile						
1%	872,316	583,335	1,756,457	918,427	1,019,224	2,218,221
5%	945,174	1,161,993	2,358,478	989,862	1,462,135	2,684,842
10%	998,059	1,594,067	2,791,767	1,035,656	1,793,448	3,024,261
15%	1,036,328	1,922,247	3,121,867	1,068,262	2,043,752	3,279,425
20%	1,067,022	2,209,515	3,407,940	1,095,750	2,262,721	3,497,627
25%	1,093,240	2,462,157	3,657,462	1,121,263	2,454,289	3,693,355
30%	1,117,539	2,692,754	3,893,805	1,145,099	2,637,004	3,879,868
35%	1,139,266	2,913,494	4,114,834	1,167,704	2,813,109	4,057,590
40%	1,160,427	3,133,371	4,333,057	1,190,012	2,979,504	4,228,166
45%	1,180,850	3,346,793	4,553,143	1,211,954	3,147,257	4,399,607
50%	1,201,069	3,568,150	4,772,998	1,235,173	3,317,459	4,570,583
55%	1,220,708	3,795,731	5,001,939	1,258,333	3,492,652	4,743,925
60%	1,241,683	4,025,948	5,231,032	1,282,448	3,671,218	4,922,869
65%	1,263,431	4,271,779	5,480,888	1,307,817	3,862,799	5,118,084
70%	1,285,744	4,543,830	5,753,868	1,335,014	4,074,350	5,334,255
75%	1,309,538	4,842,393	6,049,714	1,364,839	4,304,160	5,567,692
80%	1,336,254	5,185,603	6,396,850	1,398,495	4,566,549	5,830,948
85%	1,367,361	5,599,326	6,805,875	1,438,184	4,887,850	6,160,430
90%	1,407,025	6,131,129	7,336,113	1,489,869	5,303,333	6,575,655
95%	1,464,162	6,929,193	8,149,573	1,564,673	5,932,972	7,211,992
99%	1,576,306	8,448,706	9,629,246	1,708,231	7,112,082	8,424,459

Table E.21-Risk profile statistics for highway bridge with modification 1a ADT case 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	168,106	1,191,470	794,935	1,406,645	2,510,383
Maximum	1,900,008	29,801,489	31,090,376	2,117,072	25,660,251	26,967,980
Mean	1,203,146	9,158,966	10,362,112	1,250,889	8,499,989	9,750,878
Std Dev	156,583	4,360,248	4,363,015	175,993	3,390,877	3,401,917
Percentile						
1%	872,316	1,277,851	2,468,095	918,427	2,425,776	3,652,798
5%	945,174	2,722,589	3,929,628	989,862	3,526,149	4,758,878
10%	998,059	3,801,069	5,001,271	1,035,656	4,356,068	5,598,399
15%	1,036,328	4,622,680	5,827,959	1,068,262	4,983,611	6,223,611
20%	1,067,022	5,336,871	6,533,341	1,095,750	5,527,492	6,767,014
25%	1,093,240	5,971,690	7,170,912	1,121,263	6,004,540	7,247,829
30%	1,117,539	6,542,224	7,746,759	1,145,099	6,458,996	7,706,494
35%	1,139,266	7,092,901	8,293,575	1,167,704	6,896,524	8,142,161
40%	1,160,427	7,640,337	8,837,343	1,190,012	7,313,531	8,566,048
45%	1,180,850	8,175,023	9,375,704	1,211,954	7,733,883	8,982,544
50%	1,201,069	8,722,896	9,930,136	1,235,173	8,154,275	9,408,297
55%	1,220,708	9,286,985	10,491,821	1,258,333	8,592,671	9,839,576
60%	1,241,683	9,856,682	11,063,874	1,282,448	9,036,346	10,287,804
65%	1,263,431	10,468,818	11,677,675	1,307,817	9,510,853	10,755,360
70%	1,285,744	11,145,870	12,358,697	1,335,014	10,036,815	11,291,875
75%	1,309,538	11,891,578	13,095,909	1,364,839	10,610,228	11,870,950
80%	1,336,254	12,744,660	13,949,661	1,398,495	11,262,566	12,518,538
85%	1,367,361	13,772,002	14,973,482	1,438,184	12,065,175	13,328,162
90%	1,407,025	15,092,570	16,295,835	1,489,869	13,096,259	14,360,132
95%	1,464,162	17,076,288	18,286,772	1,564,673	14,665,803	15,925,793
99%	1,576,306	20,850,612	22,031,936	1,708,231	17,599,181	18,868,732

Table E.22-Risk profile statistics for highway bridge with modification 1a ADT case 4 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	642,010	1,771,192	794,935	717,009	1,775,760
Maximum	1,900,008	8,529,020	9,817,908	2,117,072	6,666,214	8,073,471
Mean	1,203,146	3,164,359	4,367,505	1,250,889	2,629,633	3,880,523
Std Dev	156,583	1,045,795	1,058,676	175,993	794,843	825,713
Percentile						
1%	872,316	1,258,634	2,419,910	918,427	1,205,917	2,358,550
5%	945,174	1,640,809	2,819,098	989,862	1,478,195	2,675,969
10%	998,059	1,895,584	3,081,438	1,035,656	1,666,617	2,879,974
15%	1,036,328	2,083,236	3,275,555	1,068,262	1,812,154	3,033,052
20%	1,067,022	2,244,368	3,442,253	1,095,750	1,933,629	3,159,281
25%	1,093,240	2,391,810	3,589,094	1,121,263	2,043,447	3,278,524
30%	1,117,539	2,529,702	3,726,621	1,145,099	2,145,312	3,387,241
35%	1,139,266	2,662,735	3,862,247	1,167,704	2,249,019	3,491,116
40%	1,160,427	2,794,292	3,993,504	1,190,012	2,347,291	3,592,615
45%	1,180,850	2,921,849	4,123,998	1,211,954	2,446,127	3,696,558
50%	1,201,069	3,052,076	4,259,276	1,235,173	2,543,022	3,794,775
55%	1,220,708	3,193,318	4,398,662	1,258,333	2,644,258	3,901,123
60%	1,241,683	3,333,619	4,537,359	1,282,448	2,752,254	4,013,061
65%	1,263,431	3,481,404	4,690,594	1,307,817	2,866,938	4,129,807
70%	1,285,744	3,644,032	4,856,531	1,335,014	2,988,436	4,255,846
75%	1,309,538	3,819,026	5,037,071	1,364,839	3,123,061	4,395,470
80%	1,336,254	4,024,042	5,242,987	1,398,495	3,278,814	4,552,408
85%	1,367,361	4,274,788	5,487,659	1,438,184	3,465,580	4,748,451
90%	1,407,025	4,585,916	5,806,514	1,489,869	3,708,530	4,998,910
95%	1,464,162	5,066,175	6,283,098	1,564,673	4,074,613	5,367,879
99%	1,576,306	5,959,638	7,192,815	1,708,231	4,778,293	6,107,046

Table E.23-Risk profile statistics for highway bridge with modification 1a ADT case 5 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	670,698	1,801,763	794,935	1,020,890	2,169,823
Maximum	1,900,008	14,436,895	15,725,783	2,117,072	11,766,955	13,074,684
Mean	1,203,146	4,968,957	6,172,103	1,250,889	4,310,659	5,561,548
Std Dev	156,583	1,892,132	1,899,248	175,993	1,457,543	1,477,515
Percentile						
1%	872,316	1,575,032	2,743,552	918,427	1,724,391	2,913,798
5%	945,174	2,215,293	3,408,017	989,862	2,196,267	3,413,297
10%	998,059	2,661,202	3,856,579	1,035,656	2,542,371	3,771,732
15%	1,036,328	3,009,494	4,204,284	1,068,262	2,803,700	4,039,200
20%	1,067,022	3,304,766	4,501,954	1,095,750	3,027,948	4,263,684
25%	1,093,240	3,570,901	4,768,206	1,121,263	3,232,435	4,472,647
30%	1,117,539	3,819,268	5,018,345	1,145,099	3,424,641	4,668,350
35%	1,139,266	4,058,087	5,259,468	1,167,704	3,611,496	4,856,750
40%	1,160,427	4,299,558	5,496,743	1,190,012	3,796,244	5,042,664
45%	1,180,850	4,529,320	5,730,417	1,211,954	3,972,270	5,224,136
50%	1,201,069	4,766,424	5,972,543	1,235,173	4,152,253	5,404,507
55%	1,220,708	5,013,043	6,221,386	1,258,333	4,341,019	5,594,613
60%	1,241,683	5,268,833	6,470,136	1,282,448	4,533,513	5,789,633
65%	1,263,431	5,538,018	6,745,132	1,307,817	4,743,805	5,999,135
70%	1,285,744	5,829,558	7,039,733	1,335,014	4,968,614	6,227,590
75%	1,309,538	6,153,921	7,365,776	1,364,839	5,216,906	6,478,907
80%	1,336,254	6,526,298	7,736,039	1,398,495	5,498,219	6,762,812
85%	1,367,361	6,973,195	8,186,452	1,438,184	5,847,661	7,115,695
90%	1,407,025	7,554,707	8,760,929	1,489,869	6,292,134	7,567,834
95%	1,464,162	8,415,690	9,632,605	1,564,673	6,966,491	8,241,989
99%	1,576,306	10,042,927	11,272,776	1,708,231	8,237,043	9,545,733

Table E.24-Risk profile statistics for highway bridge with modification 1a ADT case 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	756,764	1,878,062	794,935	1,869,712	3,094,899
Maximum	1,900,008	32,160,520	33,449,407	2,117,072	27,069,177	28,376,906
Mean	1,203,146	10,382,751	11,585,897	1,250,889	9,353,736	10,604,625
Std Dev	156,583	4,484,671	4,487,634	175,993	3,477,407	3,489,522
Percentile						
1%	872,316	2,332,655	3,532,769	918,427	3,170,503	4,388,169
5%	945,174	3,809,736	5,004,451	989,862	4,279,339	5,519,735
10%	998,059	4,890,918	6,096,907	1,035,656	5,117,681	6,355,594
15%	1,036,328	5,718,814	6,919,969	1,068,262	5,756,658	6,993,299
20%	1,067,022	6,441,654	7,647,795	1,095,750	6,298,123	7,535,326
25%	1,093,240	7,088,499	8,282,768	1,121,263	6,788,551	8,027,523
30%	1,117,539	7,672,997	8,876,055	1,145,099	7,255,803	8,498,880
35%	1,139,266	8,238,469	9,441,882	1,167,704	7,696,878	8,946,118
40%	1,160,427	8,801,078	10,000,055	1,190,012	8,128,977	9,378,029
45%	1,180,850	9,347,148	10,553,182	1,211,954	8,556,178	9,806,382
50%	1,201,069	9,924,011	11,129,998	1,235,173	8,986,386	10,241,860
55%	1,220,708	10,503,668	11,709,480	1,258,333	9,435,293	10,684,449
60%	1,241,683	11,098,011	12,300,194	1,282,448	9,891,651	11,145,651
65%	1,263,431	11,732,557	12,934,898	1,307,817	10,387,019	11,630,014
70%	1,285,744	12,419,411	13,631,429	1,335,014	10,928,777	12,183,379
75%	1,309,538	13,193,320	14,395,870	1,364,839	11,515,149	12,772,000
80%	1,336,254	14,072,070	15,279,160	1,398,495	12,189,775	13,451,938
85%	1,367,361	15,127,400	16,338,058	1,438,184	13,008,667	14,271,654
90%	1,407,025	16,492,394	17,692,526	1,489,869	14,073,898	15,344,131
95%	1,464,162	18,549,604	19,762,810	1,564,673	15,693,767	16,957,775
99%	1,576,306	22,423,928	23,645,323	1,708,231	18,693,984	19,981,028

Table E.25-Risk profile statistics for highway bridge with modification 1a ADT case 7 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	2,956,087	4,012,547	794,935	2,369,518	3,443,181
Maximum	1,900,008	20,074,314	21,438,445	2,117,072	15,347,922	16,496,884
Mean	1,203,146	8,603,403	9,806,549	1,250,889	6,424,063	7,674,953
Std Dev	156,583	2,197,875	2,206,502	175,993	1,552,791	1,582,094
Percentile						
1%	872,316	4,465,754	5,644,656	918,427	3,528,004	4,696,844
5%	945,174	5,325,220	6,517,269	989,862	4,141,612	5,341,159
10%	998,059	5,903,678	7,089,596	1,035,656	4,532,428	5,755,112
15%	1,036,328	6,320,163	7,519,347	1,068,262	4,833,873	6,056,036
20%	1,067,022	6,674,350	7,873,262	1,095,750	5,077,816	6,303,979
25%	1,093,240	7,000,415	8,198,952	1,121,263	5,297,420	6,527,704
30%	1,117,539	7,301,874	8,500,382	1,145,099	5,495,509	6,734,208
35%	1,139,266	7,583,302	8,783,267	1,167,704	5,689,813	6,931,764
40%	1,160,427	7,860,236	9,062,461	1,190,012	5,886,554	7,124,974
45%	1,180,850	8,141,292	9,344,022	1,211,954	6,083,077	7,325,691
50%	1,201,069	8,414,048	9,617,236	1,235,173	6,276,841	7,527,360
55%	1,220,708	8,692,930	9,900,772	1,258,333	6,472,007	7,730,012
60%	1,241,683	8,990,510	10,193,211	1,282,448	6,678,784	7,940,918
65%	1,263,431	9,306,283	10,508,589	1,307,817	6,901,675	8,161,561
70%	1,285,744	9,636,301	10,849,126	1,335,014	7,138,812	8,403,624
75%	1,309,538	10,001,446	11,207,134	1,364,839	7,398,173	8,668,785
80%	1,336,254	10,420,380	11,630,980	1,398,495	7,693,722	8,967,514
85%	1,367,361	10,914,810	12,128,048	1,438,184	8,054,170	9,331,975
90%	1,407,025	11,557,559	12,770,846	1,489,869	8,514,851	9,795,780
95%	1,464,162	12,528,913	13,744,229	1,564,673	9,203,966	10,509,761
99%	1,576,306	14,400,405	15,625,073	1,708,231	10,595,308	11,928,909

Table E.26-Risk profile statistics for highway bridge with modification 1a ADT case 8 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	3,076,646	4,160,174	794,935	2,673,399	3,841,428
Maximum	1,900,008	24,921,478	26,210,365	2,117,072	18,878,028	20,288,470
Mean	1,203,146	10,408,001	11,611,147	1,250,889	8,105,089	9,355,978
Std Dev	156,583	2,861,880	2,868,488	175,993	2,093,914	2,117,765
Percentile						
1%	872,316	5,066,257	6,242,360	918,427	4,243,157	5,422,548
5%	945,174	6,182,493	7,372,902	989,862	5,044,770	6,258,382
10%	998,059	6,901,578	8,099,713	1,035,656	5,569,733	6,793,244
15%	1,036,328	7,444,228	8,645,607	1,068,262	5,950,411	7,176,311
20%	1,067,022	7,897,230	9,093,226	1,095,750	6,276,663	7,507,743
25%	1,093,240	8,309,691	9,510,777	1,121,263	6,569,581	7,806,266
30%	1,117,539	8,695,026	9,892,703	1,145,099	6,848,010	8,087,304
35%	1,139,266	9,063,264	10,265,840	1,167,704	7,113,727	8,356,416
40%	1,160,427	9,419,228	10,618,942	1,190,012	7,372,759	8,619,827
45%	1,180,850	9,784,031	10,988,206	1,211,954	7,630,150	8,879,099
50%	1,201,069	10,148,137	11,350,609	1,235,173	7,897,302	9,141,470
55%	1,220,708	10,518,290	11,720,536	1,258,333	8,167,842	9,422,124
60%	1,241,683	10,902,672	12,102,207	1,282,448	8,448,227	9,704,457
65%	1,263,431	11,308,308	12,513,996	1,307,817	8,741,642	10,002,771
70%	1,285,744	11,749,359	12,955,900	1,335,014	9,058,735	10,319,762
75%	1,309,538	12,233,301	13,441,958	1,364,839	9,413,700	10,676,581
80%	1,336,254	12,772,219	13,985,034	1,398,495	9,819,331	11,085,661
85%	1,367,361	13,427,567	14,638,717	1,438,184	10,306,708	11,580,532
90%	1,407,025	14,262,808	15,474,093	1,489,869	10,935,629	12,214,854
95%	1,464,162	15,543,452	16,760,078	1,564,673	11,871,299	13,148,019
99%	1,576,306	17,958,254	19,165,358	1,708,231	13,746,767	15,059,833

Table E.27-Risk profile statistics for highway bridge with modification 1a ADT case 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	3,210,049	4,463,100	794,935	3,585,043	4,777,869
Maximum	1,900,008	42,645,102	43,933,990	2,117,072	33,331,071	34,638,800
Mean	1,203,146	15,821,795	17,024,941	1,250,889	13,148,166	14,399,055
Std Dev	156,583	5,228,973	5,232,555	175,993	3,974,215	3,990,066
Percentile						
1%	872,316	6,293,168	7,507,595	918,427	6,029,587	7,234,775
5%	945,174	8,204,045	9,401,734	989,862	7,390,977	8,616,700
10%	998,059	9,477,921	10,674,422	1,035,656	8,333,083	9,570,171
15%	1,036,328	10,416,179	11,621,841	1,068,262	9,060,772	10,297,799
20%	1,067,022	11,221,838	12,429,409	1,095,750	9,668,144	10,908,457
25%	1,093,240	11,959,051	13,161,047	1,121,263	10,217,237	11,449,992
30%	1,117,539	12,648,508	13,842,045	1,145,099	10,726,561	11,971,849
35%	1,139,266	13,313,676	14,518,855	1,167,704	11,245,093	12,493,007
40%	1,160,427	13,971,462	15,174,979	1,190,012	11,736,454	12,984,129
45%	1,180,850	14,609,245	15,814,882	1,211,954	12,230,633	13,480,860
50%	1,201,069	15,260,379	16,474,302	1,235,173	12,715,112	13,964,203
55%	1,220,708	15,966,588	17,161,367	1,258,333	13,221,292	14,475,638
60%	1,241,683	16,668,096	17,863,934	1,282,448	13,761,268	15,015,849
65%	1,263,431	17,407,021	18,613,495	1,307,817	14,334,688	15,588,001
70%	1,285,744	18,220,159	19,429,094	1,335,014	14,942,179	16,199,912
75%	1,309,538	19,095,131	20,315,728	1,364,839	15,615,304	16,874,316
80%	1,336,254	20,120,211	21,326,163	1,398,495	16,394,069	17,650,827
85%	1,367,361	21,373,942	22,579,698	1,438,184	17,327,900	18,603,276
90%	1,407,025	22,929,578	24,132,666	1,489,869	18,542,650	19,809,358
95%	1,464,162	25,330,877	26,527,996	1,564,673	20,373,063	21,643,298
99%	1,576,306	29,798,190	31,028,078	1,708,231	23,891,464	25,162,864

Table E.28-Risk profile statistics for highway bridge with modification 1b ADT case 1 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	792,740	90,021	1,027,298	808,309	325,137	1,327,996
Maximum	1,944,452	6,169,989	7,503,321	2,146,195	5,257,288	6,611,554
Mean	1,247,249	1,940,574	3,187,823	1,272,986	1,775,886	3,048,873
Std Dev	157,243	882,656	896,632	177,405	685,605	715,229
Percentile						
1%	909,437	350,983	1,542,613	936,836	552,626	1,724,515
5%	987,669	641,569	1,868,950	1,009,296	772,733	1,998,067
10%	1,042,125	858,168	2,089,047	1,055,715	938,675	2,176,296
15%	1,080,624	1,022,892	2,256,740	1,089,072	1,065,372	2,310,547
20%	1,111,453	1,165,884	2,402,901	1,116,431	1,173,812	2,423,929
25%	1,137,683	1,293,179	2,531,709	1,142,526	1,270,432	2,526,670
30%	1,161,984	1,409,749	2,651,148	1,166,589	1,362,892	2,623,376
35%	1,183,711	1,520,568	2,763,153	1,189,459	1,451,651	2,713,262
40%	1,204,872	1,631,253	2,875,041	1,211,881	1,534,851	2,805,375
45%	1,225,295	1,738,344	2,986,307	1,234,111	1,619,499	2,892,470
50%	1,245,513	1,851,573	3,100,183	1,257,297	1,705,154	2,980,107
55%	1,265,153	1,964,694	3,215,442	1,280,642	1,793,216	3,070,626
60%	1,286,127	2,082,071	3,333,154	1,304,810	1,883,209	3,162,718
65%	1,307,875	2,205,917	3,462,756	1,330,303	1,979,547	3,263,939
70%	1,330,189	2,342,544	3,599,787	1,357,949	2,086,393	3,375,736
75%	1,353,983	2,492,286	3,751,284	1,387,921	2,201,981	3,496,441
80%	1,380,699	2,666,429	3,926,162	1,421,829	2,335,023	3,632,643
85%	1,411,806	2,874,579	4,134,195	1,461,708	2,496,929	3,798,429
90%	1,451,469	3,142,691	4,404,918	1,513,580	2,705,669	4,016,266
95%	1,508,607	3,547,200	4,819,204	1,589,424	3,024,648	4,337,728
99%	1,620,750	4,309,443	5,566,691	1,733,931	3,614,423	4,973,817

Table E.29-Risk profile statistics for highway bridge with modification 1b ADT case 2 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	792,740	118,709	1,098,158	808,309	601,470	1,647,654
Maximum	1,944,452	12,077,864	13,411,196	2,146,195	10,358,029	11,695,896
Mean	1,247,249	3,745,172	4,992,421	1,272,986	3,456,912	4,729,898
Std Dev	157,243	1,751,880	1,758,926	177,405	1,361,823	1,380,218
Percentile						
1%	909,437	583,335	1,800,325	936,836	1,019,224	2,239,490
5%	987,669	1,161,993	2,402,316	1,009,296	1,462,135	2,706,265
10%	1,042,125	1,594,067	2,835,769	1,055,715	1,793,448	3,045,345
15%	1,080,624	1,922,247	3,166,062	1,089,072	2,043,752	3,300,793
20%	1,111,453	2,209,515	3,452,184	1,116,431	2,262,721	3,520,034
25%	1,137,683	2,462,157	3,701,251	1,142,526	2,454,289	3,715,374
30%	1,161,984	2,692,754	3,938,109	1,166,589	2,637,004	3,901,400
35%	1,183,711	2,913,494	4,158,958	1,189,459	2,813,109	4,079,700
40%	1,204,872	3,133,371	4,376,839	1,211,881	2,979,504	4,250,507
45%	1,225,295	3,346,793	4,597,366	1,234,111	3,147,257	4,421,319
50%	1,245,513	3,568,150	4,816,827	1,257,297	3,317,459	4,592,720
55%	1,265,153	3,795,731	5,046,169	1,280,642	3,492,652	4,766,220
60%	1,286,127	4,025,948	5,274,931	1,304,810	3,671,218	4,945,272
65%	1,307,875	4,271,779	5,524,808	1,330,303	3,862,799	5,140,729
70%	1,330,189	4,543,830	5,798,034	1,357,949	4,074,350	5,356,842
75%	1,353,983	4,842,393	6,093,998	1,387,921	4,304,160	5,589,340
80%	1,380,699	5,185,603	6,441,133	1,421,829	4,566,549	5,853,548
85%	1,411,806	5,599,326	6,850,029	1,461,708	4,887,850	6,183,198
90%	1,451,469	6,131,129	7,380,430	1,513,580	5,303,333	6,598,026
95%	1,508,607	6,929,193	8,193,805	1,589,424	5,932,972	7,235,192
99%	1,620,750	8,448,706	9,672,596	1,733,931	7,112,082	8,447,405

Table E.30-Risk profile statistics for highway bridge with modification 1b ADT case 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	792,740	168,106	1,235,915	808,309	1,406,645	2,531,366
Maximum	1,944,452	29,801,489	31,134,821	2,146,195	25,660,251	26,998,118
Mean	1,247,249	9,158,966	10,406,214	1,272,986	8,499,989	9,772,975
Std Dev	157,243	4,360,248	4,363,039	177,405	3,390,877	3,402,251
Percentile						
1%	909,437	1,277,851	2,512,540	936,836	2,425,776	3,673,196
5%	987,669	2,722,589	3,973,555	1,009,296	3,526,149	4,780,419
10%	1,042,125	3,801,069	5,045,716	1,055,715	4,356,068	5,619,889
15%	1,080,624	4,622,680	5,872,142	1,089,072	4,983,611	6,244,742
20%	1,111,453	5,336,871	6,577,596	1,116,431	5,527,492	6,789,275
25%	1,137,683	5,971,690	7,215,241	1,142,526	6,004,540	7,269,772
30%	1,161,984	6,542,224	7,789,990	1,166,589	6,458,996	7,727,454
35%	1,183,711	7,092,901	8,337,722	1,189,459	6,896,524	8,163,191
40%	1,204,872	7,640,337	8,881,592	1,211,881	7,313,531	8,586,967
45%	1,225,295	8,175,023	9,419,962	1,234,111	7,733,883	9,004,201
50%	1,245,513	8,722,896	9,974,581	1,257,297	8,154,275	9,429,955
55%	1,265,153	9,286,985	10,536,100	1,280,642	8,592,671	9,861,931
60%	1,286,127	9,856,682	11,108,088	1,304,810	9,036,346	10,309,819
65%	1,307,875	10,468,818	11,721,793	1,330,303	9,510,853	10,778,112
70%	1,330,189	11,145,870	12,402,487	1,357,949	10,036,815	11,314,651
75%	1,353,983	11,891,578	13,140,354	1,387,921	10,610,228	11,892,448
80%	1,380,699	12,744,660	13,994,106	1,421,829	11,262,566	12,540,607
85%	1,411,806	13,772,002	15,017,927	1,461,708	12,065,175	13,350,542
90%	1,451,469	15,092,570	16,339,853	1,513,580	13,096,259	14,383,696
95%	1,508,607	17,076,288	18,329,580	1,589,424	14,665,803	15,952,314
99%	1,620,750	20,850,612	22,076,381	1,733,931	17,599,181	18,894,407

Table E.31-Risk profile statistics for highway bridge with modification 1b ADT case 4 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	792,740	642,010	1,815,637	808,309	717,009	1,789,808
Maximum	1,944,452	8,529,020	9,862,352	2,146,195	6,666,214	8,100,251
Mean	1,247,249	3,164,359	4,411,608	1,272,986	2,629,633	3,902,619
Std Dev	157,243	1,045,795	1,058,776	177,405	794,843	826,455
Percentile						
1%	909,437	1,258,634	2,463,450	936,836	1,205,917	2,377,572
5%	987,669	1,640,809	2,863,018	1,009,296	1,478,195	2,696,613
10%	1,042,125	1,895,584	3,125,760	1,055,715	1,666,617	2,901,171
15%	1,080,624	2,083,236	3,319,584	1,089,072	1,812,154	3,054,425
20%	1,111,453	2,244,368	3,486,222	1,116,431	1,933,629	3,180,512
25%	1,137,683	2,391,810	3,633,105	1,142,526	2,043,447	3,300,842
30%	1,161,984	2,529,702	3,770,395	1,166,589	2,145,312	3,409,131
35%	1,183,711	2,662,735	3,906,336	1,189,459	2,249,019	3,513,336
40%	1,204,872	2,794,292	4,037,721	1,211,881	2,347,291	3,614,703
45%	1,225,295	2,921,849	4,168,336	1,234,111	2,446,127	3,718,450
50%	1,245,513	3,052,076	4,303,478	1,257,297	2,543,022	3,817,188
55%	1,265,153	3,193,318	4,442,638	1,280,642	2,644,258	3,923,034
60%	1,286,127	3,333,619	4,581,448	1,304,810	2,752,254	4,035,454
65%	1,307,875	3,481,404	4,734,713	1,330,303	2,866,938	4,152,032
70%	1,330,189	3,644,032	4,900,877	1,357,949	2,988,436	4,277,958
75%	1,353,983	3,819,026	5,081,215	1,387,921	3,123,061	4,418,273
80%	1,380,699	4,024,042	5,286,941	1,421,829	3,278,814	4,574,997
85%	1,411,806	4,274,788	5,531,505	1,461,708	3,465,580	4,770,915
90%	1,451,469	4,585,916	5,850,747	1,513,580	3,708,530	5,022,203
95%	1,508,607	5,066,175	6,327,521	1,589,424	4,074,613	5,391,735
99%	1,620,750	5,959,638	7,237,259	1,733,931	4,778,293	6,130,148

Table E.32-Risk profile statistics for highway bridge with modification 1b ADT case 5 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	792,740	670,698	1,846,207	808,309	1,020,890	2,188,054
Maximum	1,944,452	14,436,895	15,770,227	2,146,195	11,766,955	13,104,822
Mean	1,247,249	4,968,957	6,216,206	1,272,986	4,310,659	5,583,645
Std Dev	157,243	1,892,132	1,899,304	177,405	1,457,543	1,478,048
Percentile						
1%	909,437	1,575,032	2,787,996	936,836	1,724,391	2,934,139
5%	987,669	2,215,293	3,452,060	1,009,296	2,196,267	3,434,892
10%	1,042,125	2,661,202	3,900,457	1,055,715	2,542,371	3,793,302
15%	1,080,624	3,009,494	4,248,094	1,089,072	2,803,700	4,060,825
20%	1,111,453	3,304,766	4,546,198	1,116,431	3,027,948	4,285,685
25%	1,137,683	3,570,901	4,812,392	1,142,526	3,232,435	4,494,366
30%	1,161,984	3,819,268	5,062,552	1,166,589	3,424,641	4,689,853
35%	1,183,711	4,058,087	5,303,625	1,189,459	3,611,496	4,878,929
40%	1,204,872	4,299,558	5,540,877	1,211,881	3,796,244	5,064,965
45%	1,225,295	4,529,320	5,774,559	1,234,111	3,972,270	5,245,814
50%	1,245,513	4,766,424	6,016,546	1,257,297	4,152,253	5,426,838
55%	1,265,153	5,013,043	6,265,475	1,280,642	4,341,019	5,616,453
60%	1,286,127	5,268,833	6,514,365	1,304,810	4,533,513	5,811,249
65%	1,307,875	5,538,018	6,789,417	1,330,303	4,743,805	6,021,282
70%	1,330,189	5,829,558	7,083,921	1,357,949	4,968,614	6,249,763
75%	1,353,983	6,153,921	7,409,864	1,387,921	5,216,906	6,501,222
80%	1,380,699	6,526,298	7,780,179	1,421,829	5,498,219	6,784,903
85%	1,411,806	6,973,195	8,230,571	1,461,708	5,847,661	7,138,972
90%	1,451,469	7,554,707	8,805,369	1,513,580	6,292,134	7,590,386
95%	1,508,607	8,415,690	9,677,050	1,589,424	6,966,491	8,263,839
99%	1,620,750	10,042,927	11,317,221	1,733,931	8,237,043	9,568,238

Table E.33-Risk profile statistics for highway bridge with modification 1b ADT case 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	792,740	756,764	1,922,507	808,309	1,869,712	3,120,798
Maximum	1,944,452	32,160,520	33,493,852	2,146,195	27,069,177	28,407,044
Mean	1,247,249	10,382,751	11,629,999	1,272,986	9,353,736	10,626,722
Std Dev	157,243	4,484,671	4,487,658	177,405	3,477,407	3,489,897
Percentile						
1%	909,437	2,332,655	3,576,925	936,836	3,170,503	4,409,842
5%	987,669	3,809,736	5,047,962	1,009,296	4,279,339	5,542,346
10%	1,042,125	4,890,918	6,141,088	1,055,715	5,117,681	6,377,337
15%	1,080,624	5,718,814	6,963,648	1,089,072	5,756,658	7,015,326
20%	1,111,453	6,441,654	7,691,619	1,116,431	6,298,123	7,556,706
25%	1,137,683	7,088,499	8,327,125	1,142,526	6,788,551	8,049,385
30%	1,161,984	7,672,997	8,920,399	1,166,589	7,255,803	8,520,795
35%	1,183,711	8,238,469	9,485,868	1,189,459	7,696,878	8,968,457
40%	1,204,872	8,801,078	10,044,357	1,211,881	8,128,977	9,399,801
45%	1,225,295	9,347,148	10,597,140	1,234,111	8,556,178	9,828,770
50%	1,245,513	9,924,011	11,173,945	1,257,297	8,986,386	10,264,287
55%	1,265,153	10,503,668	11,753,239	1,280,642	9,435,293	10,706,111
60%	1,286,127	11,098,011	12,344,287	1,304,810	9,891,651	11,167,673
65%	1,307,875	11,732,557	12,978,326	1,330,303	10,387,019	11,651,786
70%	1,330,189	12,419,411	13,675,633	1,357,949	10,928,777	12,206,215
75%	1,353,983	13,193,320	14,440,189	1,387,921	11,515,149	12,795,270
80%	1,380,699	14,072,070	15,322,313	1,421,829	12,189,775	13,475,177
85%	1,411,806	15,127,400	16,382,341	1,461,708	13,008,667	14,294,526
90%	1,451,469	16,492,394	17,736,971	1,513,580	14,073,898	15,366,126
95%	1,508,607	18,549,604	19,807,254	1,589,424	15,693,767	16,981,518
99%	1,620,750	22,423,928	23,689,441	1,733,931	18,693,984	20,004,580

Table E.34-Risk profile statistics for highway bridge with modification 1b ADT case 7 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	792,740	2,956,087	4,056,992	808,309	2,369,518	3,457,229
Maximum	1,944,452	20,074,314	21,482,889	2,146,195	15,347,922	16,522,568
Mean	1,247,249	8,603,403	9,850,652	1,272,986	6,424,063	7,697,050
Std Dev	157,243	2,197,875	2,206,554	177,405	1,552,791	1,582,961
Percentile						
1%	909,437	4,465,754	5,688,280	936,836	3,528,004	4,718,047
5%	987,669	5,325,220	6,561,403	1,009,296	4,141,612	5,361,785
10%	1,042,125	5,903,678	7,133,710	1,055,715	4,532,428	5,775,661
15%	1,080,624	6,320,163	7,562,988	1,089,072	4,833,873	6,077,302
20%	1,111,453	6,674,350	7,917,585	1,116,431	5,077,816	6,325,406
25%	1,137,683	7,000,415	8,243,200	1,142,526	5,297,420	6,549,117
30%	1,161,984	7,301,874	8,544,355	1,166,589	5,495,509	6,755,573
35%	1,183,711	7,583,302	8,827,404	1,189,459	5,689,813	6,953,574
40%	1,204,872	7,860,236	9,106,642	1,211,881	5,886,554	7,147,287
45%	1,225,295	8,141,292	9,388,161	1,234,111	6,083,077	7,347,974
50%	1,245,513	8,414,048	9,661,366	1,257,297	6,276,841	7,548,467
55%	1,265,153	8,692,930	9,944,880	1,280,642	6,472,007	7,752,317
60%	1,286,127	8,990,510	10,237,146	1,304,810	6,678,784	7,962,711
65%	1,307,875	9,306,283	10,552,908	1,330,303	6,901,675	8,183,808
70%	1,330,189	9,636,301	10,893,225	1,357,949	7,138,812	8,426,128
75%	1,353,983	10,001,446	11,251,306	1,387,921	7,398,173	8,691,476
80%	1,380,699	10,420,380	11,675,233	1,421,829	7,693,722	8,990,889
85%	1,411,806	10,914,810	12,171,993	1,461,708	8,054,170	9,355,328
90%	1,451,469	11,557,559	12,815,032	1,513,580	8,514,851	9,817,797
95%	1,508,607	12,528,913	13,788,656	1,589,424	9,203,966	10,533,982
99%	1,620,750	14,400,405	15,669,517	1,733,931	10,595,308	11,953,431

Table E.35-Risk profile statistics for highway bridge with modification 1b ADT case 8 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	792,740	3,076,646	4,204,618	808,309	2,673,399	3,855,475
Maximum	1,944,452	24,921,478	26,254,810	2,146,195	18,878,028	20,315,155
Mean	1,247,249	10,408,001	11,655,250	1,272,986	8,105,089	9,378,075
Std Dev	157,243	2,861,880	2,868,528	177,405	2,093,914	2,118,495
Percentile						
1%	909,437	5,066,257	6,286,805	936,836	4,243,157	5,442,619
5%	987,669	6,182,493	7,417,120	1,009,296	5,044,770	6,279,707
10%	1,042,125	6,901,578	8,144,157	1,055,715	5,569,733	6,814,998
15%	1,080,624	7,444,228	8,690,011	1,089,072	5,950,411	7,197,490
20%	1,111,453	7,897,230	9,137,170	1,116,431	6,276,663	7,529,030
25%	1,137,683	8,309,691	9,554,974	1,142,526	6,569,581	7,828,390
30%	1,161,984	8,695,026	9,936,792	1,166,589	6,848,010	8,109,006
35%	1,183,711	9,063,264	10,309,881	1,189,459	7,113,727	8,378,178
40%	1,204,872	9,419,228	10,663,242	1,211,881	7,372,759	8,641,049
45%	1,225,295	9,784,031	11,031,918	1,234,111	7,630,150	8,901,114
50%	1,245,513	10,148,137	11,394,754	1,257,297	7,897,302	9,163,765
55%	1,265,153	10,518,290	11,764,884	1,280,642	8,167,842	9,443,952
60%	1,286,127	10,902,672	12,145,930	1,304,810	8,448,227	9,726,794
65%	1,307,875	11,308,308	12,558,050	1,330,303	8,741,642	10,025,717
70%	1,330,189	11,749,359	13,000,320	1,357,949	9,058,735	10,342,546
75%	1,353,983	12,233,301	13,486,198	1,387,921	9,413,700	10,699,374
80%	1,380,699	12,772,219	14,029,134	1,421,829	9,819,331	11,108,128
85%	1,411,806	13,427,567	14,682,771	1,461,708	10,306,708	11,602,551
90%	1,451,469	14,262,808	15,518,198	1,513,580	10,935,629	12,238,260
95%	1,508,607	15,543,452	16,804,522	1,589,424	11,871,299	13,172,074
99%	1,620,750	17,958,254	19,205,114	1,733,931	13,746,767	15,085,145

Table E.36-Risk profile statistics for highway bridge with modification 1b ADT case 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	792,740	3,210,049	4,507,544	808,309	3,585,043	4,802,214
Maximum	1,944,452	42,645,102	43,978,434	2,146,195	33,331,071	34,668,938
Mean	1,247,249	15,821,795	17,069,044	1,272,986	13,148,166	14,421,152
Std Dev	157,243	5,228,973	5,232,577	177,405	3,974,215	3,990,584
Percentile						
1%	909,437	6,293,168	7,552,040	936,836	6,029,587	7,255,645
5%	987,669	8,204,045	9,446,080	1,009,296	7,390,977	8,638,237
10%	1,042,125	9,477,921	10,718,004	1,055,715	8,333,083	9,592,514
15%	1,080,624	10,416,179	11,665,935	1,089,072	9,060,772	10,319,403
20%	1,111,453	11,221,838	12,473,484	1,116,431	9,668,144	10,929,665
25%	1,137,683	11,959,051	13,204,602	1,142,526	10,217,237	11,471,954
30%	1,161,984	12,648,508	13,886,443	1,166,589	10,726,561	11,993,732
35%	1,183,711	13,313,676	14,563,274	1,189,459	11,245,093	12,514,817
40%	1,204,872	13,971,462	15,219,325	1,211,881	11,736,454	13,005,845
45%	1,225,295	14,609,245	15,858,556	1,234,111	12,230,633	13,503,464
50%	1,245,513	15,260,379	16,518,588	1,257,297	12,715,112	13,986,044
55%	1,265,153	15,966,588	17,205,375	1,280,642	13,221,292	14,498,797
60%	1,286,127	16,668,096	17,907,900	1,304,810	13,761,268	15,038,077
65%	1,307,875	17,407,021	18,657,745	1,330,303	14,334,688	15,610,458
70%	1,330,189	18,220,159	19,472,739	1,357,949	14,942,179	16,221,982
75%	1,353,983	19,095,131	20,360,172	1,387,921	15,615,304	16,896,433
80%	1,380,699	20,120,211	21,370,567	1,421,829	16,394,069	17,673,878
85%	1,411,806	21,373,942	22,624,142	1,461,708	17,327,900	18,625,620
90%	1,451,469	22,929,578	24,176,660	1,513,580	18,542,650	19,832,542
95%	1,508,607	25,330,877	26,572,121	1,589,424	20,373,063	21,663,393
99%	1,620,750	29,798,190	31,072,523	1,733,931	23,891,464	25,186,747

Table E.37-Risk profile statistics for highway bridge with modification 1c ADT case 1 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	90,021	1,057,038	820,832	325,137	1,346,887
Maximum	1,988,814	6,169,989	7,547,683	2,175,264	5,257,288	6,638,284
Mean	1,291,342	1,940,574	3,231,916	1,295,078	1,775,886	3,070,965
Std Dev	157,783	882,656	896,727	178,823	685,605	715,852
Percentile						
1%	946,742	350,983	1,585,684	954,917	552,626	1,745,801
5%	1,030,871	641,569	1,912,979	1,029,034	772,733	2,018,866
10%	1,086,197	858,168	2,132,721	1,075,676	938,675	2,197,421
15%	1,124,870	1,022,892	2,300,815	1,109,911	1,065,372	2,332,322
20%	1,155,805	1,165,884	2,447,112	1,137,403	1,173,812	2,445,790
25%	1,182,038	1,293,179	2,575,751	1,163,647	1,270,432	2,548,447
30%	1,206,346	1,409,749	2,695,035	1,188,233	1,362,892	2,645,096
35%	1,228,071	1,520,568	2,807,344	1,211,133	1,451,651	2,734,997
40%	1,249,234	1,631,253	2,919,021	1,233,824	1,534,851	2,827,337
45%	1,269,657	1,738,344	3,030,411	1,256,285	1,619,499	2,914,519
50%	1,289,875	1,851,573	3,144,289	1,279,594	1,705,154	3,002,168
55%	1,309,515	1,964,694	3,259,534	1,302,895	1,793,216	3,092,654
60%	1,330,489	2,082,071	3,377,163	1,327,225	1,883,209	3,184,976
65%	1,352,237	2,205,917	3,506,818	1,352,962	1,979,547	3,286,203
70%	1,374,551	2,342,544	3,644,110	1,380,727	2,086,393	3,398,030
75%	1,398,345	2,492,286	3,795,477	1,410,791	2,201,981	3,518,405
80%	1,425,061	2,666,429	3,970,430	1,445,178	2,335,023	3,655,060
85%	1,456,167	2,874,579	4,178,526	1,485,037	2,496,929	3,821,233
90%	1,495,831	3,142,691	4,449,280	1,537,367	2,705,669	4,039,021
95%	1,552,969	3,547,200	4,863,566	1,613,720	3,024,648	4,360,704
99%	1,665,112	4,309,443	5,610,983	1,759,239	3,614,423	4,996,673

Table E.38-Risk profile statistics for highway bridge with modification 1c ADT case 2 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	118,709	1,127,898	820,832	601,470	1,666,146
Maximum	1,988,814	12,077,864	13,455,558	2,175,264	10,358,029	11,725,978
Mean	1,291,342	3,745,172	5,036,514	1,295,078	3,456,912	4,751,990
Std Dev	157,783	1,751,880	1,758,975	178,823	1,361,823	1,380,667
Percentile						
1%	946,742	583,335	1,844,264	954,917	1,019,224	2,260,567
5%	1,030,871	1,161,993	2,446,458	1,029,034	1,462,135	2,727,541
10%	1,086,197	1,594,067	2,879,857	1,075,676	1,793,448	3,067,002
15%	1,124,870	1,922,247	3,210,124	1,109,911	2,043,752	3,322,516
20%	1,155,805	2,209,515	3,496,253	1,137,403	2,262,721	3,541,623
25%	1,182,038	2,462,157	3,745,203	1,163,647	2,454,289	3,737,500
30%	1,206,346	2,692,754	3,982,303	1,188,233	2,637,004	3,923,405
35%	1,228,071	2,913,494	4,202,924	1,211,133	2,813,109	4,101,526
40%	1,249,234	3,133,371	4,421,071	1,233,824	2,979,504	4,272,305
45%	1,269,657	3,346,793	4,641,179	1,256,285	3,147,257	4,443,327
50%	1,289,875	3,568,150	4,860,869	1,279,594	3,317,459	4,614,960
55%	1,309,515	3,795,731	5,090,302	1,302,895	3,492,652	4,788,367
60%	1,330,489	4,025,948	5,318,799	1,327,225	3,671,218	4,967,648
65%	1,352,237	4,271,779	5,568,928	1,352,962	3,862,799	5,162,386
70%	1,374,551	4,543,830	5,842,269	1,380,727	4,074,350	5,379,720
75%	1,398,345	4,842,393	6,138,209	1,410,791	4,304,160	5,612,465
80%	1,425,061	5,185,603	6,485,439	1,445,178	4,566,549	5,875,496
85%	1,456,167	5,599,326	6,894,365	1,485,037	4,887,850	6,205,620
90%	1,495,831	6,131,129	7,423,839	1,537,367	5,303,333	6,621,603
95%	1,552,969	6,929,193	8,238,167	1,613,720	5,932,972	7,258,412
99%	1,665,112	8,448,706	9,716,957	1,759,239	7,112,082	8,469,506

Table E.39-Risk profile statistics for highway bridge with modification 1c ADT case 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	168,106	1,280,277	820,832	1,406,645	2,551,759
Maximum	1,988,814	29,801,489	31,179,182	2,175,264	25,660,251	27,028,200
Mean	1,291,342	9,158,966	10,450,307	1,295,078	8,499,989	9,795,067
Std Dev	157,783	4,360,248	4,363,059	178,823	3,390,877	3,402,587
Percentile						
1%	946,742	1,277,851	2,556,902	954,917	2,425,776	3,692,704
5%	1,030,871	2,722,589	4,017,917	1,029,034	3,526,149	4,803,446
10%	1,086,197	3,801,069	5,089,534	1,075,676	4,356,068	5,641,623
15%	1,124,870	4,622,680	5,916,341	1,109,911	4,983,611	6,266,690
20%	1,155,805	5,336,871	6,621,733	1,137,403	5,527,492	6,810,291
25%	1,182,038	5,971,690	7,259,569	1,163,647	6,004,540	7,292,072
30%	1,206,346	6,542,224	7,833,543	1,188,233	6,458,996	7,749,927
35%	1,228,071	7,092,901	8,381,338	1,211,133	6,896,524	8,184,663
40%	1,249,234	7,640,337	8,925,499	1,233,824	7,313,531	8,609,767
45%	1,269,657	8,175,023	9,463,882	1,256,285	7,733,883	9,026,088
50%	1,289,875	8,722,896	10,018,926	1,279,594	8,154,275	9,451,970
55%	1,309,515	9,286,985	10,579,824	1,302,895	8,592,671	9,883,424
60%	1,330,489	9,856,682	11,152,287	1,327,225	9,036,346	10,331,755
65%	1,352,237	10,468,818	11,765,907	1,352,962	9,510,853	10,800,847
70%	1,374,551	11,145,870	12,446,830	1,380,727	10,036,815	11,337,430
75%	1,398,345	11,891,578	13,184,488	1,410,791	10,610,228	11,915,070
80%	1,425,061	12,744,660	14,038,468	1,445,178	11,262,566	12,562,123
85%	1,456,167	13,772,002	15,062,112	1,485,037	12,065,175	13,372,390
90%	1,495,831	15,092,570	16,384,215	1,537,367	13,096,259	14,406,561
95%	1,552,969	17,076,288	18,373,942	1,613,720	14,665,803	15,976,713
99%	1,665,112	20,850,612	22,120,743	1,759,239	17,599,181	18,917,288

Table E.40-Risk profile statistics for highway bridge with modification 1c ADT case 4 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	642,010	1,859,999	820,832	717,009	1,803,855
Maximum	1,988,814	8,529,020	9,906,714	2,175,264	6,666,214	8,126,982
Mean	1,291,342	3,164,359	4,455,701	1,295,078	2,629,633	3,924,711
Std Dev	157,783	1,045,795	1,058,860	178,823	794,843	827,201
Percentile						
1%	946,742	1,258,634	2,507,562	954,917	1,205,917	2,398,216
5%	1,030,871	1,640,809	2,907,369	1,029,034	1,478,195	2,716,902
10%	1,086,197	1,895,584	3,169,983	1,075,676	1,666,617	2,923,058
15%	1,124,870	2,083,236	3,363,757	1,109,911	1,812,154	3,075,791
20%	1,155,805	2,244,368	3,530,098	1,137,403	1,933,629	3,201,837
25%	1,182,038	2,391,810	3,677,419	1,163,647	2,043,447	3,322,534
30%	1,206,346	2,529,702	3,814,634	1,188,233	2,145,312	3,430,741
35%	1,228,071	2,662,735	3,950,409	1,211,133	2,249,019	3,534,794
40%	1,249,234	2,794,292	4,081,824	1,233,824	2,347,291	3,636,882
45%	1,269,657	2,921,849	4,212,503	1,256,285	2,446,127	3,740,225
50%	1,289,875	3,052,076	4,347,345	1,279,594	2,543,022	3,839,435
55%	1,309,515	3,193,318	4,486,837	1,302,895	2,644,258	3,944,798
60%	1,330,489	3,333,619	4,625,464	1,327,225	2,752,254	4,057,328
65%	1,352,237	3,481,404	4,778,885	1,352,962	2,866,938	4,174,030
70%	1,374,551	3,644,032	4,944,769	1,380,727	2,988,436	4,300,239
75%	1,398,345	3,819,026	5,125,306	1,410,791	3,123,061	4,440,633
80%	1,425,061	4,024,042	5,331,266	1,445,178	3,278,814	4,597,684
85%	1,456,167	4,274,788	5,575,650	1,485,037	3,465,580	4,793,863
90%	1,495,831	4,585,916	5,894,908	1,537,367	3,708,530	5,044,774
95%	1,552,969	5,066,175	6,371,813	1,613,720	4,074,613	5,413,902
99%	1,665,112	5,959,638	7,281,621	1,759,239	4,778,293	6,151,815

Table E.41-Risk profile statistics for highway bridge with modification 1c ADT case 5 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	670,698	1,890,569	820,832	1,020,890	2,202,102
Maximum	1,988,814	14,436,895	15,814,589	2,175,264	11,766,955	13,134,904
Mean	1,291,342	4,968,957	6,260,299	1,295,078	4,310,659	5,605,737
Std Dev	157,783	1,892,132	1,899,350	178,823	1,457,543	1,478,583
Percentile						
1%	946,742	1,575,032	2,831,220	954,917	1,724,391	2,954,293
5%	1,030,871	2,215,293	3,496,239	1,029,034	2,196,267	3,456,757
10%	1,086,197	2,661,202	3,944,335	1,075,676	2,542,371	3,814,910
15%	1,124,870	3,009,494	4,292,279	1,109,911	2,803,700	4,082,602
20%	1,155,805	3,304,766	4,590,224	1,137,403	3,027,948	4,308,008
25%	1,182,038	3,570,901	4,856,534	1,163,647	3,232,435	4,515,833
30%	1,206,346	3,819,268	5,106,629	1,188,233	3,424,641	4,711,487
35%	1,228,071	4,058,087	5,347,666	1,211,133	3,611,496	4,901,307
40%	1,249,234	4,299,558	5,585,050	1,233,824	3,796,244	5,086,737
45%	1,269,657	4,529,320	5,818,309	1,256,285	3,972,270	5,267,416
50%	1,289,875	4,766,424	6,060,767	1,279,594	4,152,253	5,448,911
55%	1,309,515	5,013,043	6,309,406	1,302,895	4,341,019	5,638,243
60%	1,330,489	5,268,833	6,558,167	1,327,225	4,533,513	5,833,585
65%	1,352,237	5,538,018	6,833,638	1,352,962	4,743,805	6,042,890
70%	1,374,551	5,829,558	7,128,046	1,380,727	4,968,614	6,272,104
75%	1,398,345	6,153,921	7,454,203	1,410,791	5,216,906	6,523,581
80%	1,425,061	6,526,298	7,824,306	1,445,178	5,498,219	6,807,238
85%	1,456,167	6,973,195	8,274,240	1,485,037	5,847,661	7,162,081
90%	1,495,831	7,554,707	8,849,665	1,537,367	6,292,134	7,613,500
95%	1,552,969	8,415,690	9,721,412	1,613,720	6,966,491	8,286,659
99%	1,665,112	10,042,927	11,361,583	1,759,239	8,237,043	9,593,199

Table E.42-Risk profile statistics for highway bridge with modification 1c ADT case 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	756,764	1,966,869	820,832	1,869,712	3,146,649
Maximum	1,988,814	32,160,520	33,538,214	2,175,264	27,069,177	28,437,126
Mean	1,291,342	10,382,751	11,674,092	1,295,078	9,353,736	10,648,814
Std Dev	157,783	4,484,671	4,487,678	178,823	3,477,407	3,490,273
Percentile						
1%	946,742	2,332,655	3,621,285	954,917	3,170,503	4,430,248
5%	1,030,871	3,809,736	5,092,324	1,029,034	4,279,339	5,563,711
10%	1,086,197	4,890,918	6,184,438	1,075,676	5,117,681	6,399,857
15%	1,124,870	5,718,814	7,007,855	1,109,911	5,756,658	7,037,210
20%	1,155,805	6,441,654	7,735,778	1,137,403	6,298,123	7,578,745
25%	1,182,038	7,088,499	8,371,487	1,163,647	6,788,551	8,071,874
30%	1,206,346	7,672,997	8,963,807	1,188,233	7,255,803	8,542,870
35%	1,228,071	8,238,469	9,530,010	1,211,133	7,696,878	8,990,566
40%	1,249,234	8,801,078	10,088,478	1,233,824	8,128,977	9,421,400
45%	1,269,657	9,347,148	10,641,280	1,256,285	8,556,178	9,850,512
50%	1,289,875	9,924,011	11,217,999	1,279,594	8,986,386	10,286,124
55%	1,309,515	10,503,668	11,797,323	1,302,895	9,435,293	10,727,480
60%	1,330,489	11,098,011	12,388,287	1,327,225	9,891,651	11,189,932
65%	1,352,237	11,732,557	13,022,281	1,352,962	10,387,019	11,674,745
70%	1,374,551	12,419,411	13,719,943	1,380,727	10,928,777	12,227,600
75%	1,398,345	13,193,320	14,484,309	1,410,791	11,515,149	12,818,244
80%	1,425,061	14,072,070	15,366,352	1,445,178	12,189,775	13,498,272
85%	1,456,167	15,127,400	16,426,703	1,485,037	13,008,667	14,316,935
90%	1,495,831	16,492,394	17,781,333	1,537,367	14,073,898	15,389,437
95%	1,552,969	18,549,604	19,850,531	1,613,720	15,693,767	17,004,943
99%	1,665,112	22,423,928	23,733,803	1,759,239	18,693,984	20,028,870

Table E.43-Risk profile statistics for highway bridge with modification 1c ADT case 7 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	2,956,087	4,101,354	820,832	2,369,518	3,471,277
Maximum	1,988,814	20,074,314	21,527,251	2,175,264	15,347,922	16,548,204
Mean	1,291,342	8,603,403	9,894,745	1,295,078	6,424,063	7,719,142
Std Dev	157,783	2,197,875	2,206,598	178,823	1,552,791	1,583,830
Percentile						
1%	946,742	4,465,754	5,732,012	954,917	3,528,004	4,737,391
5%	1,030,871	5,325,220	6,605,574	1,029,034	4,141,612	5,382,376
10%	1,086,197	5,903,678	7,178,037	1,075,676	4,532,428	5,796,507
15%	1,124,870	6,320,163	7,607,186	1,109,911	4,833,873	6,097,980
20%	1,155,805	6,674,350	7,961,542	1,137,403	5,077,816	6,347,469
25%	1,182,038	7,000,415	8,287,333	1,163,647	5,297,420	6,570,583
30%	1,206,346	7,301,874	8,588,303	1,188,233	5,495,509	6,777,137
35%	1,228,071	7,583,302	8,871,460	1,211,133	5,689,813	6,975,470
40%	1,249,234	7,860,236	9,150,814	1,233,824	5,886,554	7,168,897
45%	1,269,657	8,141,292	9,432,269	1,256,285	6,083,077	7,370,406
50%	1,289,875	8,414,048	9,705,333	1,279,594	6,276,841	7,570,280
55%	1,309,515	8,692,930	9,988,915	1,302,895	6,472,007	7,774,778
60%	1,330,489	8,990,510	10,281,413	1,327,225	6,678,784	7,985,217
65%	1,352,237	9,306,283	10,597,250	1,352,962	6,901,675	8,206,133
70%	1,374,551	9,636,301	10,937,451	1,380,727	7,138,812	8,448,637
75%	1,398,345	10,001,446	11,295,590	1,410,791	7,398,173	8,713,562
80%	1,425,061	10,420,380	11,719,341	1,445,178	7,693,722	9,014,007
85%	1,456,167	10,914,810	12,215,967	1,485,037	8,054,170	9,377,907
90%	1,495,831	11,557,559	12,859,332	1,537,367	8,514,851	9,840,899
95%	1,552,969	12,528,913	13,833,018	1,613,720	9,203,966	10,558,396
99%	1,665,112	14,400,405	15,713,879	1,759,239	10,595,308	11,976,158

Table E.44-Risk profile statistics for highway bridge with modification 1c ADT case 8 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	3,076,646	4,248,980	820,832	2,673,399	3,869,523
Maximum	1,988,814	24,921,478	26,299,172	2,175,264	18,878,028	20,341,791
Mean	1,291,342	10,408,001	11,699,343	1,295,078	8,105,089	9,400,167
Std Dev	157,783	2,861,880	2,868,563	178,823	2,093,914	2,119,227
Percentile						
1%	946,742	5,066,257	6,331,167	954,917	4,243,157	5,462,112
5%	1,030,871	6,182,493	7,461,353	1,029,034	5,044,770	6,301,477
10%	1,086,197	6,901,578	8,188,123	1,075,676	5,569,733	6,836,353
15%	1,124,870	7,444,228	8,734,291	1,109,911	5,950,411	7,218,665
20%	1,155,805	7,897,230	9,181,436	1,137,403	6,276,663	7,550,531
25%	1,182,038	8,309,691	9,599,241	1,163,647	6,569,581	7,849,555
30%	1,206,346	8,695,026	9,980,860	1,188,233	6,848,010	8,130,528
35%	1,228,071	9,063,264	10,353,981	1,211,133	7,113,727	8,400,270
40%	1,249,234	9,419,228	10,707,014	1,233,824	7,372,759	8,662,728
45%	1,269,657	9,784,031	11,076,060	1,256,285	7,630,150	8,922,738
50%	1,289,875	10,148,137	11,438,789	1,279,594	7,897,302	9,185,496
55%	1,309,515	10,518,290	11,808,915	1,302,895	8,167,842	9,466,429
60%	1,330,489	10,902,672	12,190,087	1,327,225	8,448,227	9,748,765
65%	1,352,237	11,308,308	12,602,174	1,352,962	8,741,642	10,048,131
70%	1,374,551	11,749,359	13,044,642	1,380,727	9,058,735	10,365,269
75%	1,398,345	12,233,301	13,530,347	1,410,791	9,413,700	10,721,869
80%	1,425,061	12,772,219	14,073,130	1,445,178	9,819,331	11,130,095
85%	1,456,167	13,427,567	14,726,770	1,485,037	10,306,708	11,625,800
90%	1,495,831	14,262,808	15,562,413	1,537,367	10,935,629	12,261,350
95%	1,552,969	15,543,452	16,848,884	1,613,720	11,871,299	13,196,738
99%	1,665,112	17,958,254	19,249,476	1,759,239	13,746,767	15,110,538

Table E.45-Risk profile statistics for highway bridge with modification 1c ADT case 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	3,210,049	4,551,906	820,832	3,585,043	4,826,513
Maximum	1,988,814	42,645,102	44,022,796	2,175,264	33,331,071	34,699,020
Mean	1,291,342	15,821,795	17,113,137	1,295,078	13,148,166	14,443,244
Std Dev	157,783	5,228,973	5,232,596	178,823	3,974,215	3,991,103
Percentile						
1%	946,742	6,293,168	7,596,402	954,917	6,029,587	7,275,770
5%	1,030,871	8,204,045	9,490,363	1,029,034	7,390,977	8,660,948
10%	1,086,197	9,477,921	10,761,943	1,075,676	8,333,083	9,614,395
15%	1,124,870	10,416,179	11,710,083	1,109,911	9,060,772	10,341,102
20%	1,155,805	11,221,838	12,517,810	1,137,403	9,668,144	10,951,397
25%	1,182,038	11,959,051	13,248,875	1,163,647	10,217,237	11,493,244
30%	1,206,346	12,648,508	13,930,734	1,188,233	10,726,561	12,016,120
35%	1,228,071	13,313,676	14,607,583	1,211,133	11,245,093	12,536,832
40%	1,249,234	13,971,462	15,263,454	1,233,824	11,736,454	13,028,016
45%	1,269,657	14,609,245	15,902,713	1,256,285	12,230,633	13,525,430
50%	1,289,875	15,260,379	16,562,773	1,279,594	12,715,112	14,008,419
55%	1,309,515	15,966,588	17,249,557	1,302,895	13,221,292	14,521,019
60%	1,330,489	16,668,096	17,952,135	1,327,225	13,761,268	15,060,416
65%	1,352,237	17,407,021	18,701,019	1,352,962	14,334,688	15,632,730
70%	1,374,551	18,220,159	19,516,179	1,380,727	14,942,179	16,244,051
75%	1,398,345	19,095,131	20,404,441	1,410,791	15,615,304	16,918,755
80%	1,425,061	20,120,211	21,414,903	1,445,178	16,394,069	17,696,684
85%	1,456,167	21,373,942	22,668,504	1,485,037	17,327,900	18,648,662
90%	1,495,831	22,929,578	24,221,022	1,537,367	18,542,650	19,855,043
95%	1,552,969	25,330,877	26,616,483	1,613,720	20,373,063	21,688,611
99%	1,665,112	29,798,190	31,116,885	1,759,239	23,891,464	25,211,166

Table E.46-Risk profile statistics for highway bridge with modification 2a ADT case 1 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	78,929	947,298	794,935	308,443	1,266,557
Maximum	1,900,008	4,013,285	5,302,172	2,117,072	3,548,792	5,036,640
Mean	1,203,146	1,358,661	2,561,807	1,250,889	1,334,318	2,585,208
Std Dev	156,583	577,938	598,904	175,993	452,048	492,168
Percentile						
1%	872,316	261,977	1,392,932	918,427	485,859	1,618,019
5%	945,174	472,674	1,645,864	989,862	648,989	1,837,408
10%	998,059	629,667	1,809,847	1,035,656	768,321	1,972,804
15%	1,036,328	748,818	1,932,876	1,068,262	860,266	2,073,249
20%	1,067,022	852,220	2,037,376	1,095,750	936,865	2,156,322
25%	1,093,240	941,210	2,131,090	1,121,263	1,005,739	2,231,343
30%	1,117,539	1,022,089	2,216,285	1,145,099	1,069,283	2,299,095
35%	1,139,266	1,098,332	2,293,653	1,167,704	1,128,227	2,364,896
40%	1,160,427	1,171,362	2,370,300	1,190,012	1,187,023	2,428,110
45%	1,180,850	1,244,661	2,446,054	1,211,954	1,243,136	2,489,544
50%	1,201,069	1,317,547	2,520,764	1,235,173	1,300,025	2,551,265
55%	1,220,708	1,392,337	2,598,577	1,258,333	1,357,844	2,612,884
60%	1,241,683	1,467,604	2,678,055	1,282,448	1,417,563	2,677,571
65%	1,263,431	1,548,091	2,763,264	1,307,817	1,479,832	2,745,756
70%	1,285,744	1,633,231	2,850,811	1,335,014	1,548,391	2,821,069
75%	1,309,538	1,729,559	2,948,178	1,364,839	1,622,169	2,901,393
80%	1,336,254	1,838,976	3,059,368	1,398,495	1,706,325	2,991,553
85%	1,367,361	1,970,768	3,191,833	1,438,184	1,808,990	3,101,294
90%	1,407,025	2,136,337	3,363,370	1,489,869	1,941,792	3,242,103
95%	1,464,162	2,384,873	3,622,426	1,564,673	2,138,970	3,454,572
99%	1,576,306	2,853,280	4,091,705	1,708,231	2,511,545	3,861,963

Table E.47-Risk profile statistics for highway bridge with modification 2a ADT case 2 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	93,699	996,612	794,935	574,198	1,580,217
Maximum	1,900,008	7,850,761	9,139,649	2,117,072	6,987,992	8,295,721
Mean	1,203,146	2,617,010	3,820,155	1,250,889	2,596,623	3,847,513
Std Dev	156,583	1,149,925	1,160,561	175,993	899,595	923,728
Percentile						
1%	872,316	428,422	1,595,336	918,427	904,490	2,083,492
5%	945,174	851,953	2,039,030	989,862	1,228,602	2,448,758
10%	998,059	1,165,065	2,356,813	1,035,656	1,469,091	2,694,551
15%	1,036,328	1,403,188	2,597,595	1,068,262	1,651,544	2,880,138
20%	1,067,022	1,608,701	2,802,715	1,095,750	1,806,441	3,037,396
25%	1,093,240	1,786,369	2,979,540	1,121,263	1,943,131	3,176,100
30%	1,117,539	1,947,864	3,145,646	1,145,099	2,070,158	3,306,736
35%	1,139,266	2,099,051	3,297,193	1,167,704	2,187,387	3,431,290
40%	1,160,427	2,245,376	3,446,931	1,190,012	2,304,252	3,549,244
45%	1,180,850	2,391,613	3,592,530	1,211,954	2,415,714	3,665,446
50%	1,201,069	2,535,767	3,742,340	1,235,173	2,529,916	3,780,947
55%	1,220,708	2,685,491	3,889,029	1,258,333	2,644,545	3,896,948
60%	1,241,683	2,834,506	4,041,828	1,282,448	2,763,770	4,016,765
65%	1,263,431	2,995,066	4,204,204	1,307,817	2,887,609	4,145,702
70%	1,285,744	3,164,060	4,377,165	1,335,014	3,023,509	4,286,017
75%	1,309,538	3,356,654	4,565,553	1,364,839	3,170,657	4,436,727
80%	1,336,254	3,573,650	4,785,636	1,398,495	3,338,024	4,610,565
85%	1,367,361	3,835,396	5,043,901	1,438,184	3,541,683	4,817,411
90%	1,407,025	4,164,547	5,377,835	1,489,869	3,804,843	5,084,132
95%	1,464,162	4,657,696	5,885,563	1,564,673	4,195,282	5,483,292
99%	1,576,306	5,588,238	6,797,995	1,708,231	4,937,064	6,257,491

Table E.48-Risk profile statistics for highway bridge with modification 2a ADT case 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	127,832	1,106,136	794,935	1,362,788	2,423,998
Maximum	1,900,008	19,363,191	20,652,078	2,117,072	17,305,593	18,613,322
Mean	1,203,146	6,392,055	7,595,201	1,250,889	6,383,538	7,634,428
Std Dev	156,583	2,866,321	2,870,551	175,993	2,242,491	2,256,353
Percentile						
1%	872,316	931,314	2,121,850	918,427	2,156,779	3,372,918
5%	945,174	1,987,056	3,183,571	989,862	2,970,341	4,209,945
10%	998,059	2,770,779	3,968,177	1,035,656	3,570,107	4,811,132
15%	1,036,328	3,364,531	4,561,987	1,068,262	4,026,508	5,261,986
20%	1,067,022	3,878,149	5,079,627	1,095,750	4,415,080	5,654,378
25%	1,093,240	4,322,657	5,521,978	1,121,263	4,755,257	5,995,492
30%	1,117,539	4,727,902	5,927,093	1,145,099	5,072,593	6,313,335
35%	1,139,266	5,102,957	6,305,448	1,167,704	5,365,653	6,612,681
40%	1,160,427	5,469,052	6,671,127	1,190,012	5,655,828	6,900,945
45%	1,180,850	5,831,555	7,029,583	1,211,954	5,932,879	7,185,343
50%	1,201,069	6,192,154	7,399,711	1,235,173	6,218,148	7,466,519
55%	1,220,708	6,562,405	7,767,329	1,258,333	6,503,052	7,756,319
60%	1,241,683	6,938,132	8,144,058	1,282,448	6,803,099	8,053,670
65%	1,263,431	7,336,844	8,542,293	1,307,817	7,109,635	8,361,248
70%	1,285,744	7,758,321	8,966,373	1,335,014	7,450,525	8,703,402
75%	1,309,538	8,234,989	9,440,388	1,364,839	7,817,292	9,075,595
80%	1,336,254	8,776,426	9,977,918	1,398,495	8,233,411	9,497,210
85%	1,367,361	9,427,539	10,631,162	1,438,184	8,742,049	10,009,568
90%	1,407,025	10,247,078	11,451,055	1,489,869	9,395,896	10,662,232
95%	1,464,162	11,474,267	12,686,019	1,564,673	10,368,572	11,645,882
99%	1,576,306	13,796,289	14,980,815	1,708,231	12,210,960	13,494,017

Table E.49-Risk profile statistics for highway bridge with modification 2a ADT case 4 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	591,932	1,645,830	794,935	680,311	1,691,693
Maximum	1,900,008	5,595,559	6,884,446	2,117,072	4,535,112	6,082,972
Mean	1,203,146	2,261,471	3,464,617	1,250,889	1,982,437	3,233,326
Std Dev	156,583	658,796	678,975	175,993	508,788	551,225
Percentile						
1%	872,316	1,011,792	2,145,779	918,427	1,031,280	2,160,910
5%	945,174	1,275,507	2,444,803	989,862	1,225,076	2,404,449
10%	998,059	1,449,534	2,626,876	1,035,656	1,356,587	2,555,311
15%	1,036,328	1,579,467	2,763,187	1,068,262	1,456,067	2,665,687
20%	1,067,022	1,685,442	2,874,459	1,095,750	1,538,574	2,756,919
25%	1,093,240	1,783,393	2,974,682	1,121,263	1,612,976	2,837,548
30%	1,117,539	1,872,561	3,067,339	1,145,099	1,682,479	2,912,694
35%	1,139,266	1,957,845	3,155,712	1,167,704	1,747,383	2,984,257
40%	1,160,427	2,040,489	3,240,682	1,190,012	1,810,594	3,053,171
45%	1,180,850	2,122,831	3,323,459	1,211,954	1,873,931	3,120,595
50%	1,201,069	2,205,228	3,407,754	1,235,173	1,937,428	3,189,360
55%	1,220,708	2,289,561	3,495,902	1,258,333	2,002,135	3,258,603
60%	1,241,683	2,376,193	3,587,877	1,282,448	2,069,687	3,332,473
65%	1,263,431	2,467,183	3,680,150	1,307,817	2,141,025	3,409,548
70%	1,285,744	2,568,752	3,782,320	1,335,014	2,217,962	3,491,612
75%	1,309,538	2,678,705	3,898,536	1,364,839	2,300,897	3,582,814
80%	1,336,254	2,803,672	4,026,034	1,398,495	2,398,717	3,685,089
85%	1,367,361	2,956,200	4,180,645	1,438,184	2,515,533	3,806,113
90%	1,407,025	3,150,282	4,375,524	1,489,869	2,665,896	3,970,574
95%	1,464,162	3,444,807	4,675,107	1,564,673	2,893,255	4,209,203
99%	1,576,306	3,997,146	5,230,090	1,708,231	3,336,851	4,690,465

Table E.50-Risk profile statistics for highway bridge with modification 2a ADT case 5 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	617,723	1,667,198	794,935	958,389	2,038,505
Maximum	1,900,008	9,433,035	10,721,923	2,117,072	7,974,312	9,282,041
Mean	1,203,146	3,519,820	4,722,966	1,250,889	3,244,742	4,495,631
Std Dev	156,583	1,215,739	1,226,750	175,993	947,355	973,953
Percentile						
1%	872,316	1,227,084	2,388,647	918,427	1,481,922	2,647,706
5%	945,174	1,681,946	2,869,886	989,862	1,822,530	3,032,949
10%	998,059	2,003,840	3,194,434	1,035,656	2,068,448	3,292,334
15%	1,036,328	2,247,618	3,440,470	1,068,262	2,257,300	3,483,757
20%	1,067,022	2,455,670	3,650,015	1,095,750	2,413,619	3,644,902
25%	1,093,240	2,638,628	3,833,175	1,121,263	2,554,964	3,788,890
30%	1,117,539	2,803,918	4,000,930	1,145,099	2,686,522	3,923,743
35%	1,139,266	2,966,042	4,164,299	1,167,704	2,810,571	4,051,062
40%	1,160,427	3,117,576	4,317,359	1,190,012	2,929,765	4,175,782
45%	1,180,850	3,269,144	4,471,299	1,211,954	3,046,115	4,296,112
50%	1,201,069	3,423,759	4,628,057	1,235,173	3,166,428	4,418,473
55%	1,220,708	3,580,718	4,785,604	1,258,333	3,285,900	4,540,559
60%	1,241,683	3,740,491	4,948,581	1,282,448	3,414,276	4,667,961
65%	1,263,431	3,905,221	5,114,652	1,307,817	3,545,498	4,801,995
70%	1,285,744	4,089,894	5,301,693	1,335,014	3,688,401	4,951,699
75%	1,309,538	4,293,857	5,504,046	1,364,839	3,845,388	5,112,124
80%	1,336,254	4,526,845	5,737,546	1,398,495	4,021,378	5,295,278
85%	1,367,361	4,806,389	6,016,458	1,438,184	4,238,889	5,515,474
90%	1,407,025	5,159,980	6,375,001	1,489,869	4,517,643	5,802,530
95%	1,464,162	5,691,958	6,917,776	1,564,673	4,937,199	6,225,451
99%	1,576,306	6,697,402	7,913,117	1,708,231	5,735,306	7,053,316

Table E.51-Risk profile statistics for highway bridge with modification 2a ADT case 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	689,015	1,727,365	794,935	1,755,654	2,914,370
Maximum	1,900,008	20,945,465	22,234,352	2,117,072	18,291,914	19,599,643
Mean	1,203,146	7,294,866	8,498,011	1,250,889	7,031,657	8,282,546
Std Dev	156,583	2,922,082	2,926,628	175,993	2,284,306	2,299,460
Percentile						
1%	872,316	1,774,381	2,960,301	918,427	2,760,500	3,975,836
5%	945,174	2,830,968	4,031,496	989,862	3,577,956	4,806,718
10%	998,059	3,616,066	4,814,580	1,035,656	4,176,818	5,419,030
15%	1,036,328	4,213,265	5,417,741	1,068,262	4,640,209	5,872,341
20%	1,067,022	4,733,439	5,933,829	1,095,750	5,023,088	6,264,472
25%	1,093,240	5,182,274	6,381,843	1,121,263	5,372,103	6,612,031
30%	1,117,539	5,589,822	6,787,648	1,145,099	5,691,357	6,934,756
35%	1,139,266	5,969,555	7,168,779	1,167,704	5,986,215	7,235,869
40%	1,160,427	6,340,356	7,542,375	1,190,012	6,281,710	7,530,557
45%	1,180,850	6,706,647	7,910,595	1,211,954	6,564,454	7,817,174
50%	1,201,069	7,080,610	8,285,787	1,235,173	6,850,362	8,103,062
55%	1,220,708	7,456,941	8,664,908	1,258,333	7,145,440	8,397,260
60%	1,241,683	7,840,403	9,044,836	1,282,448	7,448,397	8,700,039
65%	1,263,431	8,243,085	9,448,031	1,307,817	7,763,326	9,018,111
70%	1,285,744	8,675,817	9,886,925	1,335,014	8,107,913	9,365,331
75%	1,309,538	9,160,396	10,371,135	1,364,839	8,486,121	9,741,198
80%	1,336,254	9,722,103	10,927,413	1,398,495	8,912,855	10,176,400
85%	1,367,361	10,388,192	11,592,602	1,438,184	9,428,254	10,699,207
90%	1,407,025	11,227,889	12,433,323	1,489,869	10,097,358	11,364,721
95%	1,464,162	12,497,744	13,717,234	1,564,673	11,103,441	12,379,651
99%	1,576,306	14,883,292	16,084,446	1,708,231	12,997,375	14,289,184

Table E.52-Risk profile statistics for highway bridge with modification 2a ADT case 7 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	2,683,260	3,641,301	794,935	2,215,176	3,187,943
Maximum	1,900,008	13,297,485	14,661,615	2,117,072	10,527,202	11,676,164
Mean	1,203,146	6,273,960	7,477,106	1,250,889	4,862,963	6,113,852
Std Dev	156,583	1,325,011	1,339,015	175,993	955,762	995,000
Percentile						
1%	872,316	3,772,649	4,937,529	918,427	3,067,367	4,210,830
5%	945,174	4,325,386	5,503,095	989,862	3,468,170	4,651,042
10%	998,059	4,670,818	5,849,353	1,035,656	3,714,345	4,917,004
15%	1,036,328	4,914,601	6,106,747	1,068,262	3,888,640	5,104,559
20%	1,067,022	5,126,754	6,319,045	1,095,750	4,040,107	5,259,300
25%	1,093,240	5,312,452	6,509,507	1,121,263	4,171,958	5,395,225
30%	1,117,539	5,490,793	6,685,807	1,145,099	4,295,208	5,525,402
35%	1,139,266	5,655,838	6,853,213	1,167,704	4,415,210	5,651,208
40%	1,160,427	5,817,094	7,020,279	1,190,012	4,531,751	5,774,476
45%	1,180,850	5,981,392	7,182,528	1,211,954	4,648,460	5,895,958
50%	1,201,069	6,143,859	7,349,778	1,235,173	4,765,756	6,019,770
55%	1,220,708	6,313,024	7,521,566	1,258,333	4,888,622	6,143,513
60%	1,241,683	6,490,961	7,697,628	1,282,448	5,015,442	6,278,535
65%	1,263,431	6,676,561	7,885,659	1,307,817	5,146,277	6,416,444
70%	1,285,744	6,883,594	8,090,756	1,335,014	5,295,229	6,568,445
75%	1,309,538	7,106,324	8,319,817	1,364,839	5,455,335	6,731,643
80%	1,336,254	7,360,158	8,578,569	1,398,495	5,639,248	6,920,051
85%	1,367,361	7,660,263	8,877,871	1,438,184	5,854,938	7,147,491
90%	1,407,025	8,052,656	9,271,903	1,489,869	6,148,712	7,440,558
95%	1,464,162	8,654,708	9,887,205	1,564,673	6,580,837	7,899,457
99%	1,576,306	9,821,619	11,059,651	1,708,231	7,469,647	8,820,397

Table E.53-Risk profile statistics for highway bridge with modification 2a ADT case 8 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	2,882,282	3,981,174	794,935	2,511,771	3,561,870
Maximum	1,900,008	16,465,364	17,754,251	2,117,072	12,919,265	14,224,469
Mean	1,203,146	7,532,309	8,735,455	1,250,889	6,125,268	7,376,157
Std Dev	156,583	1,745,619	1,756,244	175,993	1,304,546	1,335,853
Percentile						
1%	872,316	4,211,796	5,376,057	918,427	3,661,849	4,826,061
5%	945,174	4,945,512	6,132,513	989,862	4,206,371	5,403,833
10%	998,059	5,410,309	6,598,361	1,035,656	4,543,188	5,755,155
15%	1,036,328	5,740,546	6,934,480	1,068,262	4,789,982	6,005,385
20%	1,067,022	6,018,517	7,216,084	1,095,750	4,996,143	6,224,894
25%	1,093,240	6,271,119	7,467,426	1,121,263	5,184,207	6,416,447
30%	1,117,539	6,500,630	7,700,067	1,145,099	5,356,898	6,591,748
35%	1,139,266	6,723,971	7,922,764	1,167,704	5,517,149	6,760,363
40%	1,160,427	6,941,171	8,140,033	1,190,012	5,679,853	6,925,475
45%	1,180,850	7,154,030	8,357,918	1,211,954	5,840,125	7,089,758
50%	1,201,069	7,368,758	8,571,434	1,235,173	6,003,326	7,253,950
55%	1,220,708	7,592,289	8,798,434	1,258,333	6,170,856	7,421,067
60%	1,241,683	7,825,854	9,029,353	1,282,448	6,337,773	7,599,175
65%	1,263,431	8,073,028	9,278,372	1,307,817	6,518,057	7,785,477
70%	1,285,744	8,340,592	9,553,873	1,335,014	6,715,764	7,986,207
75%	1,309,538	8,637,039	9,847,477	1,364,839	6,937,390	8,207,361
80%	1,336,254	8,963,984	10,175,960	1,398,495	7,186,157	8,459,705
85%	1,367,361	9,367,750	10,580,217	1,438,184	7,487,156	8,768,431
90%	1,407,025	9,871,275	11,091,890	1,489,869	7,877,563	9,165,014
95%	1,464,162	10,666,711	11,878,283	1,564,673	8,460,748	9,763,995
99%	1,576,306	12,156,586	13,384,190	1,708,231	9,639,339	10,967,749

Table E.54-Risk profile statistics for highway bridge with modification 2a ADT case 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	760,300	2,959,658	4,082,313	794,935	3,401,555	4,594,381
Maximum	1,900,008	27,977,793	29,266,681	2,117,072	22,675,560	23,983,289
Mean	1,203,146	11,307,355	12,510,501	1,250,889	9,912,183	11,163,072
Std Dev	156,583	3,293,978	3,299,575	175,993	2,543,942	2,563,720
Percentile						
1%	872,316	5,058,960	6,244,660	918,427	5,156,399	6,362,468
5%	945,174	6,377,537	7,572,868	989,862	6,125,381	7,345,824
10%	998,059	7,247,668	8,441,689	1,035,656	6,782,936	8,015,469
15%	1,036,328	7,897,333	9,097,458	1,068,262	7,280,337	8,519,744
20%	1,067,022	8,427,211	9,627,570	1,095,750	7,692,870	8,924,156
25%	1,093,240	8,916,963	10,114,409	1,121,263	8,064,880	9,301,287
30%	1,117,539	9,362,805	10,563,822	1,145,099	8,412,394	9,655,007
35%	1,139,266	9,789,223	10,989,508	1,167,704	8,736,917	9,983,418
40%	1,160,427	10,202,445	11,404,427	1,190,012	9,052,970	10,300,428
45%	1,180,850	10,614,153	11,812,708	1,211,954	9,369,656	10,621,712
50%	1,201,069	11,026,138	12,230,818	1,235,173	9,687,138	10,937,159
55%	1,220,708	11,447,806	12,649,734	1,258,333	10,010,676	11,261,102
60%	1,241,683	11,880,965	13,083,196	1,282,448	10,348,433	11,600,693
65%	1,263,431	12,335,916	13,546,206	1,307,817	10,705,127	11,962,501
70%	1,285,744	12,843,762	14,048,296	1,335,014	11,089,808	12,345,853
75%	1,309,538	13,393,523	14,602,078	1,364,839	11,504,486	12,766,224
80%	1,336,254	14,018,362	15,225,794	1,398,495	11,993,586	13,259,262
85%	1,367,361	14,780,998	15,992,097	1,438,184	12,577,667	13,852,193
90%	1,407,025	15,751,410	16,957,693	1,489,869	13,329,478	14,611,444
95%	1,464,162	17,224,035	18,431,115	1,564,673	14,466,273	15,750,409
99%	1,576,306	19,985,728	21,191,987	1,708,231	16,684,256	17,981,111

Table E.55-Risk profile statistics for highway bridge with modification 2b ADT case 1 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	78,929	1,006,778	820,832	308,443	1,304,375
Maximum	1,988,814	4,013,285	5,390,979	2,175,264	3,548,792	5,090,150
Mean	1,291,342	1,358,661	2,650,003	1,295,078	1,334,318	2,629,396
Std Dev	157,783	577,938	599,220	178,823	452,048	493,737
Percentile						
1%	946,742	261,977	1,480,251	954,917	485,859	1,659,104
5%	1,030,871	472,674	1,734,077	1,029,034	648,989	1,879,650
10%	1,086,197	629,667	1,897,259	1,075,676	768,321	2,014,829
15%	1,124,870	748,818	2,020,490	1,109,911	860,266	2,116,166
20%	1,155,805	852,220	2,124,864	1,137,403	936,865	2,199,096
25%	1,182,038	941,210	2,219,124	1,163,647	1,005,739	2,273,980
30%	1,206,346	1,022,089	2,304,308	1,188,233	1,069,283	2,342,785
35%	1,228,071	1,098,332	2,381,633	1,211,133	1,128,227	2,408,267
40%	1,249,234	1,171,362	2,458,678	1,233,824	1,187,023	2,472,232
45%	1,269,657	1,244,661	2,534,421	1,256,285	1,243,136	2,533,317
50%	1,289,875	1,317,547	2,609,038	1,279,594	1,300,025	2,595,083
55%	1,309,515	1,392,337	2,686,967	1,302,895	1,357,844	2,657,262
60%	1,330,489	1,467,604	2,766,416	1,327,225	1,417,563	2,722,263
65%	1,352,237	1,548,091	2,851,658	1,352,962	1,479,832	2,790,443
70%	1,374,551	1,633,231	2,939,208	1,380,727	1,548,391	2,866,231
75%	1,398,345	1,729,559	3,036,565	1,410,791	1,622,169	2,946,801
80%	1,425,061	1,838,976	3,147,852	1,445,178	1,706,325	3,037,319
85%	1,456,167	1,970,768	3,280,335	1,485,037	1,808,990	3,146,876
90%	1,495,831	2,136,337	3,451,735	1,537,367	1,941,792	3,288,024
95%	1,552,969	2,384,873	3,711,120	1,613,720	2,138,970	3,501,098
99%	1,665,112	2,853,280	4,180,110	1,759,239	2,511,545	3,910,086

Table E.56-Risk profile statistics for highway bridge with modification 2b ADT case 2 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	93,699	1,056,091	820,832	574,198	1,617,236
Maximum	1,988,814	7,850,761	9,228,455	2,175,264	6,987,992	8,355,941
Mean	1,291,342	2,617,010	3,908,351	1,295,078	2,596,623	3,891,702
Std Dev	157,783	1,149,925	1,160,724	178,823	899,595	924,828
Percentile						
1%	946,742	428,422	1,681,405	954,917	904,490	2,125,147
5%	1,030,871	851,953	2,126,640	1,029,034	1,228,602	2,491,943
10%	1,086,197	1,165,065	2,445,215	1,075,676	1,469,091	2,737,549
15%	1,124,870	1,403,188	2,685,287	1,109,911	1,651,544	2,923,093
20%	1,155,805	1,608,701	2,890,882	1,137,403	1,806,441	3,081,022
25%	1,182,038	1,786,369	3,067,803	1,163,647	1,943,131	3,220,307
30%	1,206,346	1,947,864	3,233,704	1,188,233	2,070,158	3,351,062
35%	1,228,071	2,099,051	3,385,547	1,211,133	2,187,387	3,474,832
40%	1,249,234	2,245,376	3,535,161	1,233,824	2,304,252	3,592,711
45%	1,269,657	2,391,613	3,680,879	1,256,285	2,415,714	3,709,249
50%	1,289,875	2,535,767	3,830,252	1,279,594	2,529,916	3,825,259
55%	1,309,515	2,685,491	3,977,124	1,302,895	2,644,545	3,941,045
60%	1,330,489	2,834,506	4,130,224	1,327,225	2,763,770	4,061,325
65%	1,352,237	2,995,066	4,292,303	1,352,962	2,887,609	4,190,360
70%	1,374,551	3,164,060	4,465,248	1,380,727	3,023,509	4,330,741
75%	1,398,345	3,356,654	4,654,010	1,410,791	3,170,657	4,482,067
80%	1,425,061	3,573,650	4,874,059	1,445,178	3,338,024	4,655,617
85%	1,456,167	3,835,396	5,132,442	1,485,037	3,541,683	4,862,468
90%	1,495,831	4,164,547	5,466,494	1,537,367	3,804,843	5,130,008
95%	1,552,969	4,657,696	5,973,421	1,613,720	4,195,282	5,528,634
99%	1,665,112	5,588,238	6,884,423	1,759,239	4,937,064	6,305,326

Table E.57-Risk profile statistics for highway bridge with modification 2b ADT case 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	127,832	1,194,942	820,832	1,362,788	2,461,017
Maximum	1,988,814	19,363,191	20,740,885	2,175,264	17,305,593	18,673,543
Mean	1,291,342	6,392,055	7,683,397	1,295,078	6,383,538	7,678,617
Std Dev	157,783	2,866,321	2,870,617	178,823	2,242,491	2,257,126
Percentile						
1%	946,742	931,314	2,209,903	954,917	2,156,779	3,415,726
5%	1,030,871	1,987,056	3,272,209	1,029,034	2,970,341	4,253,673
10%	1,086,197	2,770,779	4,055,480	1,075,676	3,570,107	4,853,269
15%	1,124,870	3,364,531	4,649,997	1,109,911	4,026,508	5,306,098
20%	1,155,805	3,878,149	5,167,240	1,137,403	4,415,080	5,698,154
25%	1,182,038	4,322,657	5,610,427	1,163,647	4,755,257	6,039,679
30%	1,206,346	4,727,902	6,015,291	1,188,233	5,072,593	6,356,686
35%	1,228,071	5,102,957	6,393,754	1,211,133	5,365,653	6,656,275
40%	1,249,234	5,469,052	6,758,760	1,233,824	5,655,828	6,944,466
45%	1,269,657	5,831,555	7,118,025	1,256,285	5,932,879	7,228,926
50%	1,289,875	6,192,154	7,488,168	1,279,594	6,218,148	7,509,824
55%	1,309,515	6,562,405	7,855,472	1,302,895	6,503,052	7,800,169
60%	1,330,489	6,938,132	8,232,242	1,327,225	6,803,099	8,098,011
65%	1,352,237	7,336,844	8,630,632	1,352,962	7,109,635	8,405,065
70%	1,374,551	7,758,321	9,054,950	1,380,727	7,450,525	8,747,693
75%	1,398,345	8,234,989	9,528,224	1,410,791	7,817,292	9,119,556
80%	1,425,061	8,776,426	10,066,209	1,445,178	8,233,411	9,541,882
85%	1,456,167	9,427,539	10,719,235	1,485,037	8,742,049	10,052,911
90%	1,495,831	10,247,078	11,539,095	1,537,367	9,395,896	10,706,288
95%	1,552,969	11,474,267	12,773,547	1,613,720	10,368,572	11,689,639
99%	1,665,112	13,796,289	15,069,164	1,759,239	12,210,960	13,538,619

Table E.58-Risk profile statistics for highway bridge with modification 2b ADT case 4 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	591,932	1,705,310	820,832	680,311	1,715,843
Maximum	1,988,814	5,595,559	6,973,253	2,175,264	4,535,112	6,136,483
Mean	1,291,342	2,261,471	3,552,813	1,295,078	1,982,437	3,277,515
Std Dev	157,783	658,796	679,258	178,823	508,788	553,082
Percentile						
1%	946,742	1,011,792	2,232,565	954,917	1,031,280	2,200,550
5%	1,030,871	1,275,507	2,532,461	1,029,034	1,225,076	2,445,697
10%	1,086,197	1,449,534	2,714,992	1,075,676	1,356,587	2,597,120
15%	1,124,870	1,579,467	2,851,579	1,109,911	1,456,067	2,707,821
20%	1,155,805	1,685,442	2,962,662	1,137,403	1,538,574	2,799,562
25%	1,182,038	1,783,393	3,062,537	1,163,647	1,612,976	2,880,766
30%	1,206,346	1,872,561	3,155,299	1,188,233	1,682,479	2,955,902
35%	1,228,071	1,957,845	3,243,944	1,211,133	1,747,383	3,027,658
40%	1,249,234	2,040,489	3,328,680	1,233,824	1,810,594	3,096,615
45%	1,269,657	2,122,831	3,411,978	1,256,285	1,873,931	3,165,003
50%	1,289,875	2,205,228	3,496,107	1,279,594	1,937,428	3,233,400
55%	1,309,515	2,289,561	3,584,255	1,302,895	2,002,135	3,303,160
60%	1,330,489	2,376,193	3,676,204	1,327,225	2,069,687	3,377,392
65%	1,352,237	2,467,183	3,768,314	1,352,962	2,141,025	3,454,224
70%	1,374,551	2,568,752	3,870,856	1,380,727	2,217,962	3,536,281
75%	1,398,345	2,678,705	3,986,669	1,410,791	2,300,897	3,627,606
80%	1,425,061	2,803,672	4,114,362	1,445,178	2,398,717	3,730,342
85%	1,456,167	2,956,200	4,269,222	1,485,037	2,515,533	3,851,765
90%	1,495,831	3,150,282	4,463,867	1,537,367	2,665,896	4,016,924
95%	1,552,969	3,444,807	4,763,607	1,613,720	2,893,255	4,256,401
99%	1,665,112	3,997,146	5,318,849	1,759,239	3,336,851	4,738,842

Table E.59-Risk profile statistics for highway bridge with modification 2b ADT case 5 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	617,723	1,754,624	820,832	958,389	2,077,641
Maximum	1,988,814	9,433,035	10,810,729	2,175,264	7,974,312	9,342,262
Mean	1,291,342	3,519,820	4,811,161	1,295,078	3,244,742	4,539,820
Std Dev	157,783	1,215,739	1,226,906	178,823	947,355	975,255
Percentile						
1%	946,742	1,227,084	2,475,973	954,917	1,481,922	2,689,300
5%	1,030,871	1,681,946	2,958,138	1,029,034	1,822,530	3,075,318
10%	1,086,197	2,003,840	3,282,582	1,075,676	2,068,448	3,334,707
15%	1,124,870	2,247,618	3,528,666	1,109,911	2,257,300	3,526,850
20%	1,155,805	2,455,670	3,738,055	1,137,403	2,413,619	3,688,879
25%	1,182,038	2,638,628	3,921,650	1,163,647	2,554,964	3,832,125
30%	1,206,346	2,803,918	4,089,002	1,188,233	2,686,522	3,966,959
35%	1,228,071	2,966,042	4,252,506	1,211,133	2,810,571	4,094,112
40%	1,249,234	3,117,576	4,405,747	1,233,824	2,929,765	4,219,364
45%	1,269,657	3,269,144	4,559,442	1,256,285	3,046,115	4,340,577
50%	1,289,875	3,423,759	4,716,088	1,279,594	3,166,428	4,462,768
55%	1,309,515	3,580,718	4,873,596	1,302,895	3,285,900	4,585,144
60%	1,330,489	3,740,491	5,036,896	1,327,225	3,414,276	4,711,977
65%	1,352,237	3,905,221	5,202,973	1,352,962	3,545,498	4,847,165
70%	1,374,551	4,089,894	5,390,014	1,380,727	3,688,401	4,996,736
75%	1,398,345	4,293,857	5,592,382	1,410,791	3,845,388	5,156,789
80%	1,425,061	4,526,845	5,825,779	1,445,178	4,021,378	5,340,934
85%	1,456,167	4,806,389	6,104,894	1,485,037	4,238,889	5,560,633
90%	1,495,831	5,159,980	6,463,373	1,537,367	4,517,643	5,848,849
95%	1,552,969	5,691,958	7,006,257	1,613,720	4,937,199	6,271,969
99%	1,665,112	6,697,402	8,001,047	1,759,239	5,735,306	7,100,787

Table E.60-Risk profile statistics for highway bridge with modification 2b ADT case 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	689,015	1,816,171	820,832	1,755,654	2,953,506
Maximum	1,988,814	20,945,465	22,323,159	2,175,264	18,291,914	19,659,863
Mean	1,291,342	7,294,866	8,586,207	1,295,078	7,031,657	8,326,735
Std Dev	157,783	2,922,082	2,926,694	178,823	2,284,306	2,300,328
Percentile						
1%	946,742	1,774,381	3,049,107	954,917	2,760,500	4,019,057
5%	1,030,871	2,830,968	4,120,302	1,029,034	3,577,956	4,849,066
10%	1,086,197	3,616,066	4,902,223	1,075,676	4,176,818	5,461,945
15%	1,124,870	4,213,265	5,505,687	1,109,911	4,640,209	5,915,652
20%	1,155,805	4,733,439	6,021,791	1,137,403	5,023,088	6,308,214
25%	1,182,038	5,182,274	6,470,270	1,163,647	5,372,103	6,655,986
30%	1,206,346	5,589,822	6,875,907	1,188,233	5,691,357	6,977,435
35%	1,228,071	5,969,555	7,256,547	1,211,133	5,986,215	7,278,868
40%	1,249,234	6,340,356	7,630,681	1,233,824	6,281,710	7,574,554
45%	1,269,657	6,706,647	7,998,797	1,256,285	6,564,454	7,861,027
50%	1,289,875	7,080,610	8,373,957	1,279,594	6,850,362	8,146,048
55%	1,309,515	7,456,941	8,753,208	1,302,895	7,145,440	8,441,070
60%	1,330,489	7,840,403	9,133,060	1,327,225	7,448,397	8,743,853
65%	1,352,237	8,243,085	9,535,960	1,352,962	7,763,326	9,063,648
70%	1,374,551	8,675,817	9,975,082	1,380,727	8,107,913	9,409,177
75%	1,398,345	9,160,396	10,459,148	1,410,791	8,486,121	9,786,503
80%	1,425,061	9,722,103	11,015,905	1,445,178	8,912,855	10,222,446
85%	1,456,167	10,388,192	11,680,998	1,485,037	9,428,254	10,744,816
90%	1,495,831	11,227,889	12,521,397	1,537,367	10,097,358	11,411,419
95%	1,552,969	12,497,744	13,806,040	1,613,720	11,103,441	12,425,060
99%	1,665,112	14,883,292	16,173,252	1,759,239	12,997,375	14,335,179

Table E.61-Risk profile statistics for highway bridge with modification 2b ADT case 7 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	2,683,260	3,730,108	820,832	2,215,176	3,216,038
Maximum	1,988,814	13,297,485	14,750,422	2,175,264	10,527,202	11,727,483
Mean	1,291,342	6,273,960	7,565,302	1,295,078	4,862,963	6,158,041
Std Dev	157,783	1,325,011	1,339,169	178,823	955,762	997,154
Percentile						
1%	946,742	3,772,649	5,025,300	954,917	3,067,367	4,251,380
5%	1,030,871	4,325,386	5,590,951	1,029,034	3,468,170	4,691,742
10%	1,086,197	4,670,818	5,936,722	1,075,676	3,714,345	4,958,175
15%	1,124,870	4,914,601	6,194,503	1,109,911	3,888,640	5,146,428
20%	1,155,805	5,126,754	6,407,529	1,137,403	4,040,107	5,301,646
25%	1,182,038	5,312,452	6,597,742	1,163,647	4,171,958	5,437,871
30%	1,206,346	5,490,793	6,773,904	1,188,233	4,295,208	5,568,206
35%	1,228,071	5,655,838	6,941,598	1,211,133	4,415,210	5,694,584
40%	1,249,234	5,817,094	7,108,251	1,233,824	4,531,751	5,818,052
45%	1,269,657	5,981,392	7,270,496	1,256,285	4,648,460	5,939,879
50%	1,289,875	6,143,859	7,438,243	1,279,594	4,765,756	6,063,655
55%	1,309,515	6,313,024	7,609,809	1,302,895	4,888,622	6,187,948
60%	1,330,489	6,490,961	7,786,275	1,327,225	5,015,442	6,323,275
65%	1,352,237	6,676,561	7,974,105	1,352,962	5,146,277	6,461,124
70%	1,374,551	6,883,594	8,179,147	1,380,727	5,295,229	6,613,383
75%	1,398,345	7,106,324	8,408,173	1,410,791	5,455,335	6,777,442
80%	1,425,061	7,360,158	8,666,901	1,445,178	5,639,248	6,965,378
85%	1,456,167	7,660,263	8,966,530	1,485,037	5,854,938	7,193,726
90%	1,495,831	8,052,656	9,360,407	1,537,367	6,148,712	7,487,592
95%	1,552,969	8,654,708	9,975,275	1,613,720	6,580,837	7,947,348
99%	1,665,112	9,821,619	11,146,639	1,759,239	7,469,647	8,866,926

Table E.62-Risk profile statistics for highway bridge with modification 2b ADT case 8 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	2,882,282	4,069,981	820,832	2,511,771	3,589,965
Maximum	1,988,814	16,465,364	17,843,058	2,175,264	12,919,265	14,280,074
Mean	1,291,342	7,532,309	8,823,651	1,295,078	6,125,268	7,420,346
Std Dev	157,783	1,745,619	1,756,361	178,823	1,304,546	1,337,640
Percentile						
1%	946,742	4,211,796	5,463,587	954,917	3,661,849	4,865,255
5%	1,030,871	4,945,512	6,220,629	1,029,034	4,206,371	5,445,611
10%	1,086,197	5,410,309	6,686,067	1,075,676	4,543,188	5,796,992
15%	1,124,870	5,740,546	7,022,927	1,109,911	4,789,982	6,046,867
20%	1,155,805	6,018,517	7,303,989	1,137,403	4,996,143	6,267,422
25%	1,182,038	6,271,119	7,555,739	1,163,647	5,184,207	6,458,999
30%	1,206,346	6,500,630	7,788,228	1,188,233	5,356,898	6,634,332
35%	1,228,071	6,723,971	8,011,173	1,211,133	5,517,149	6,803,598
40%	1,249,234	6,941,171	8,228,126	1,233,824	5,679,853	6,968,419
45%	1,269,657	7,154,030	8,446,259	1,256,285	5,840,125	7,133,376
50%	1,289,875	7,368,758	8,660,028	1,279,594	6,003,326	7,298,514
55%	1,309,515	7,592,289	8,886,490	1,302,895	6,170,856	7,464,808
60%	1,330,489	7,825,854	9,117,247	1,327,225	6,337,773	7,643,249
65%	1,352,237	8,073,028	9,366,996	1,352,962	6,518,057	7,830,464
70%	1,374,551	8,340,592	9,642,370	1,380,727	6,715,764	8,031,420
75%	1,398,345	8,637,039	9,935,690	1,410,791	6,937,390	8,252,516
80%	1,425,061	8,963,984	10,264,263	1,445,178	7,186,157	8,505,080
85%	1,456,167	9,367,750	10,668,087	1,485,037	7,487,156	8,815,168
90%	1,495,831	9,871,275	11,180,609	1,537,367	7,877,563	9,211,521
95%	1,552,969	10,666,711	11,967,089	1,613,720	8,460,748	9,811,332
99%	1,665,112	12,156,586	13,472,997	1,759,239	9,639,339	11,017,298

Table E.63-Risk profile statistics for highway bridge with modification 2b ADT case 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	836,262	2,959,658	4,171,120	820,832	3,401,555	4,643,025
Maximum	1,988,814	27,977,793	29,355,487	2,175,264	22,675,560	24,043,509
Mean	1,291,342	11,307,355	12,598,697	1,295,078	9,912,183	11,207,261
Std Dev	157,783	3,293,978	3,299,637	178,823	2,543,942	2,564,936
Percentile						
1%	946,742	5,058,960	6,332,306	954,917	5,156,399	6,405,547
5%	1,030,871	6,377,537	7,661,280	1,029,034	6,125,381	7,388,363
10%	1,086,197	7,247,668	8,529,494	1,075,676	6,782,936	8,057,794
15%	1,124,870	7,897,333	9,185,818	1,109,911	7,280,337	8,563,368
20%	1,155,805	8,427,211	9,715,638	1,137,403	7,692,870	8,966,782
25%	1,182,038	8,916,963	10,202,394	1,163,647	8,064,880	9,342,854
30%	1,206,346	9,362,805	10,651,819	1,188,233	8,412,394	9,698,071
35%	1,228,071	9,789,223	11,077,774	1,211,133	8,736,917	10,026,462
40%	1,249,234	10,202,445	11,493,052	1,233,824	9,052,970	10,344,584
45%	1,269,657	10,614,153	11,901,208	1,256,285	9,369,656	10,665,313
50%	1,289,875	11,026,138	12,319,100	1,279,594	9,687,138	10,981,325
55%	1,309,515	11,447,806	12,737,774	1,302,895	10,010,676	11,306,661
60%	1,330,489	11,880,965	13,171,043	1,327,225	10,348,433	11,644,756
65%	1,352,237	12,335,916	13,634,888	1,352,962	10,705,127	12,005,992
70%	1,374,551	12,843,762	14,135,978	1,380,727	11,089,808	12,389,436
75%	1,398,345	13,393,523	14,690,246	1,410,791	11,504,486	12,810,296
80%	1,425,061	14,018,362	15,313,696	1,445,178	11,993,586	13,302,778
85%	1,456,167	14,780,998	16,080,614	1,485,037	12,577,667	13,896,796
90%	1,495,831	15,751,410	17,045,823	1,537,367	13,329,478	14,656,238
95%	1,552,969	17,224,035	18,519,761	1,613,720	14,466,273	15,799,103
99%	1,665,112	19,985,728	21,280,793	1,759,239	16,684,256	18,034,818

Table E.64-Risk profile statistics for highway bridge with modification 2c ADT case 1 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	895,742	78,929	1,080,092	855,949	308,443	1,342,192
Maximum	2,077,621	4,013,285	5,479,785	2,233,456	3,548,792	5,143,661
Mean	1,379,772	1,358,661	2,738,433	1,339,385	1,334,318	2,673,703
Std Dev	158,586	577,938	599,438	181,707	452,048	495,337
Percentile						
1%	1,023,311	261,977	1,567,573	992,687	485,859	1,699,901
5%	1,118,700	472,674	1,822,511	1,068,506	648,989	1,921,664
10%	1,174,741	629,667	1,985,722	1,115,965	768,321	2,057,621
15%	1,213,633	748,818	2,108,777	1,151,129	860,266	2,159,103
20%	1,244,593	852,220	2,213,145	1,179,273	936,865	2,241,864
25%	1,270,845	941,210	2,307,615	1,206,152	1,005,739	2,317,231
30%	1,295,152	1,022,089	2,392,593	1,231,097	1,069,283	2,386,506
35%	1,316,877	1,098,332	2,470,179	1,254,380	1,128,227	2,452,106
40%	1,338,040	1,171,362	2,547,328	1,277,439	1,187,023	2,515,816
45%	1,358,464	1,244,661	2,622,842	1,300,664	1,243,136	2,577,400
50%	1,378,682	1,317,547	2,697,578	1,323,942	1,300,025	2,639,161
55%	1,398,321	1,392,337	2,775,570	1,347,627	1,357,844	2,701,889
60%	1,419,296	1,467,604	2,854,881	1,372,330	1,417,563	2,766,948
65%	1,441,044	1,548,091	2,940,220	1,398,661	1,479,832	2,835,238
70%	1,463,357	1,633,231	3,027,858	1,426,376	1,548,391	2,911,182
75%	1,487,151	1,729,559	3,125,261	1,456,844	1,622,169	2,992,285
80%	1,513,867	1,838,976	3,236,567	1,491,904	1,706,325	3,082,713
85%	1,544,974	1,970,768	3,369,003	1,532,274	1,808,990	3,192,462
90%	1,584,638	2,136,337	3,540,423	1,585,572	1,941,792	3,333,684
95%	1,641,775	2,384,873	3,799,920	1,662,394	2,138,970	3,547,917
99%	1,753,919	2,853,280	4,268,917	1,809,276	2,511,545	3,959,382

Table E.65-Risk profile statistics for highway bridge with modification 2c ADT case 2 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	895,742	93,699	1,129,405	855,949	574,198	1,654,255
Maximum	2,077,621	7,850,761	9,317,262	2,233,456	6,987,992	8,416,162
Mean	1,379,772	2,617,010	3,996,781	1,339,385	2,596,623	3,936,008
Std Dev	158,586	1,149,925	1,160,839	181,707	899,595	925,946
Percentile						
1%	1,023,311	428,422	1,769,944	992,687	904,490	2,166,398
5%	1,118,700	851,953	2,214,532	1,068,506	1,228,602	2,534,379
10%	1,174,741	1,165,065	2,533,514	1,115,965	1,469,091	2,780,187
15%	1,213,633	1,403,188	2,773,525	1,151,129	1,651,544	2,966,768
20%	1,244,593	1,608,701	2,979,154	1,179,273	1,806,441	3,124,475
25%	1,270,845	1,786,369	3,156,301	1,206,152	1,943,131	3,263,744
30%	1,295,152	1,947,864	3,321,682	1,231,097	2,070,158	3,394,790
35%	1,316,877	2,099,051	3,474,114	1,254,380	2,187,387	3,518,143
40%	1,338,040	2,245,376	3,623,276	1,277,439	2,304,252	3,636,933
45%	1,358,464	2,391,613	3,769,305	1,300,664	2,415,714	3,752,941
50%	1,378,682	2,535,767	3,918,606	1,323,942	2,529,916	3,869,703
55%	1,398,321	2,685,491	4,065,719	1,347,627	2,644,545	3,985,357
60%	1,419,296	2,834,506	4,218,763	1,372,330	2,763,770	4,105,598
65%	1,441,044	2,995,066	4,380,615	1,398,661	2,887,609	4,235,043
70%	1,463,357	3,164,060	4,553,722	1,426,376	3,023,509	4,375,718
75%	1,487,151	3,356,654	4,742,766	1,456,844	3,170,657	4,526,762
80%	1,513,867	3,573,650	4,962,622	1,491,904	3,338,024	4,700,323
85%	1,544,974	3,835,396	5,220,688	1,532,274	3,541,683	4,907,177
90%	1,584,638	4,164,547	5,555,234	1,585,572	3,804,843	5,176,126
95%	1,641,775	4,657,696	6,062,228	1,662,394	4,195,282	5,574,736
99%	1,753,919	5,588,238	6,973,230	1,809,276	4,937,064	6,353,627

Table E.66-Risk profile statistics for highway bridge with modification 2c ADT case 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	895,742	127,832	1,277,346	855,949	1,362,788	2,498,036
Maximum	2,077,621	19,363,191	20,829,691	2,233,456	17,305,593	18,733,763
Mean	1,379,772	6,392,055	7,771,827	1,339,385	6,383,538	7,722,923
Std Dev	158,586	2,866,321	2,870,667	181,707	2,242,491	2,257,909
Percentile						
1%	1,023,311	931,314	2,297,242	992,687	2,156,779	3,459,426
5%	1,118,700	1,987,056	3,360,980	1,068,506	2,970,341	4,297,195
10%	1,174,741	2,770,779	4,143,779	1,115,965	3,570,107	4,896,784
15%	1,213,633	3,364,531	4,738,612	1,151,129	4,026,508	5,350,388
20%	1,244,593	3,878,149	5,255,523	1,179,273	4,415,080	5,741,965
25%	1,270,845	4,322,657	5,699,004	1,206,152	4,755,257	6,083,655
30%	1,295,152	4,727,902	6,103,848	1,231,097	5,072,593	6,400,588
35%	1,316,877	5,102,957	6,482,032	1,254,380	5,365,653	6,700,349
40%	1,338,040	5,469,052	6,847,291	1,277,439	5,655,828	6,989,037
45%	1,358,464	5,831,555	7,206,586	1,300,664	5,932,879	7,273,022
50%	1,378,682	6,192,154	7,576,734	1,323,942	6,218,148	7,553,978
55%	1,398,321	6,562,405	7,943,812	1,347,627	6,503,052	7,844,089
60%	1,419,296	6,938,132	8,320,895	1,372,330	6,803,099	8,142,722
65%	1,441,044	7,336,844	8,719,007	1,398,661	7,109,635	8,450,057
70%	1,463,357	7,758,321	9,143,694	1,426,376	7,450,525	8,792,085
75%	1,487,151	8,234,989	9,616,937	1,456,844	7,817,292	9,163,162
80%	1,513,867	8,776,426	10,154,994	1,491,904	8,233,411	9,586,527
85%	1,544,974	9,427,539	10,807,296	1,532,274	8,742,049	10,097,793
90%	1,584,638	10,247,078	11,627,902	1,585,572	9,395,896	10,751,556
95%	1,641,775	11,474,267	12,862,026	1,662,394	10,368,572	11,735,758
99%	1,753,919	13,796,289	15,157,535	1,809,276	12,210,960	13,587,977

Table E.67-Risk profile statistics for highway bridge with modification 2c ADT case 4 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	895,742	591,932	1,778,624	855,949	680,311	1,751,672
Maximum	2,077,621	5,595,559	7,062,059	2,233,456	4,535,112	6,189,993
Mean	1,379,772	2,261,471	3,641,243	1,339,385	1,982,437	3,321,821
Std Dev	158,586	658,796	679,454	181,707	508,788	554,965
Percentile						
1%	1,023,311	1,011,792	2,319,289	992,687	1,031,280	2,239,312
5%	1,118,700	1,275,507	2,620,126	1,068,506	1,225,076	2,486,517
10%	1,174,741	1,449,534	2,803,198	1,115,965	1,356,587	2,639,101
15%	1,213,633	1,579,467	2,939,824	1,151,129	1,456,067	2,750,458
20%	1,244,593	1,685,442	3,050,903	1,179,273	1,538,574	2,842,154
25%	1,270,845	1,783,393	3,150,921	1,206,152	1,612,976	2,923,882
30%	1,295,152	1,872,561	3,243,527	1,231,097	1,682,479	2,999,557
35%	1,316,877	1,957,845	3,332,358	1,254,380	1,747,383	3,071,494
40%	1,338,040	2,040,489	3,417,119	1,277,439	1,810,594	3,140,087
45%	1,358,464	2,122,831	3,500,388	1,300,664	1,873,931	3,208,833
50%	1,378,682	2,205,228	3,584,486	1,323,942	1,937,428	3,277,453
55%	1,398,321	2,289,561	3,672,889	1,347,627	2,002,135	3,347,690
60%	1,419,296	2,376,193	3,764,825	1,372,330	2,069,687	3,421,667
65%	1,441,044	2,467,183	3,856,871	1,398,661	2,141,025	3,499,568
70%	1,463,357	2,568,752	3,959,343	1,426,376	2,217,962	3,581,600
75%	1,487,151	2,678,705	4,075,299	1,456,844	2,300,897	3,673,567
80%	1,513,867	2,803,672	4,203,020	1,491,904	2,398,717	3,776,515
85%	1,544,974	2,956,200	4,357,598	1,532,274	2,515,533	3,897,877
90%	1,584,638	3,150,282	4,552,408	1,585,572	2,665,896	4,064,043
95%	1,641,775	3,444,807	4,852,284	1,662,394	2,893,255	4,302,807
99%	1,753,919	3,997,146	5,407,656	1,809,276	3,336,851	4,786,479

Table E.68-Risk profile statistics for highway bridge with modification 2c ADT case 5 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	895,742	617,723	1,827,937	855,949	958,389	2,116,777
Maximum	2,077,621	9,433,035	10,899,536	2,233,456	7,974,312	9,402,482
Mean	1,379,772	3,519,820	4,899,591	1,339,385	3,244,742	4,584,126
Std Dev	158,586	1,215,739	1,227,018	181,707	947,355	976,573
Percentile						
1%	1,023,311	1,227,084	2,563,241	992,687	1,481,922	2,729,448
5%	1,118,700	1,681,946	3,045,848	1,068,506	1,822,530	3,117,297
10%	1,174,741	2,003,840	3,370,921	1,115,965	2,068,448	3,376,965
15%	1,213,633	2,247,618	3,616,965	1,151,129	2,257,300	3,569,922
20%	1,244,593	2,455,670	3,826,128	1,179,273	2,413,619	3,732,250
25%	1,270,845	2,638,628	4,010,006	1,206,152	2,554,964	3,875,710
30%	1,295,152	2,803,918	4,177,474	1,231,097	2,686,522	4,010,551
35%	1,316,877	2,966,042	4,340,965	1,254,380	2,810,571	4,137,713
40%	1,338,040	3,117,576	4,494,219	1,277,439	2,929,765	4,263,604
45%	1,358,464	3,269,144	4,647,826	1,300,664	3,046,115	4,384,463
50%	1,378,682	3,423,759	4,804,086	1,323,942	3,166,428	4,506,871
55%	1,398,321	3,580,718	4,962,272	1,347,627	3,285,900	4,629,571
60%	1,419,296	3,740,491	5,125,366	1,372,330	3,414,276	4,756,452
65%	1,441,044	3,905,221	5,291,464	1,398,661	3,545,498	4,892,329
70%	1,463,357	4,089,894	5,478,611	1,426,376	3,688,401	5,041,946
75%	1,487,151	4,293,857	5,680,688	1,456,844	3,845,388	5,202,736
80%	1,513,867	4,526,845	5,913,945	1,491,904	4,021,378	5,385,673
85%	1,544,974	4,806,389	6,193,591	1,532,274	4,238,889	5,605,509
90%	1,584,638	5,159,980	6,552,180	1,585,572	4,517,643	5,894,578
95%	1,641,775	5,691,958	7,095,031	1,662,394	4,937,199	6,318,316
99%	1,753,919	6,697,402	8,089,854	1,809,276	5,735,306	7,152,710

Table E.69-Risk profile statistics for highway bridge with modification 2c ADT case 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	895,742	689,015	1,904,978	855,949	1,755,654	2,992,641
Maximum	2,077,621	20,945,465	22,411,965	2,233,456	18,291,914	19,720,084
Mean	1,379,772	7,294,866	8,674,637	1,339,385	7,031,657	8,371,041
Std Dev	158,586	2,922,082	2,926,744	181,707	2,284,306	2,301,206
Percentile						
1%	1,023,311	1,774,381	3,137,629	992,687	2,760,500	4,061,092
5%	1,118,700	2,830,968	4,209,109	1,068,506	3,577,956	4,891,544
10%	1,174,741	3,616,066	4,990,940	1,115,965	4,176,818	5,504,513
15%	1,213,633	4,213,265	5,593,743	1,151,129	4,640,209	5,959,094
20%	1,244,593	4,733,439	6,109,981	1,179,273	5,023,088	6,351,295
25%	1,270,845	5,182,274	6,558,783	1,206,152	5,372,103	6,699,244
30%	1,295,152	5,589,822	6,964,244	1,231,097	5,691,357	7,021,158
35%	1,316,877	5,969,555	7,344,921	1,254,380	5,986,215	7,323,366
40%	1,338,040	6,340,356	7,718,575	1,277,439	6,281,710	7,617,950
45%	1,358,464	6,706,647	8,087,512	1,300,664	6,564,454	7,905,131
50%	1,378,682	7,080,610	8,462,276	1,323,942	6,850,362	8,190,231
55%	1,398,321	7,456,941	8,841,466	1,347,627	7,145,440	8,485,472
60%	1,419,296	7,840,403	9,221,419	1,372,330	7,448,397	8,788,062
65%	1,441,044	8,243,085	9,624,724	1,398,661	7,763,326	9,108,010
70%	1,463,357	8,675,817	10,063,825	1,426,376	8,107,913	9,453,836
75%	1,487,151	9,160,396	10,547,640	1,456,844	8,486,121	9,830,740
80%	1,513,867	9,722,103	11,104,712	1,491,904	8,912,855	10,267,352
85%	1,544,974	10,388,192	11,769,288	1,532,274	9,428,254	10,789,860
90%	1,584,638	11,227,889	12,609,980	1,585,572	10,097,358	11,456,284
95%	1,641,775	12,497,744	13,894,436	1,662,394	11,103,441	12,471,826
99%	1,753,919	14,883,292	16,261,375	1,809,276	12,997,375	14,381,003

Table E.70-Risk profile statistics for highway bridge with modification 2c ADT case 7 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	895,742	2,683,260	3,818,915	855,949	2,215,176	3,244,134
Maximum	2,077,621	13,297,485	14,839,228	2,233,456	10,527,202	11,778,803
Mean	1,379,772	6,273,960	7,653,732	1,339,385	4,862,963	6,202,347
Std Dev	158,586	1,325,011	1,339,279	181,707	955,762	999,321
Percentile						
1%	1,023,311	3,772,649	5,113,224	992,687	3,067,367	4,291,144
5%	1,118,700	4,325,386	5,679,221	1,068,506	3,468,170	4,732,429
10%	1,174,741	4,670,818	6,025,303	1,115,965	3,714,345	5,000,148
15%	1,213,633	4,914,601	6,282,928	1,151,129	3,888,640	5,188,634
20%	1,244,593	5,126,754	6,495,848	1,179,273	4,040,107	5,344,333
25%	1,270,845	5,312,452	6,685,770	1,206,152	4,171,958	5,480,212
30%	1,295,152	5,490,793	6,862,248	1,231,097	4,295,208	5,611,502
35%	1,316,877	5,655,838	7,030,055	1,254,380	4,415,210	5,737,998
40%	1,338,040	5,817,094	7,196,436	1,277,439	4,531,751	5,861,158
45%	1,358,464	5,981,392	7,358,774	1,300,664	4,648,460	5,983,983
50%	1,378,682	6,143,859	7,526,655	1,323,942	4,765,756	6,107,468
55%	1,398,321	6,313,024	7,697,791	1,347,627	4,888,622	6,233,391
60%	1,419,296	6,490,961	7,874,646	1,372,330	5,015,442	6,367,416
65%	1,441,044	6,676,561	8,062,641	1,398,661	5,146,277	6,505,801
70%	1,463,357	6,883,594	8,267,338	1,426,376	5,295,229	6,658,704
75%	1,487,151	7,106,324	8,496,964	1,456,844	5,455,335	6,823,481
80%	1,513,867	7,360,158	8,755,498	1,491,904	5,639,248	7,011,400
85%	1,544,974	7,660,263	9,054,870	1,532,274	5,854,938	7,241,000
90%	1,584,638	8,052,656	9,449,128	1,585,572	6,148,712	7,534,781
95%	1,641,775	8,654,708	10,064,082	1,662,394	6,580,837	7,995,078
99%	1,753,919	9,821,619	11,235,365	1,809,276	7,469,647	8,917,280

Table E.71-Risk profile statistics for highway bridge with modification 2c ADT case 8 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	895,742	2,882,282	4,158,787	855,949	2,511,771	3,618,061
Maximum	2,077,621	16,465,364	17,931,864	2,233,456	12,919,265	14,335,679
Mean	1,379,772	7,532,309	8,912,081	1,339,385	6,125,268	7,464,652
Std Dev	158,586	1,745,619	1,756,446	181,707	1,304,546	1,339,438
Percentile						
1%	1,023,311	4,211,796	5,552,393	992,687	3,661,849	4,904,530
5%	1,118,700	4,945,512	6,308,696	1,068,506	4,206,371	5,487,350
10%	1,174,741	5,410,309	6,774,595	1,115,965	4,543,188	5,839,207
15%	1,213,633	5,740,546	7,111,398	1,151,129	4,789,982	6,090,325
20%	1,244,593	6,018,517	7,392,066	1,179,273	4,996,143	6,310,122
25%	1,270,845	6,271,119	7,644,424	1,206,152	5,184,207	6,502,096
30%	1,295,152	6,500,630	7,876,899	1,231,097	5,356,898	6,677,466
35%	1,316,877	6,723,971	8,099,471	1,254,380	5,517,149	6,846,778
40%	1,338,040	6,941,171	8,316,601	1,277,439	5,679,853	7,012,529
45%	1,358,464	7,154,030	8,534,277	1,300,664	5,840,125	7,176,677
50%	1,378,682	7,368,758	8,748,168	1,323,942	6,003,326	7,342,681
55%	1,398,321	7,592,289	8,974,630	1,347,627	6,170,856	7,509,110
60%	1,419,296	7,825,854	9,205,895	1,372,330	6,337,773	7,688,200
65%	1,441,044	8,073,028	9,455,660	1,398,661	6,518,057	7,875,278
70%	1,463,357	8,340,592	9,731,040	1,426,376	6,715,764	8,076,536
75%	1,487,151	8,637,039	10,024,138	1,456,844	6,937,390	8,298,152
80%	1,513,867	8,963,984	10,352,808	1,491,904	7,186,157	8,550,853
85%	1,544,974	9,367,750	10,756,891	1,532,274	7,487,156	8,860,807
90%	1,584,638	9,871,275	11,269,059	1,585,572	7,877,563	9,258,328
95%	1,641,775	10,666,711	12,055,808	1,662,394	8,460,748	9,859,240
99%	1,753,919	12,156,586	13,561,803	1,809,276	9,639,339	11,063,571

Table E.72-Risk profile statistics for highway bridge with modification 2c ADT case 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	895,742	2,959,658	4,259,926	855,949	3,401,555	4,691,669
Maximum	2,077,621	27,977,793	29,444,294	2,233,456	22,675,560	24,103,729
Mean	1,379,772	11,307,355	12,687,126	1,339,385	9,912,183	11,251,568
Std Dev	158,586	3,293,978	3,299,686	181,707	2,543,942	2,566,159
Percentile						
1%	1,023,311	5,058,960	6,421,113	992,687	5,156,399	6,445,711
5%	1,118,700	6,377,537	7,749,826	1,068,506	6,125,381	7,429,803
10%	1,174,741	7,247,668	8,617,719	1,115,965	6,782,936	8,101,338
15%	1,213,633	7,897,333	9,274,560	1,151,129	7,280,337	8,606,258
20%	1,244,593	8,427,211	9,804,143	1,179,273	7,692,870	9,010,297
25%	1,270,845	8,916,963	10,290,962	1,206,152	8,064,880	9,386,136
30%	1,295,152	9,362,805	10,739,662	1,231,097	8,412,394	9,741,724
35%	1,316,877	9,789,223	11,166,094	1,254,380	8,736,917	10,069,469
40%	1,338,040	10,202,445	11,581,092	1,277,439	9,052,970	10,387,631
45%	1,358,464	10,614,153	11,989,700	1,300,664	9,369,656	10,708,942
50%	1,378,682	11,026,138	12,407,540	1,323,942	9,687,138	11,025,080
55%	1,398,321	11,447,806	12,826,322	1,347,627	10,010,676	11,350,987
60%	1,419,296	11,880,965	13,259,618	1,372,330	10,348,433	11,689,478
65%	1,441,044	12,335,916	13,723,167	1,398,661	10,705,127	12,050,249
70%	1,463,357	12,843,762	14,224,378	1,426,376	11,089,808	12,433,531
75%	1,487,151	13,393,523	14,778,832	1,456,844	11,504,486	12,854,300
80%	1,513,867	14,018,362	15,402,112	1,491,904	11,993,586	13,346,651
85%	1,544,974	14,780,998	16,169,200	1,532,274	12,577,667	13,941,327
90%	1,584,638	15,751,410	17,134,629	1,585,572	13,329,478	14,701,350
95%	1,641,775	17,224,035	18,608,398	1,662,394	14,466,273	15,845,304
99%	1,753,919	19,985,728	21,369,600	1,809,276	16,684,256	18,080,119

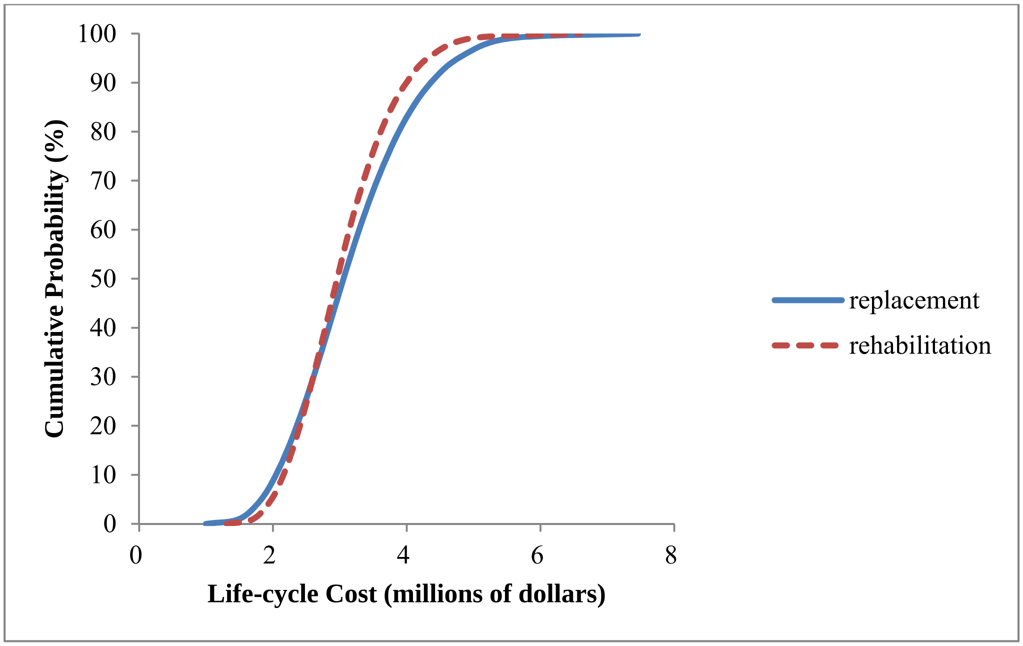


Figure E.37-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 1 (Table 3.6)

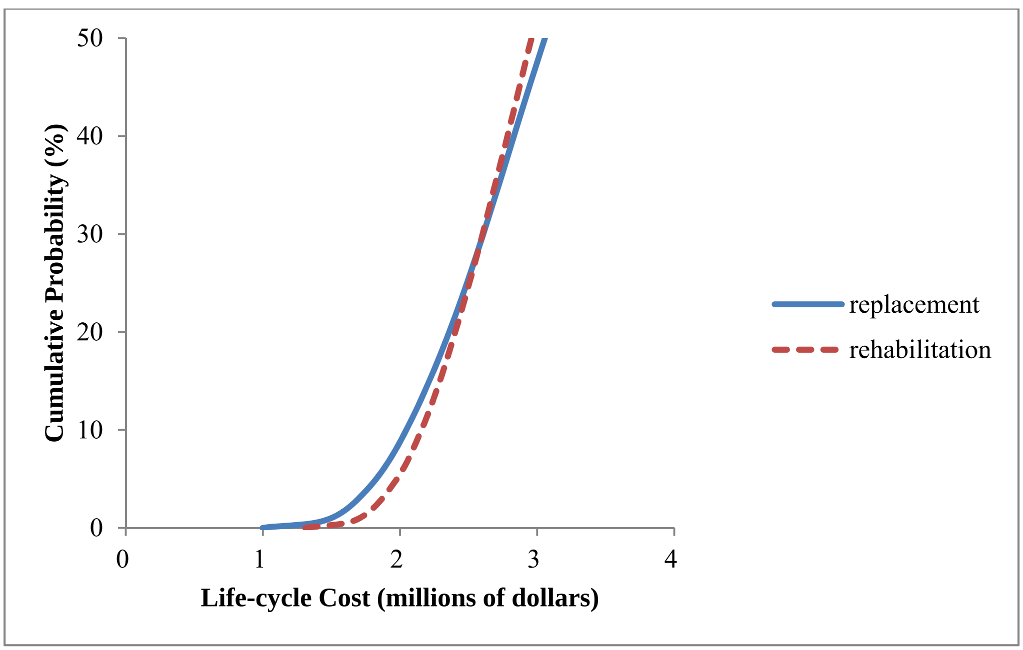


Figure E.38-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 1 (Table 3.6)

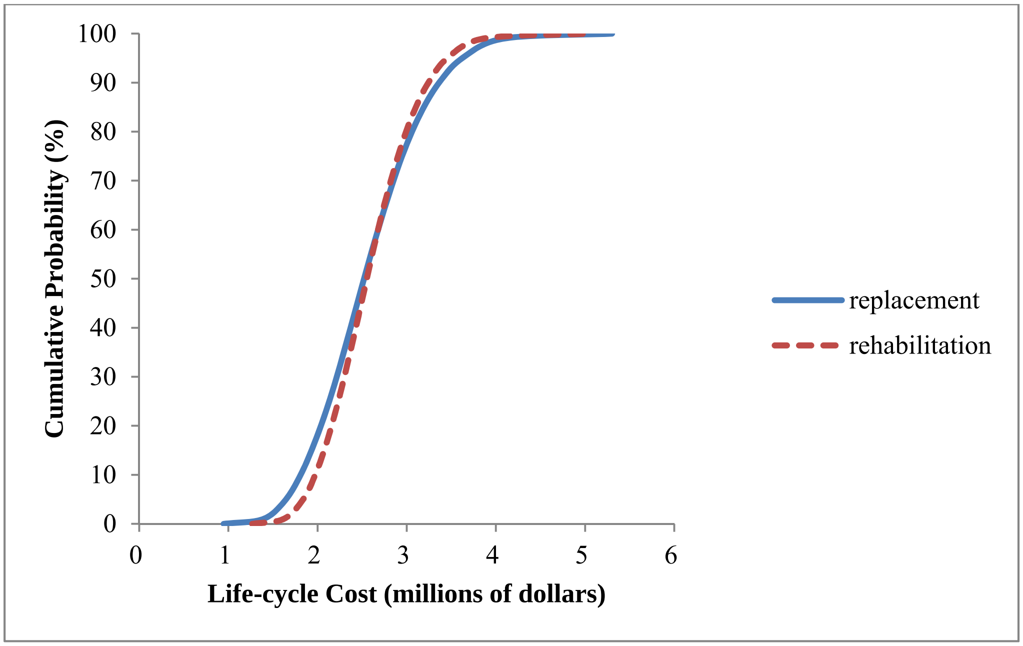


Figure E.39-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 1 (Table 3.6)

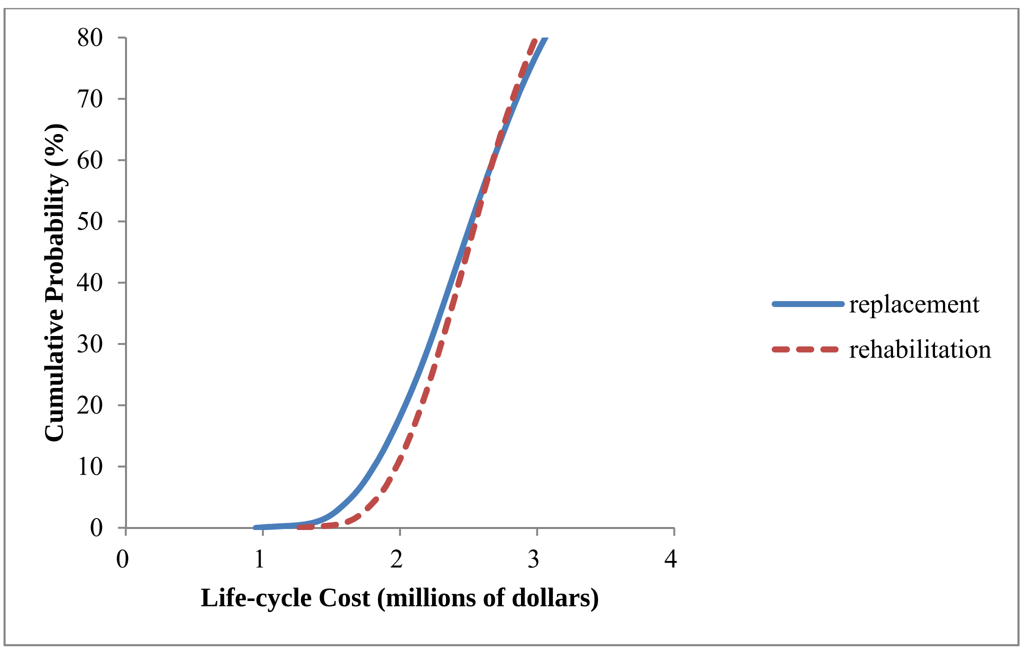


Figure E.40-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 1 (Table 3.6)

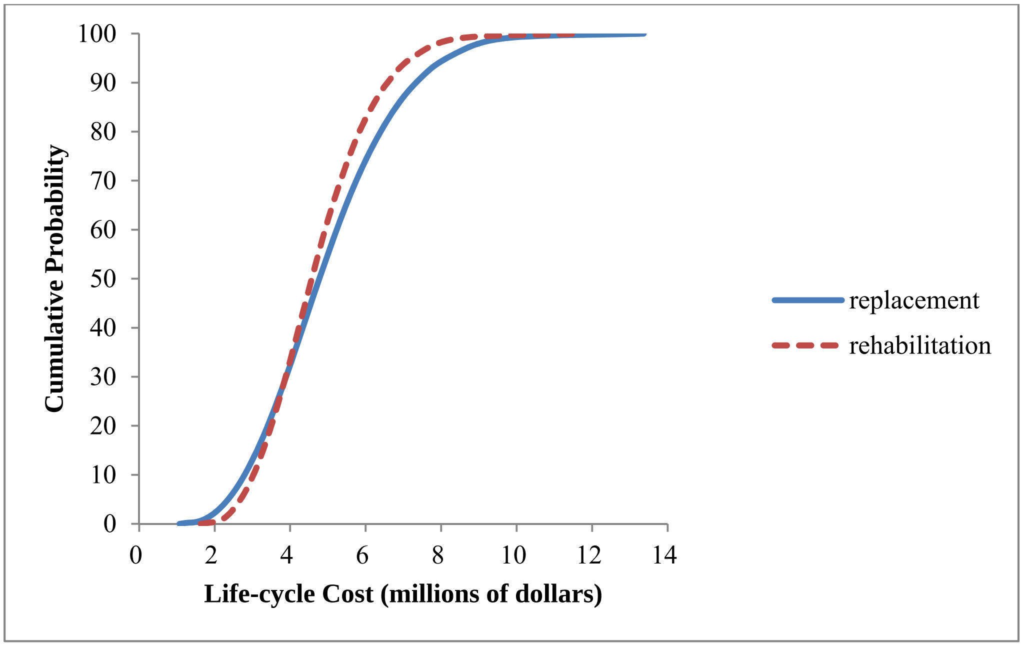


Figure E.41-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 2 (Table 3.6)

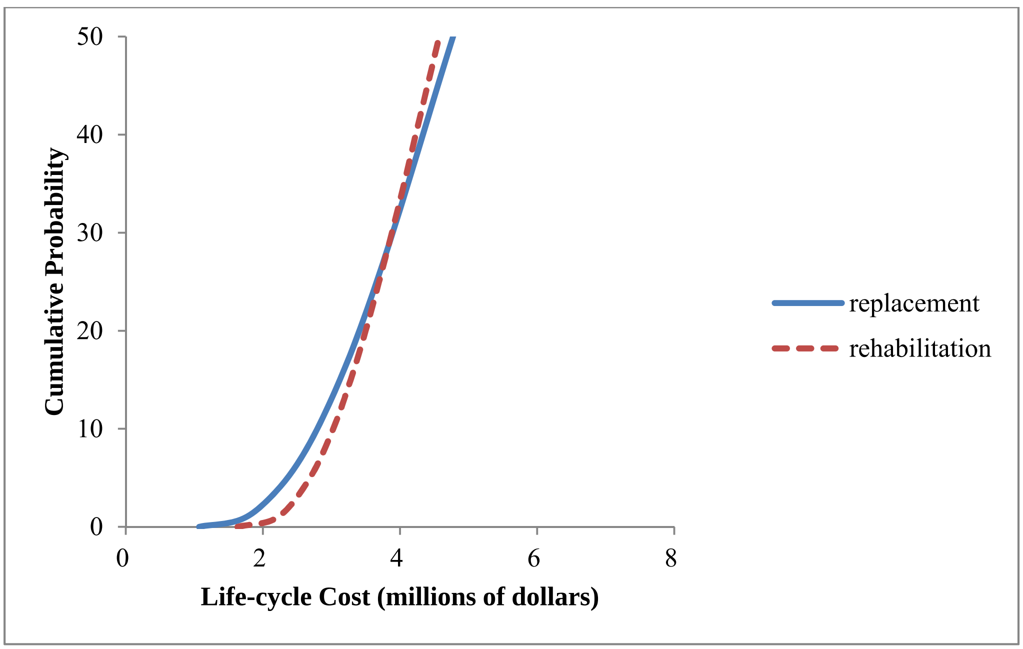


Figure E.42-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 2 (Table 3.6)

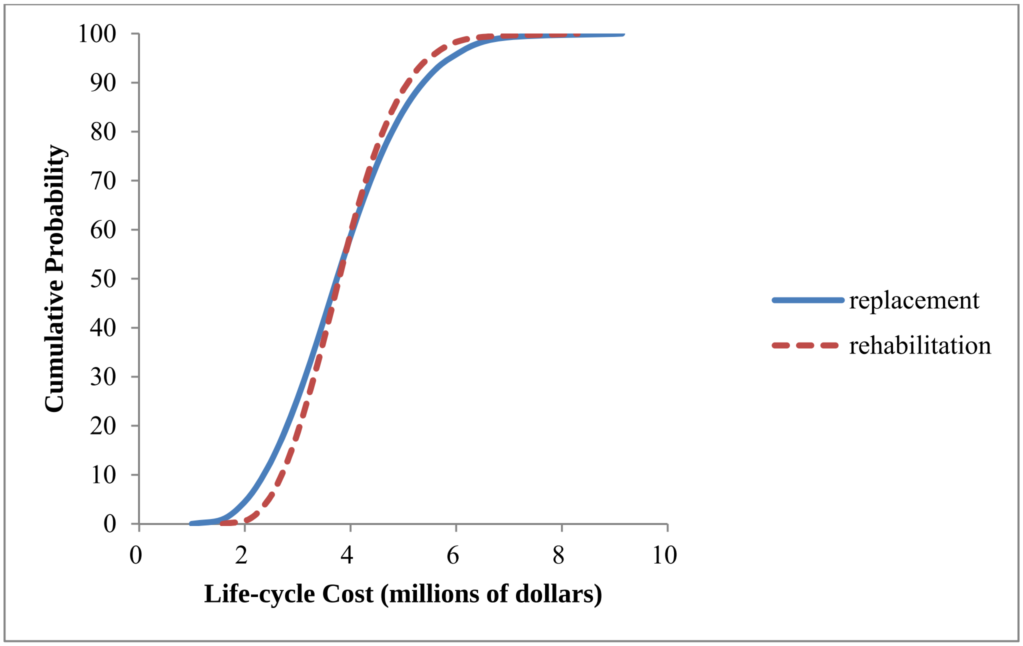


Figure E.43-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 2 (Table 3.6)

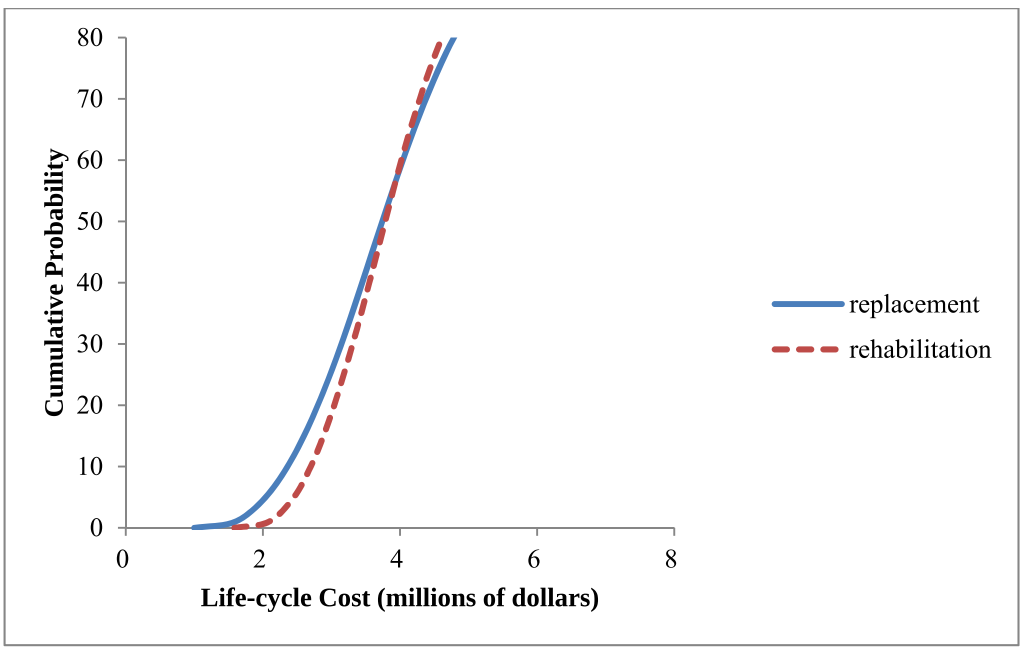


Figure E.44-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 2 (Table 3.6)

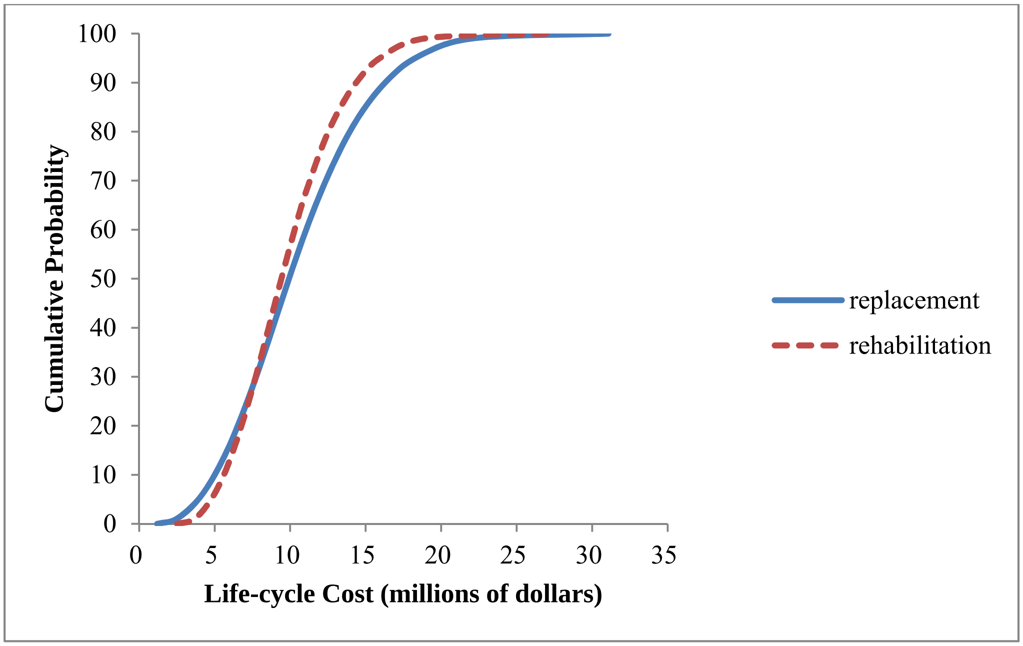


Figure E.45-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 3 (Table 3.6)

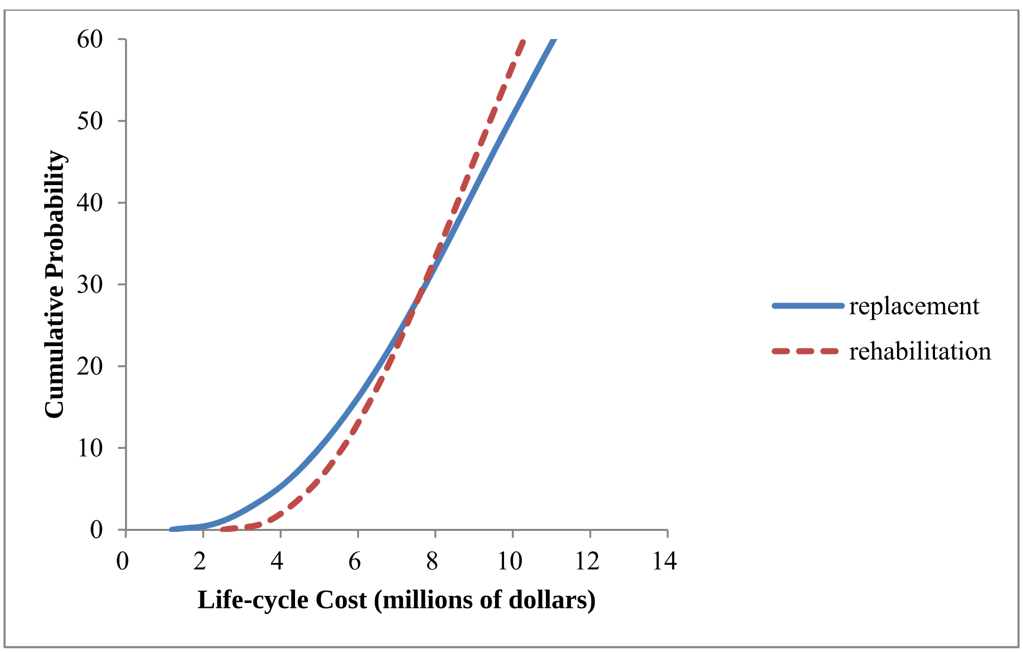


Figure E.46-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 3 (Table 3.6)

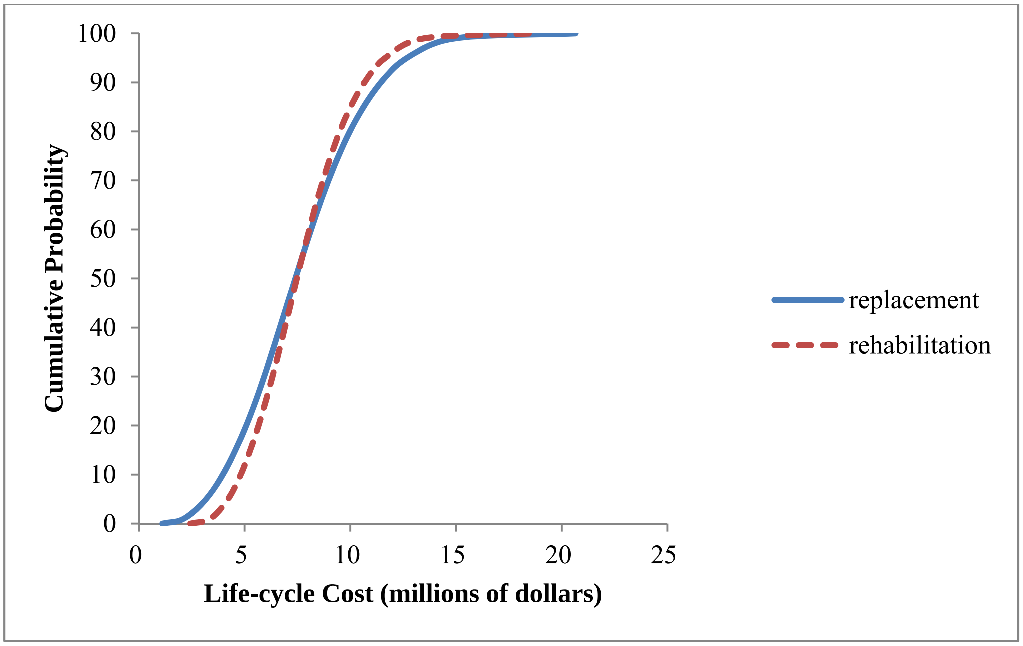


Figure E.47-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 3 (Table 3.6)

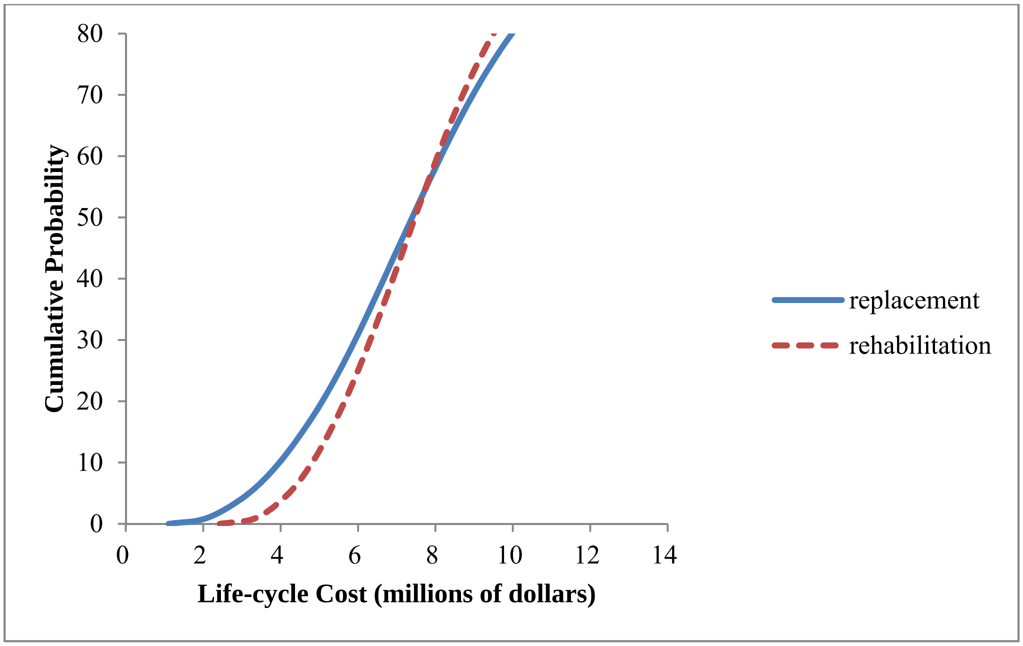


Figure E.48-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 3 (Table 3.6)

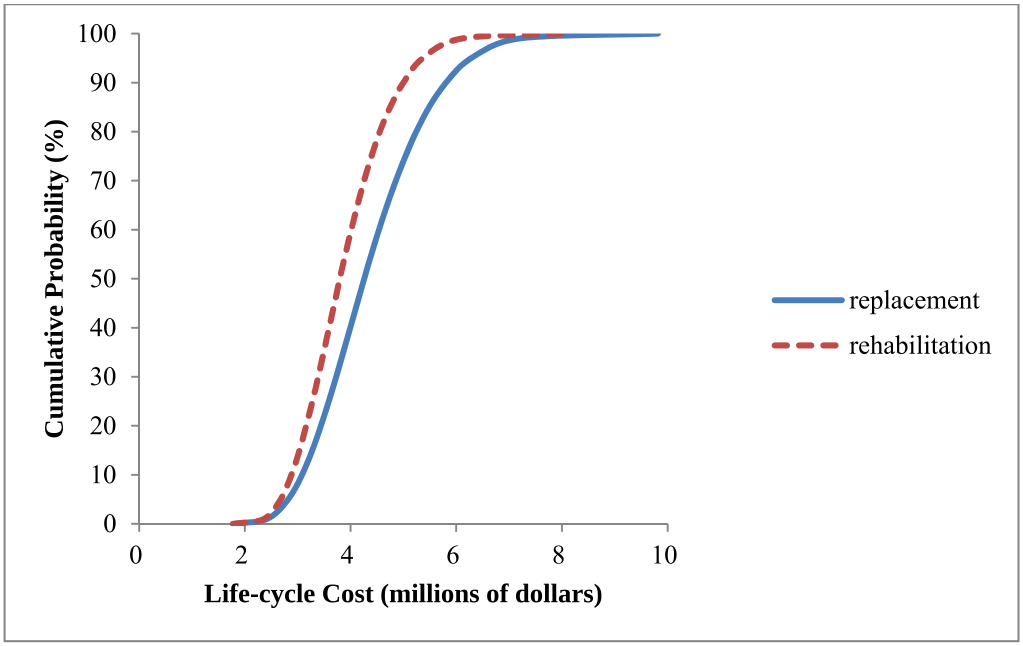


Figure E.49-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 4 (Table 3.6)

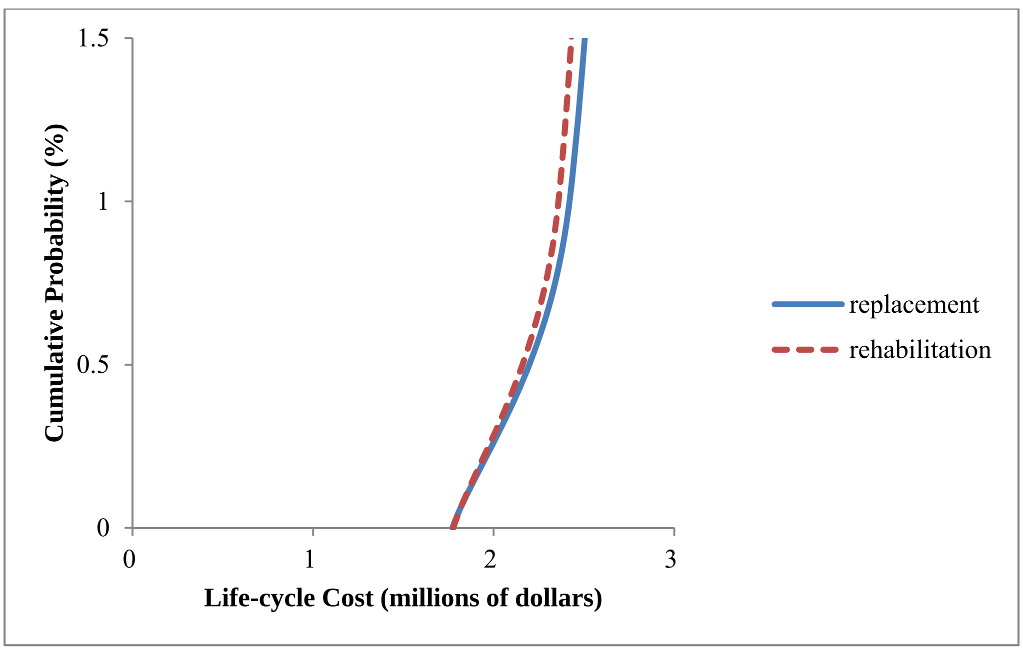


Figure E.50-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 4 (Table 3.6)

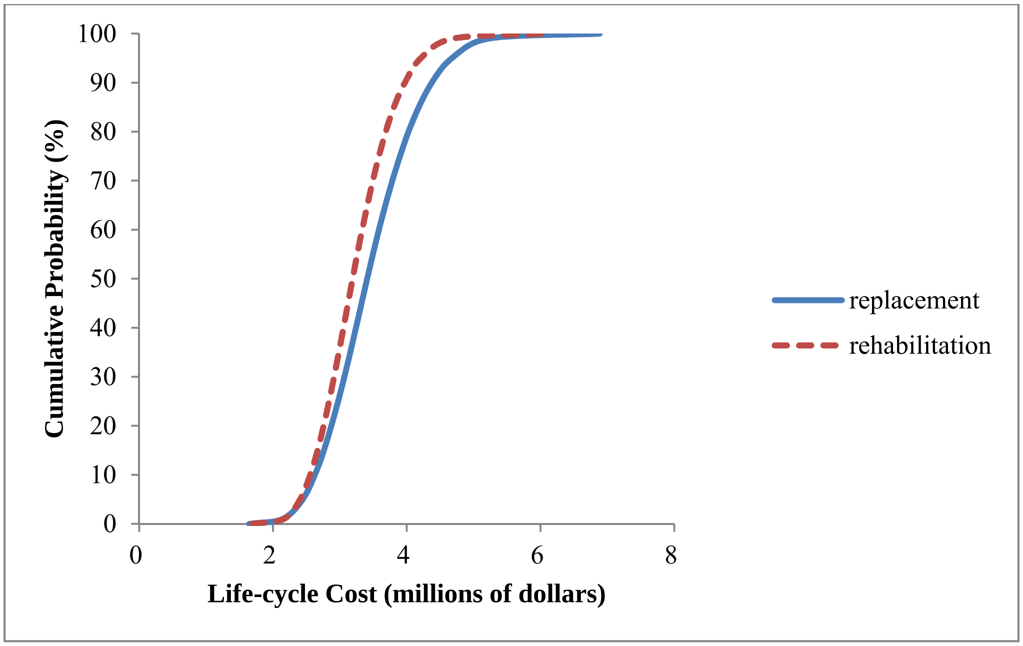


Figure E.51-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 4 (Table 3.6)

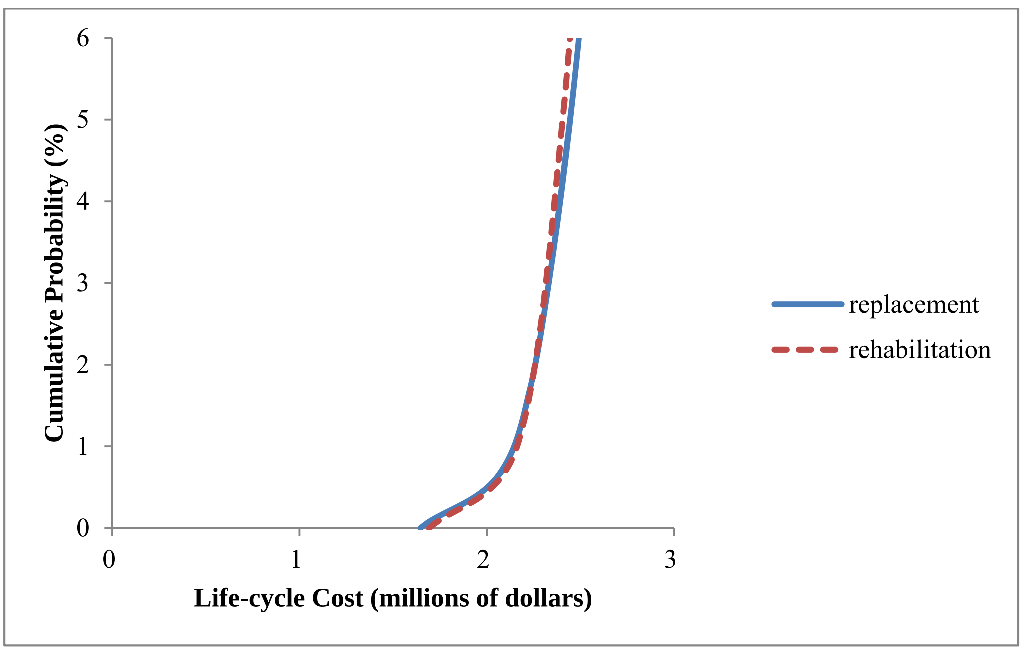


Figure E.52-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 4 (Table 3.6)

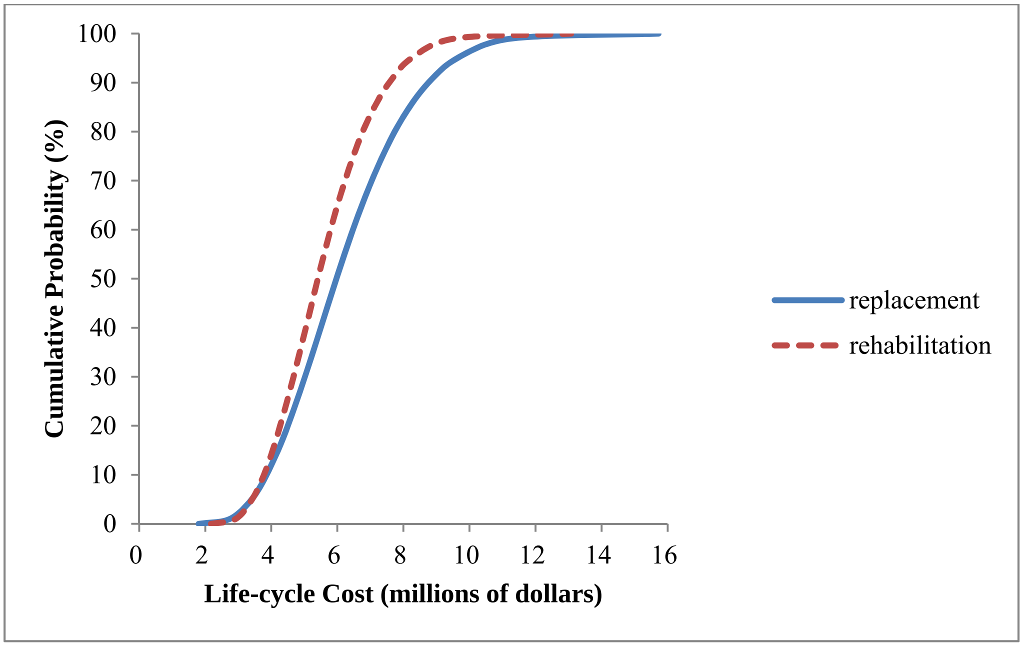


Figure E.53-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 5 (Table 3.6)

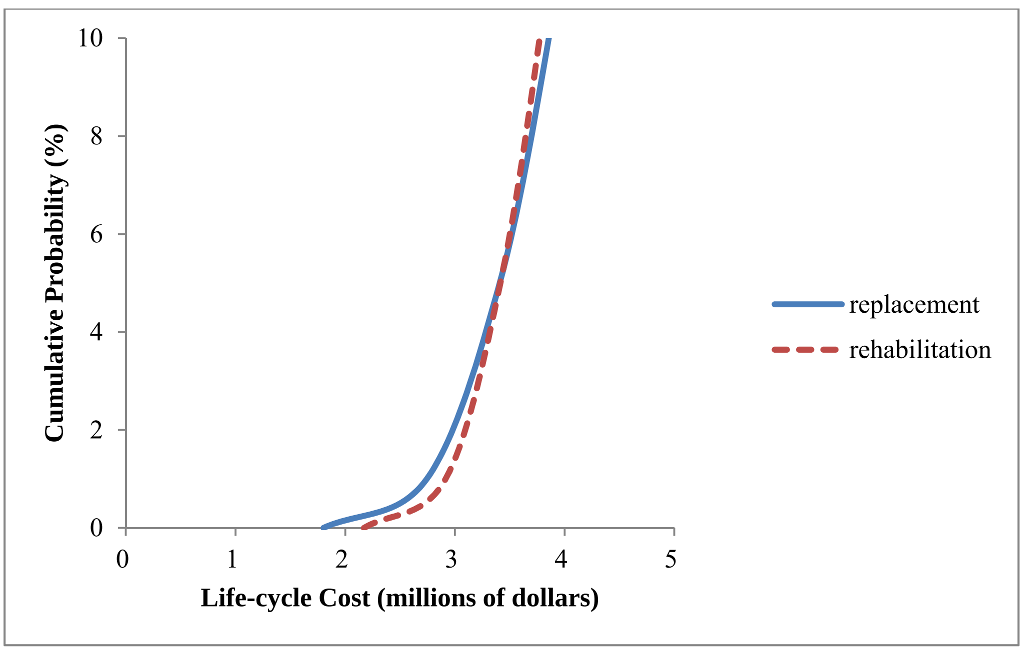


Figure E.54-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 5 (Table 3.6)

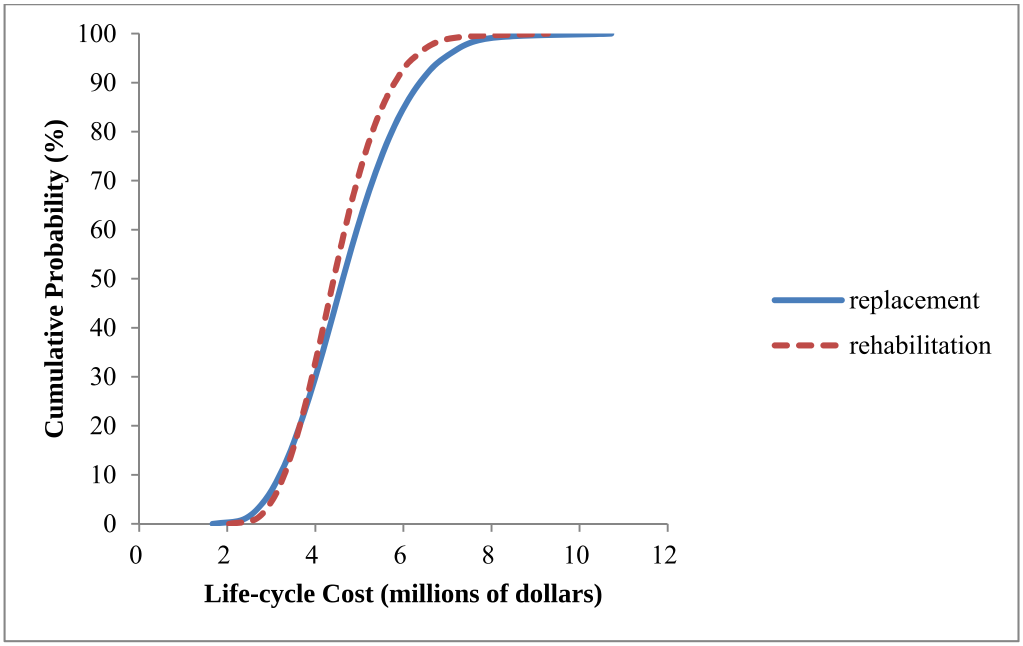


Figure E.55-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 5 (Table 3.6)

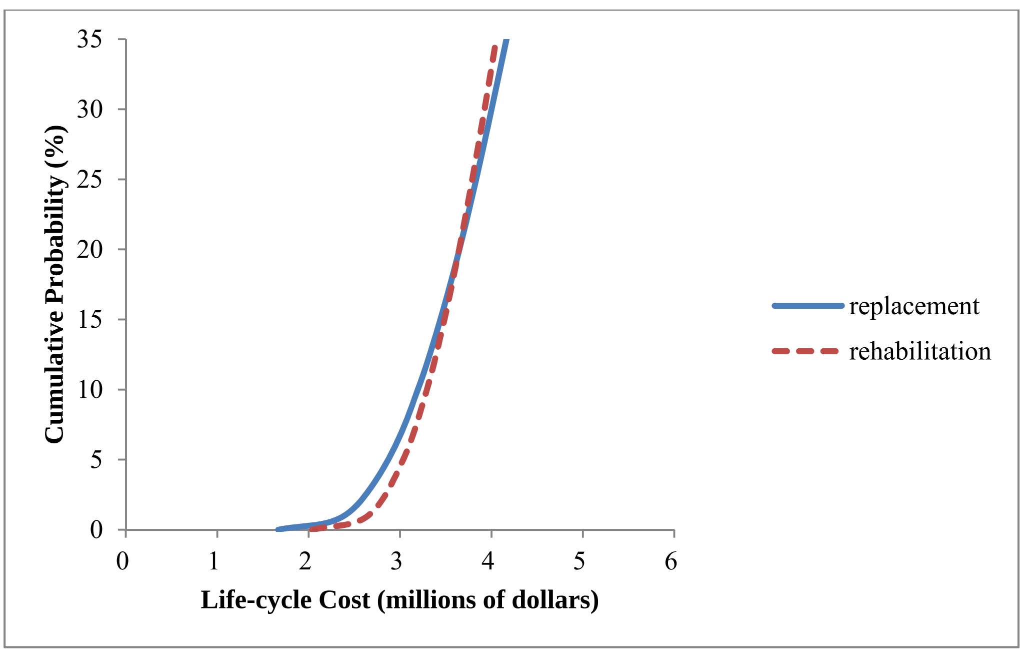


Figure E.56-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 5 (Table 3.6)

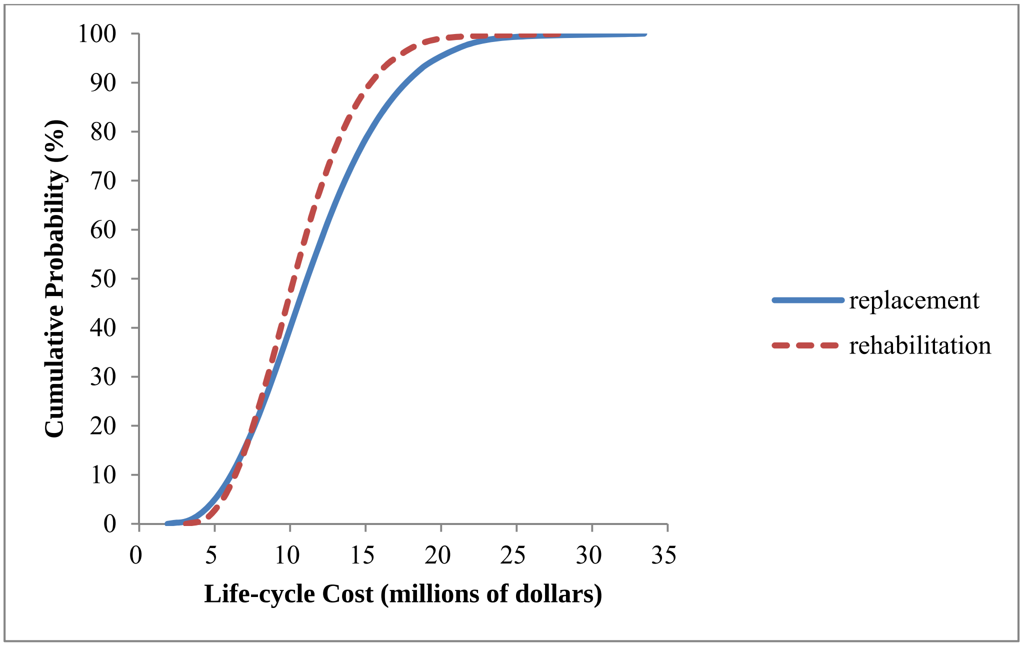


Figure E.57-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 6 (Table 3.6)

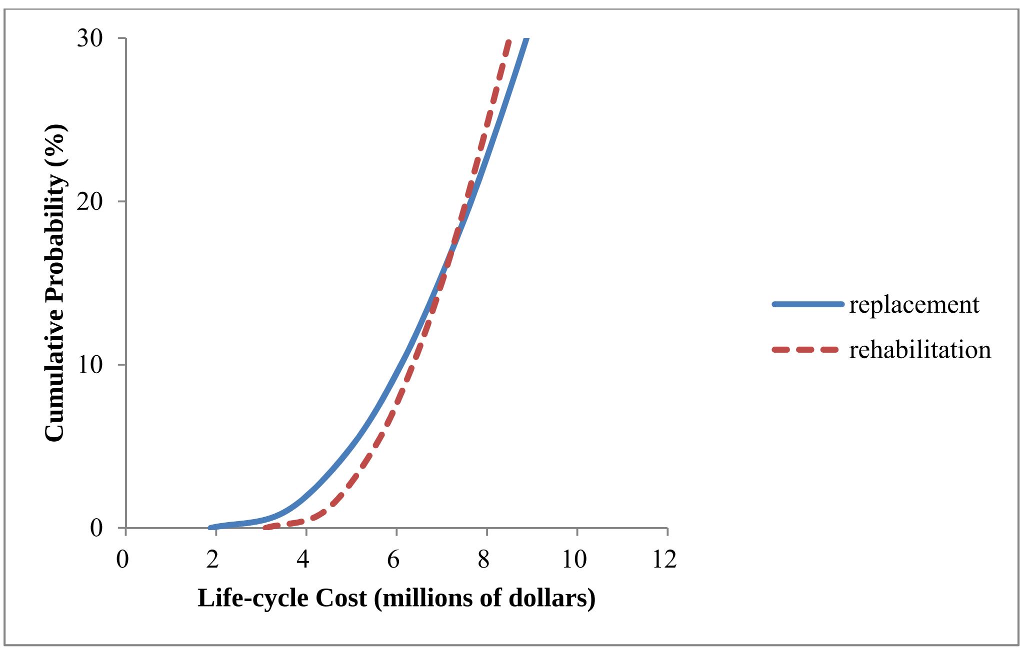


Figure E.58-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 6 (Table 3.6)

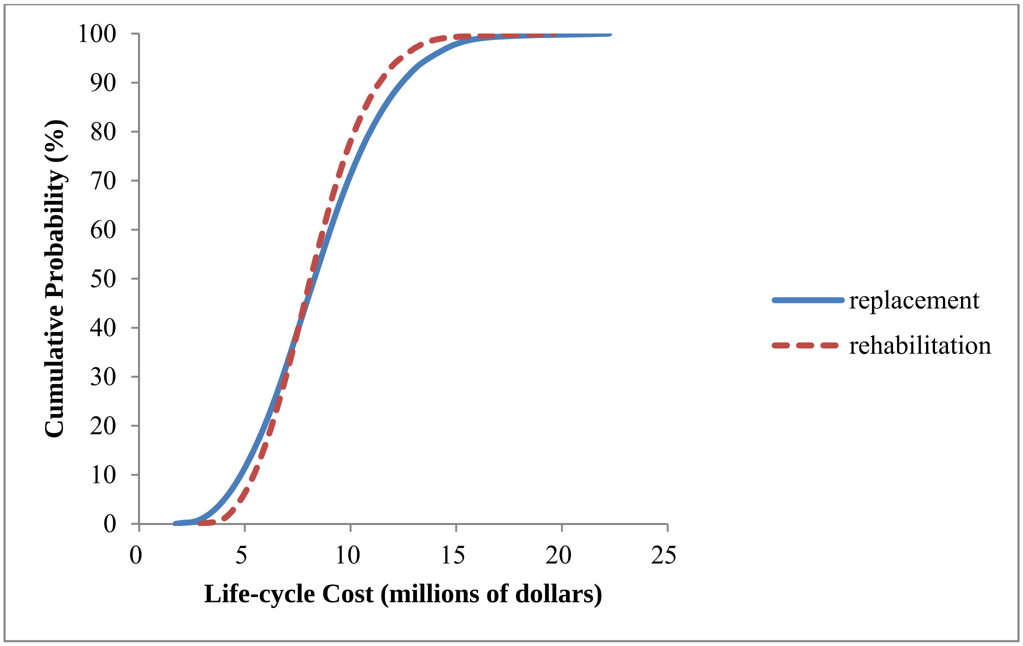


Figure E.59-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 6 (Table 3.6)

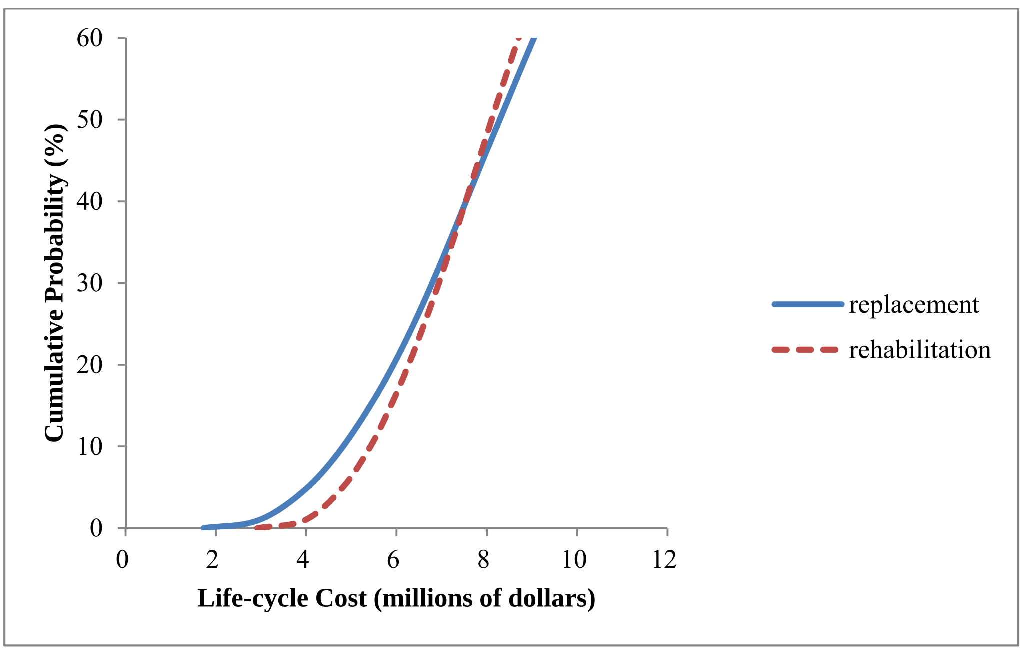


Figure E.60-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 6 (Table 3.6)

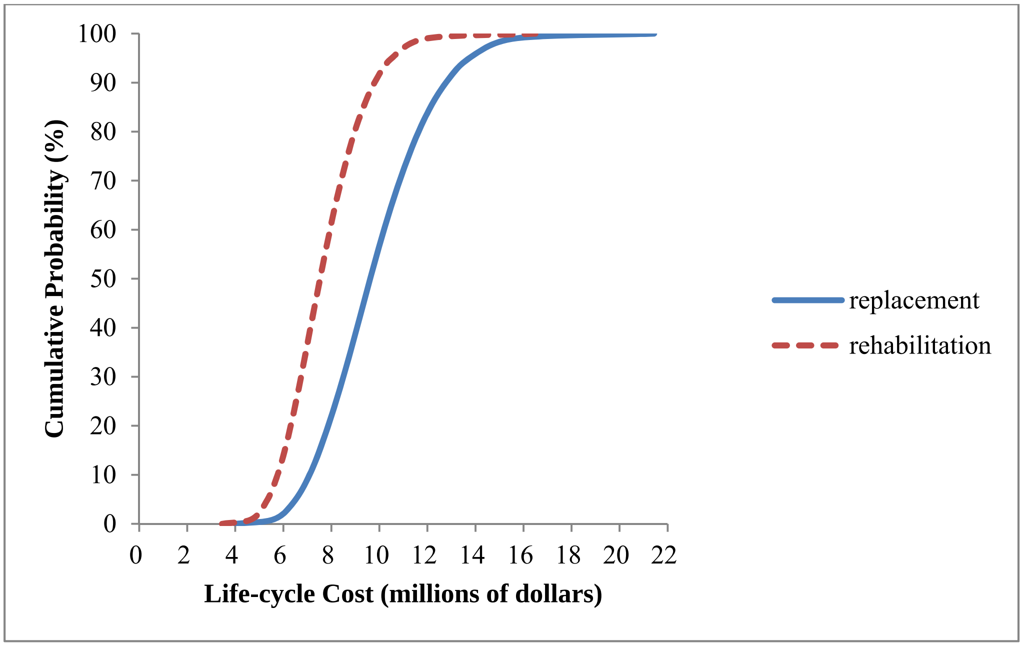


Figure E.61-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 7 (Table 3.6)

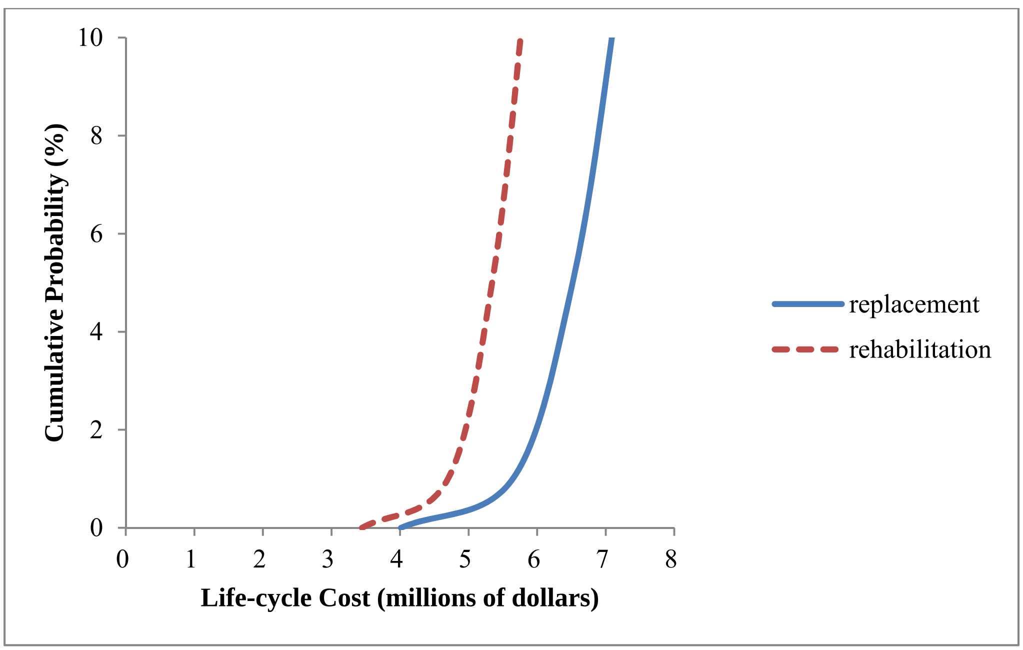


Figure E.62-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 7 (Table 3.6)

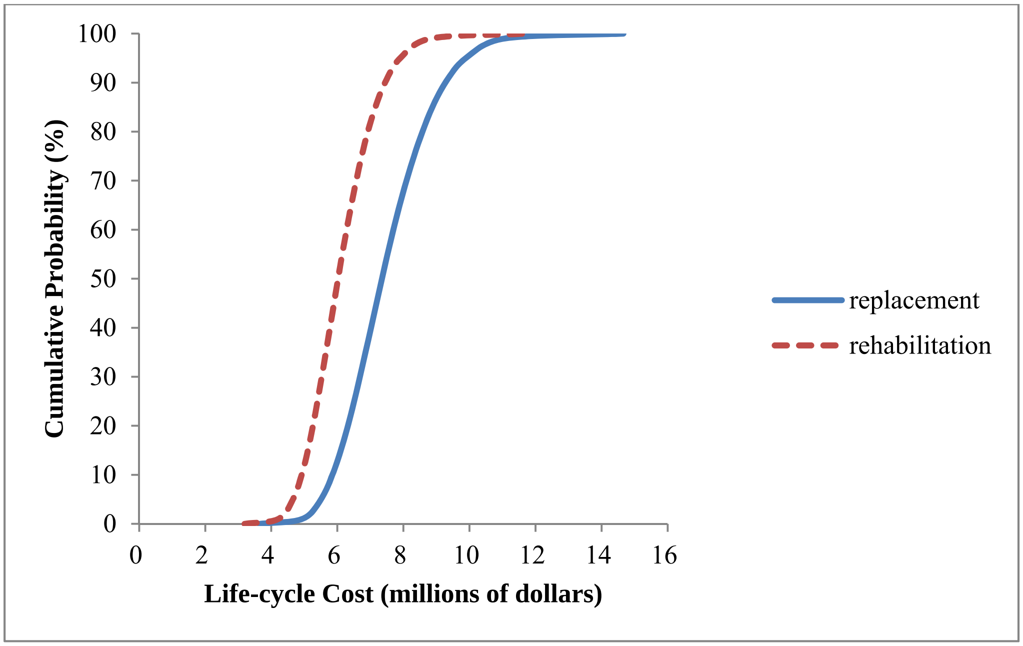


Figure E.63-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 7 (Table 3.6)

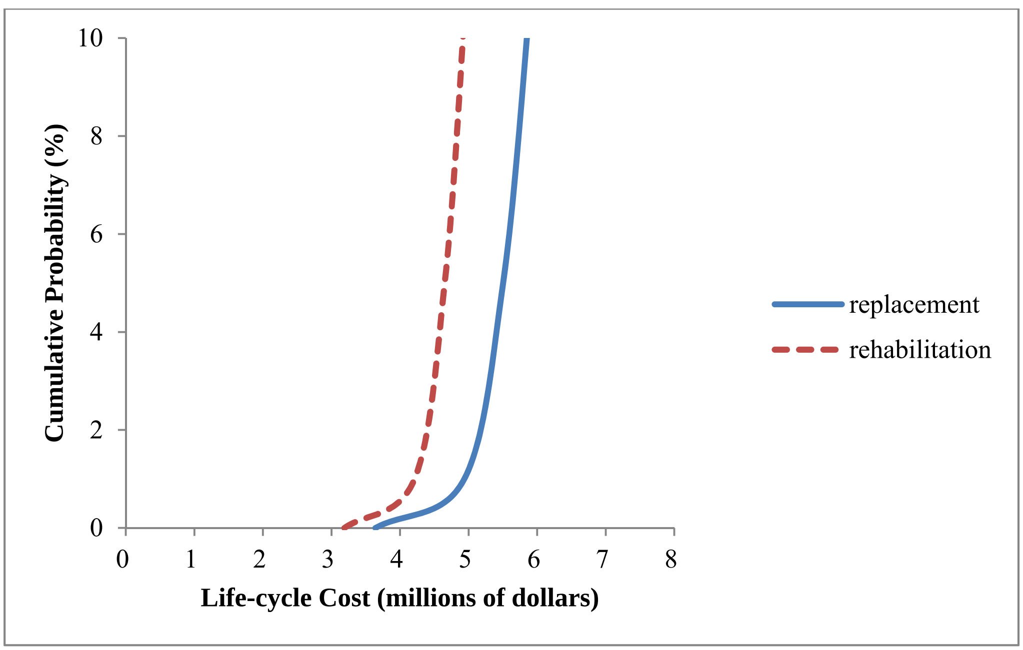


Figure E.64-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 7 (Table 3.6)

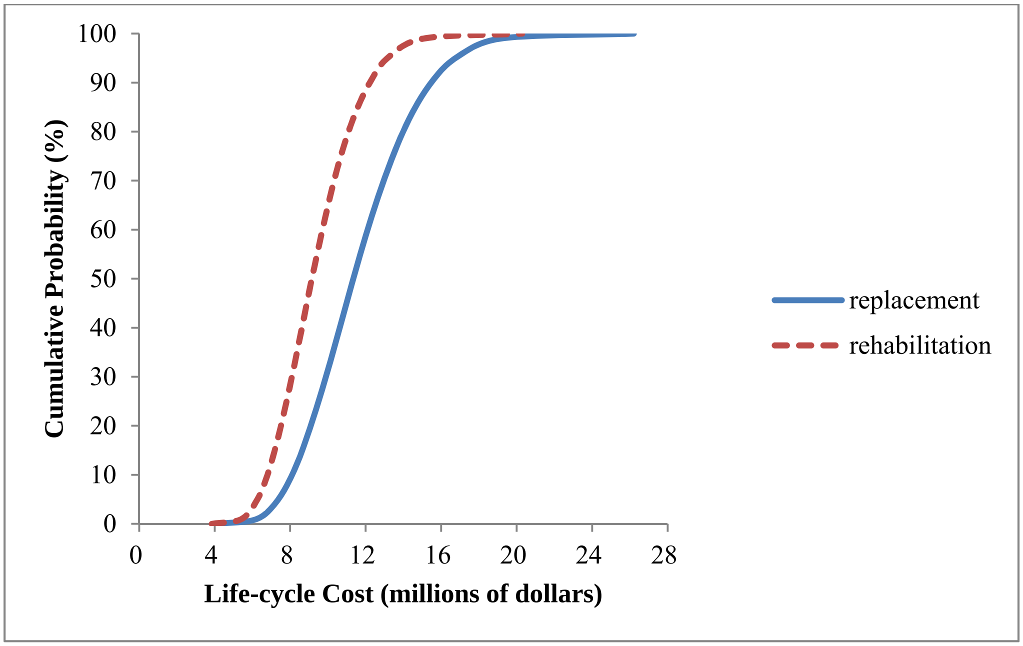


Figure E.65-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 8 (Table 3.6)

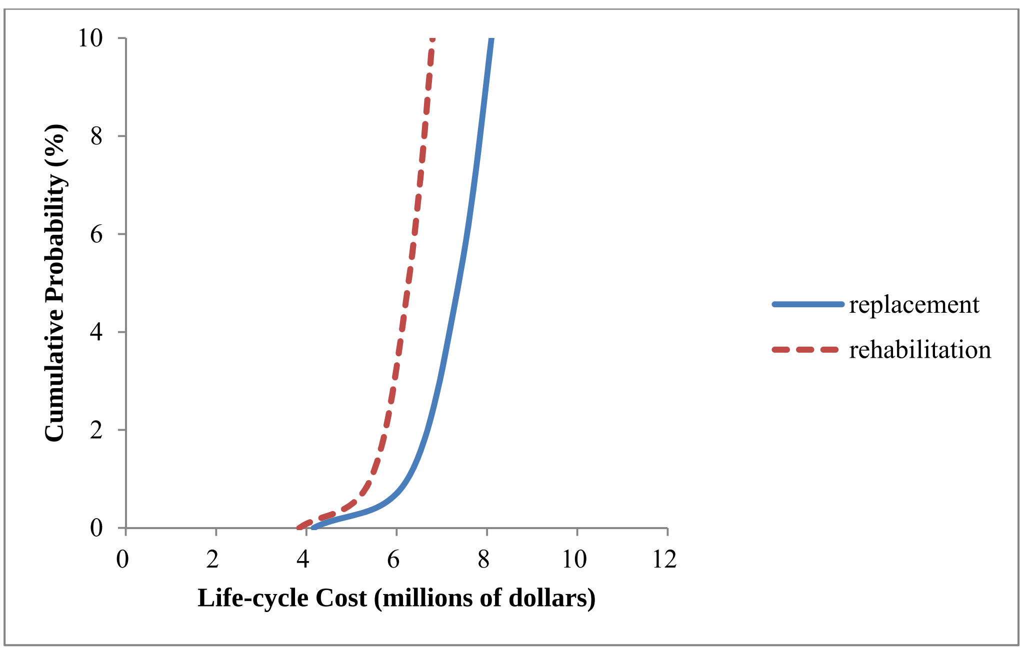


Figure E.66-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 8 (Table 3.6)

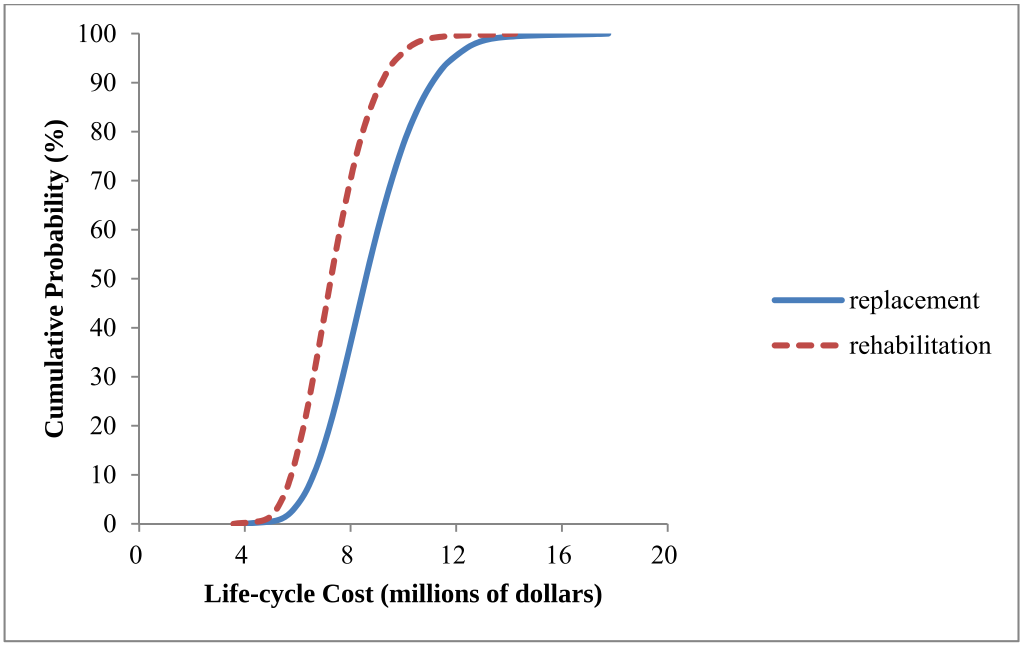


Figure E.67-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 8 (Table 3.6)

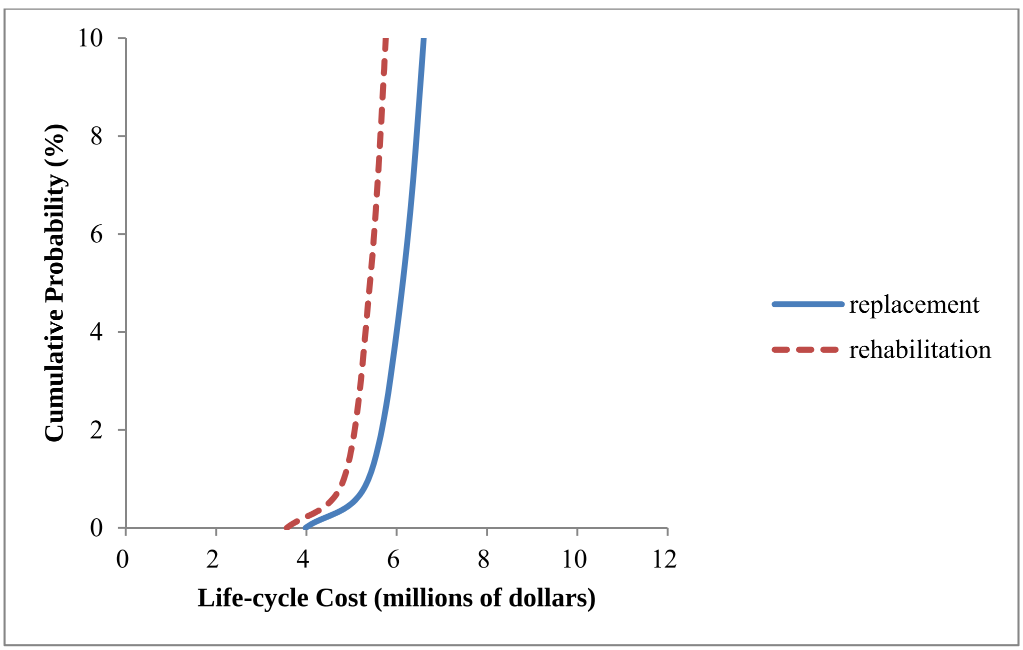


Figure E.68-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 8 (Table 3.6)

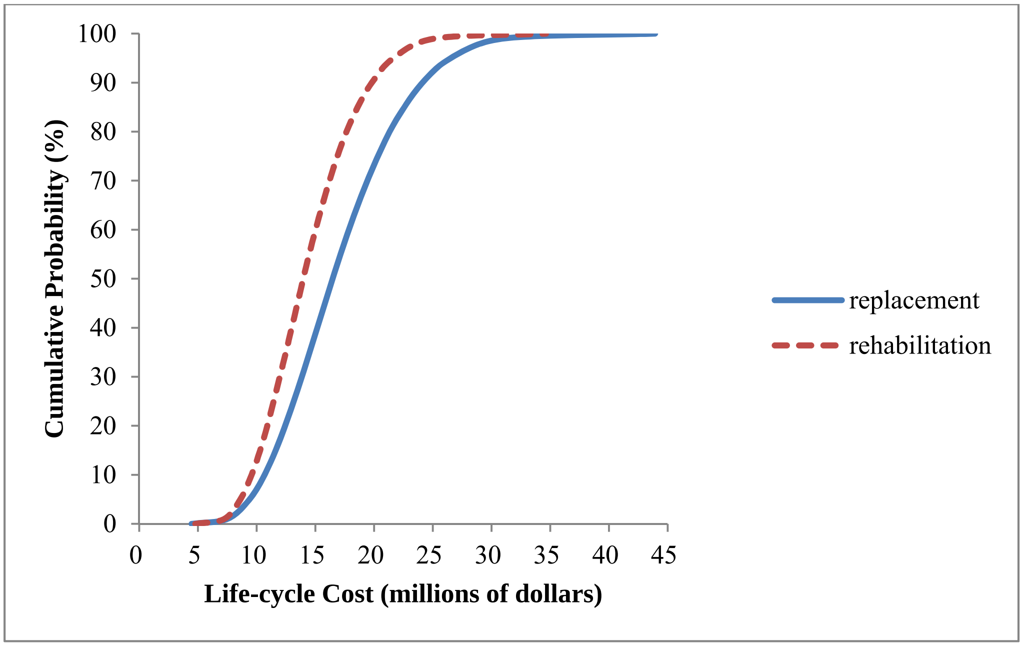


Figure E.69-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 9 (Table 3.6)

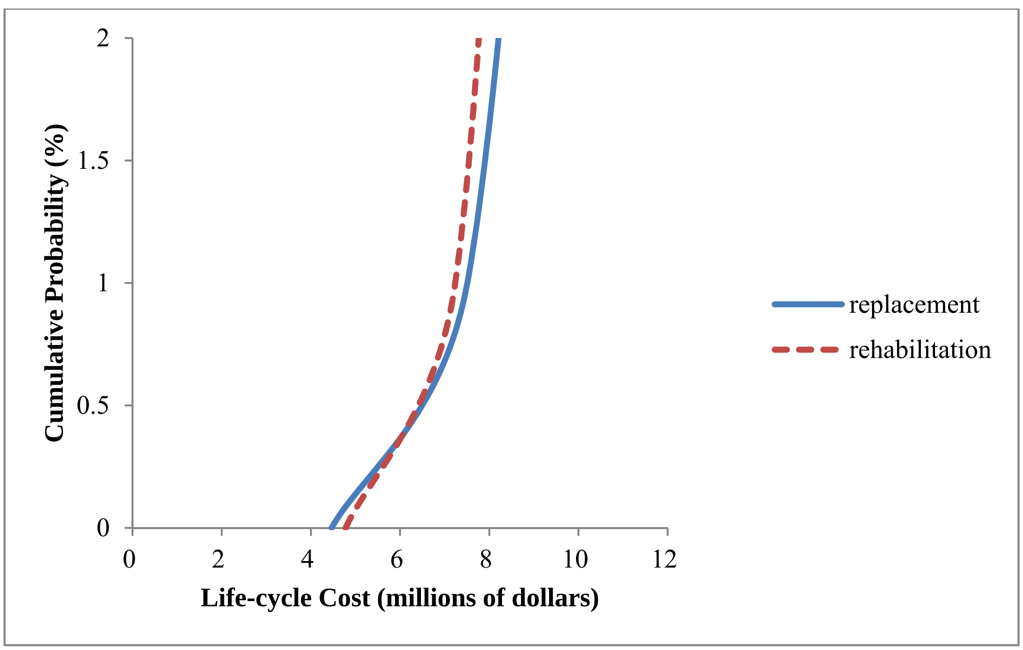


Figure E.70-Ascending cumulative probability distributions for highway bridge with modification 1a ADT case 9 (Table 3.6)

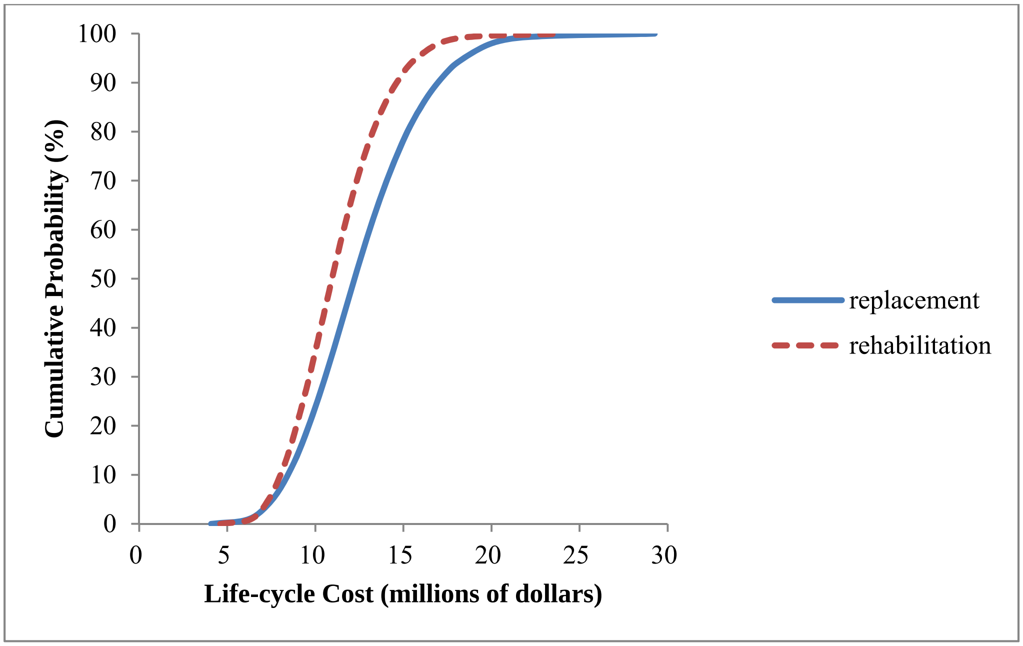


Figure E.71-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 9 (Table 3.6)

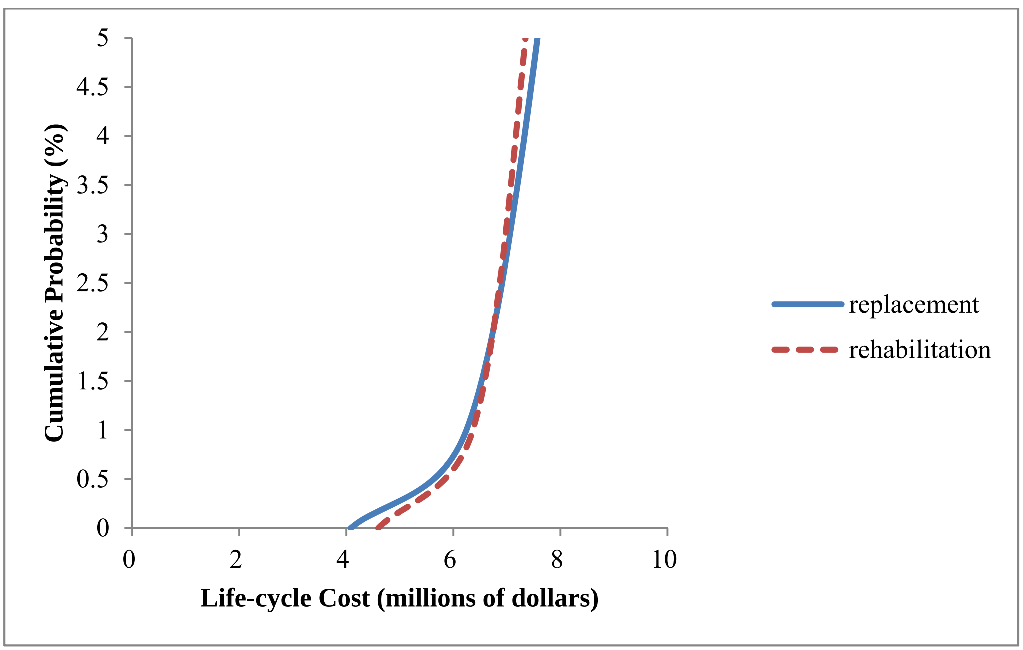


Figure E.72-Ascending cumulative probability distributions for highway bridge with modification 2a ADT case 9 (Table 3.6)

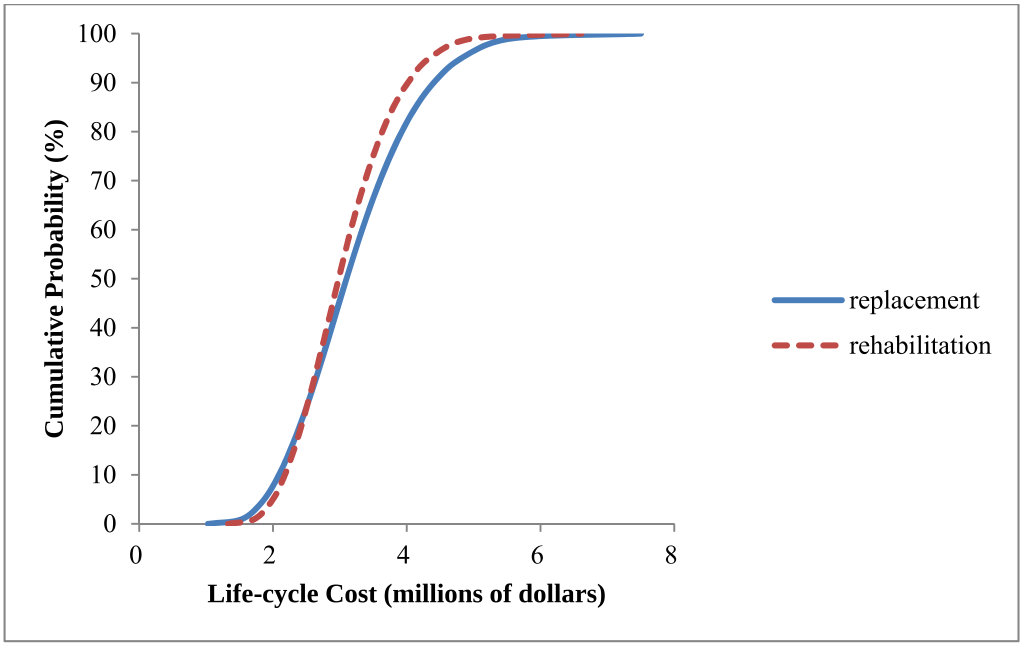


Figure E.73-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 1 (Table 3.6)

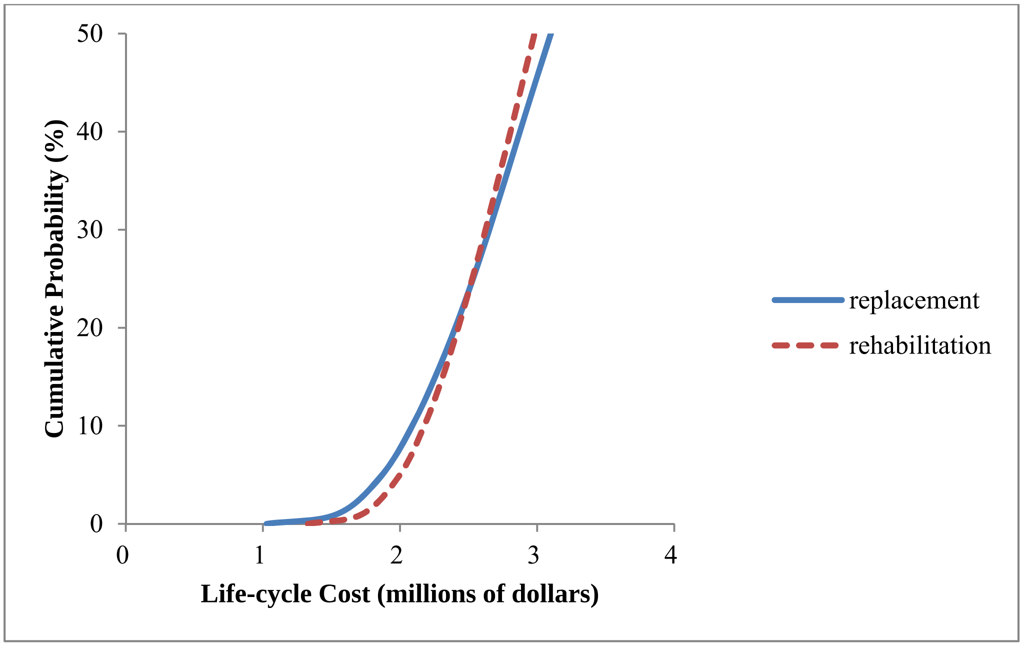


Figure E.74-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 1 (Table 3.6)

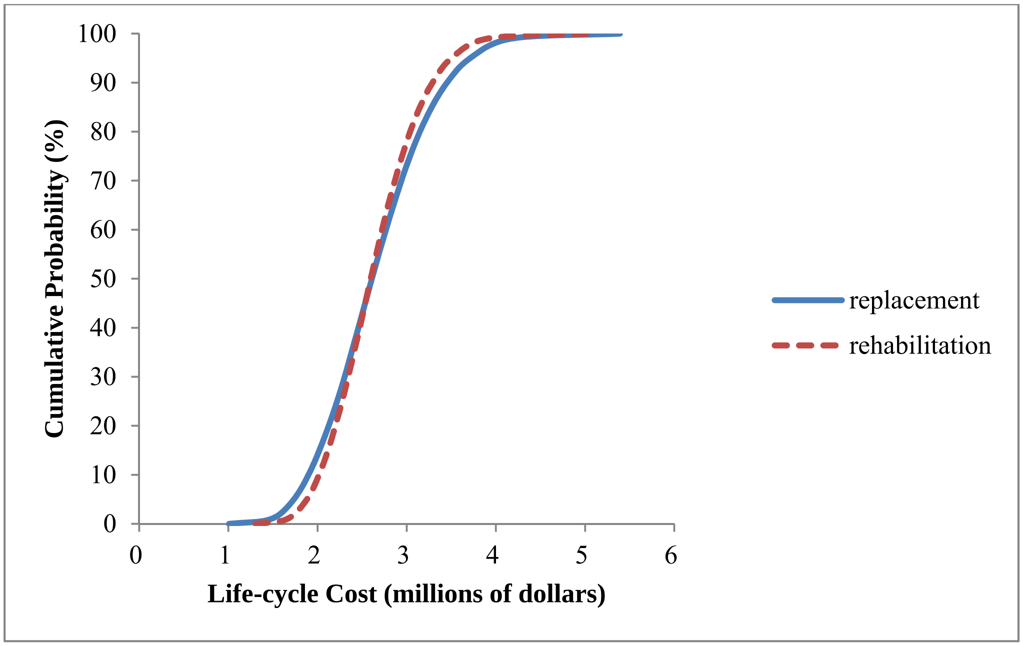


Figure E.75-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 1 (Table 3.6)

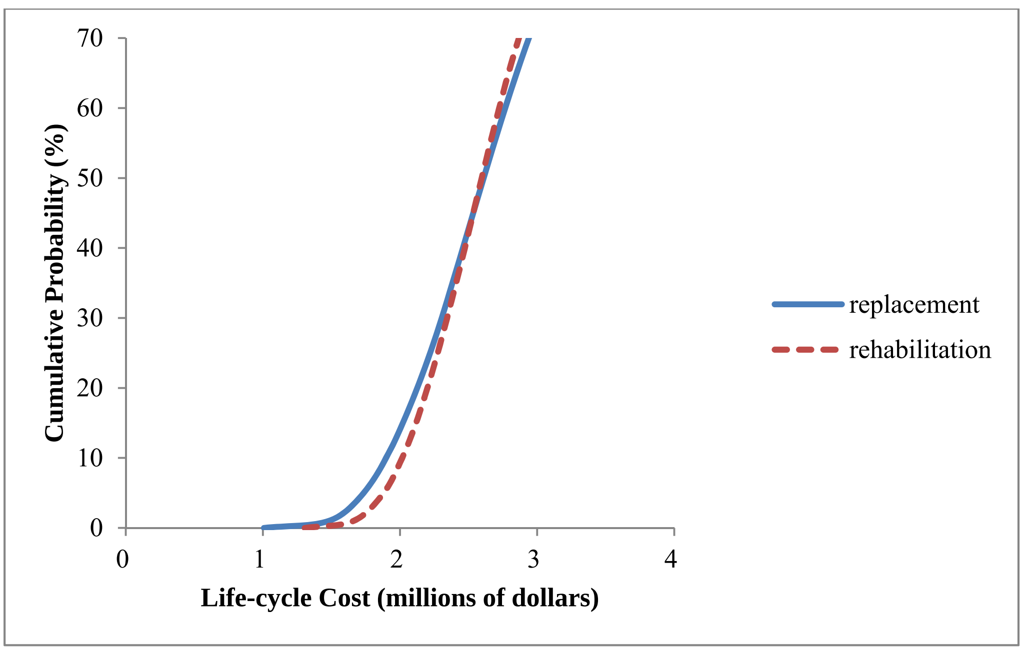


Figure E.76-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 1 (Table 3.6)

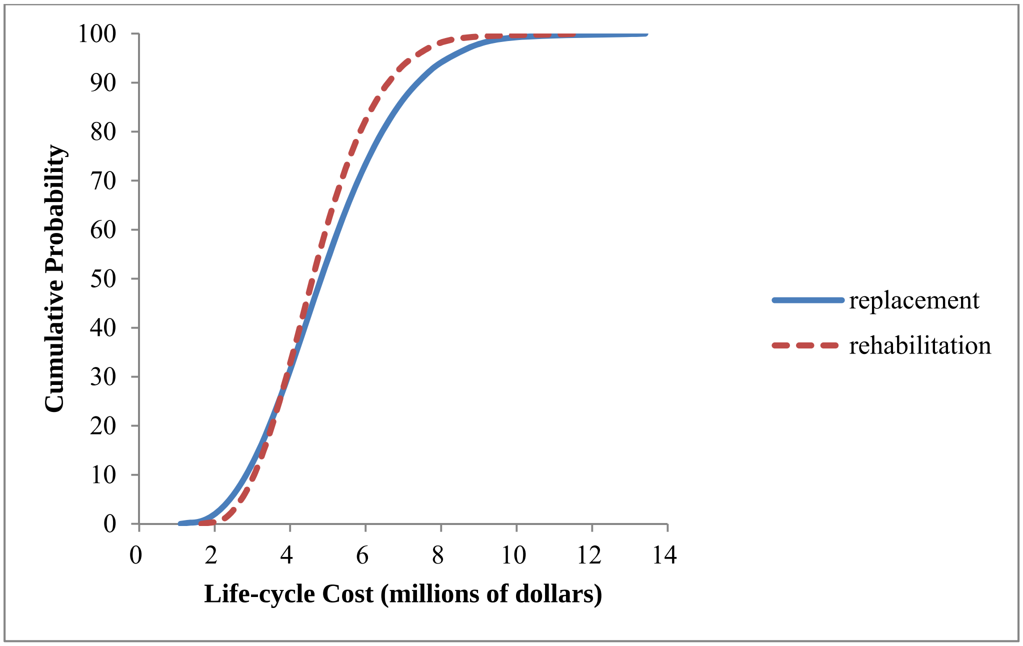


Figure E.77-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 2 (Table 3.6)

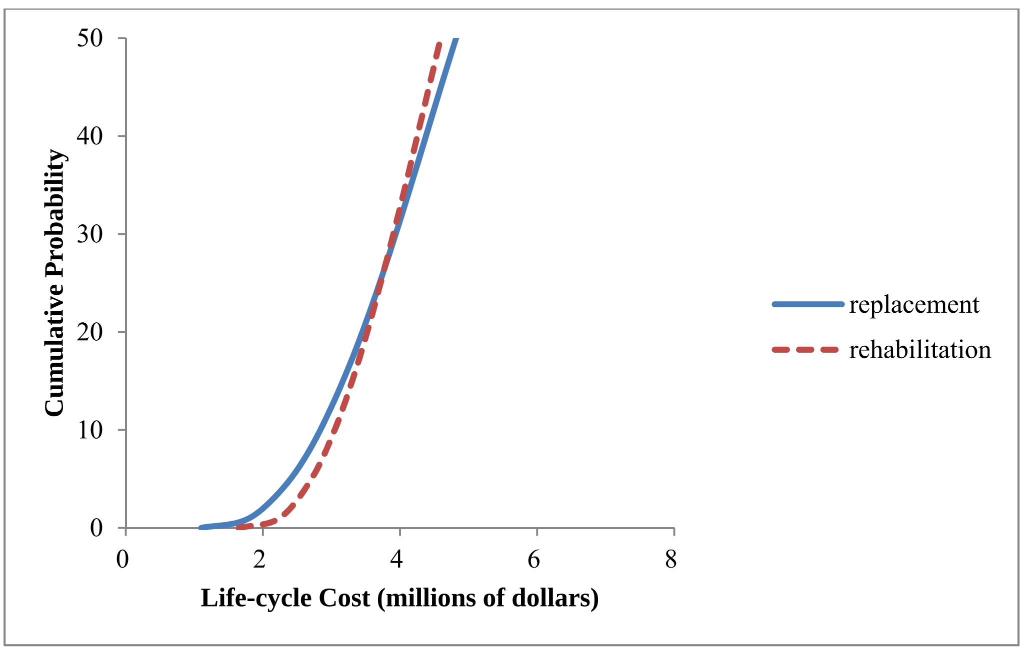


Figure E.78-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 2 (Table 3.6)

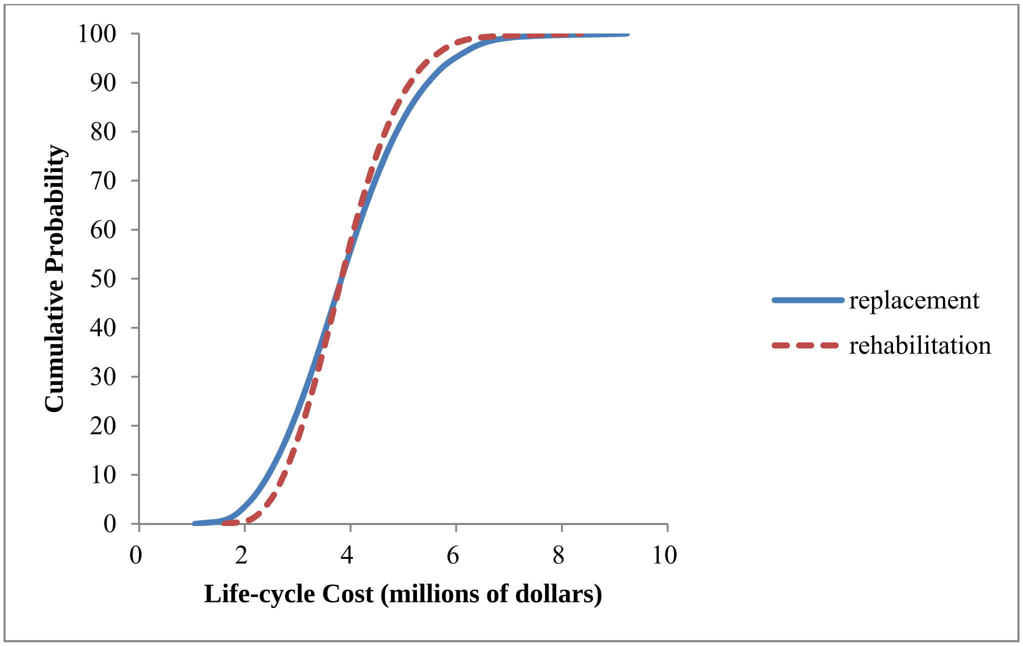


Figure E.79-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 2 (Table 3.6)

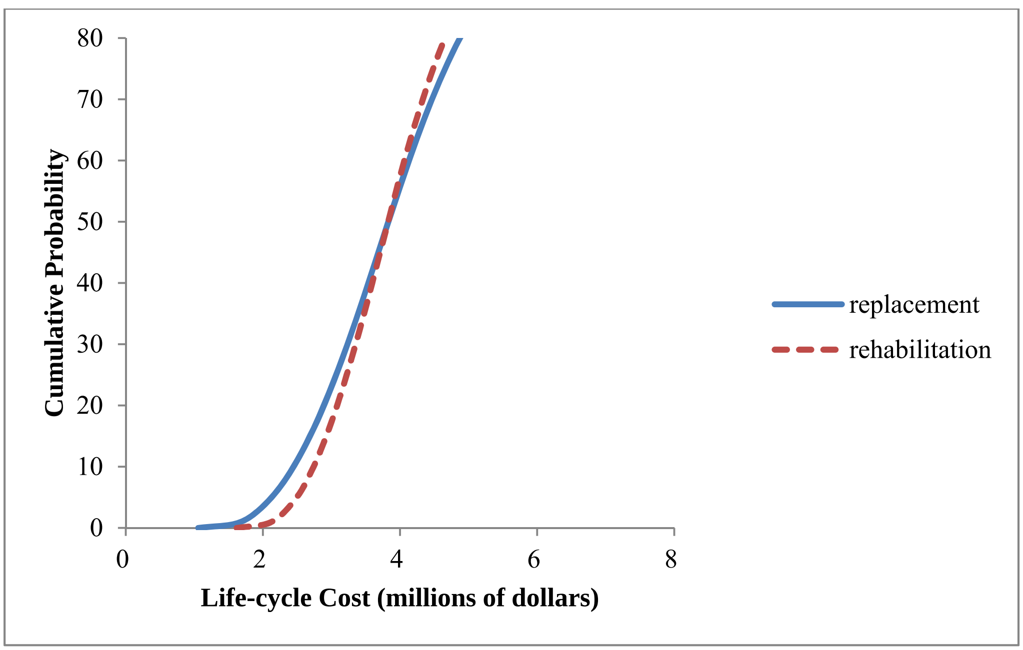


Figure E.80-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 2 (Table 3.6)

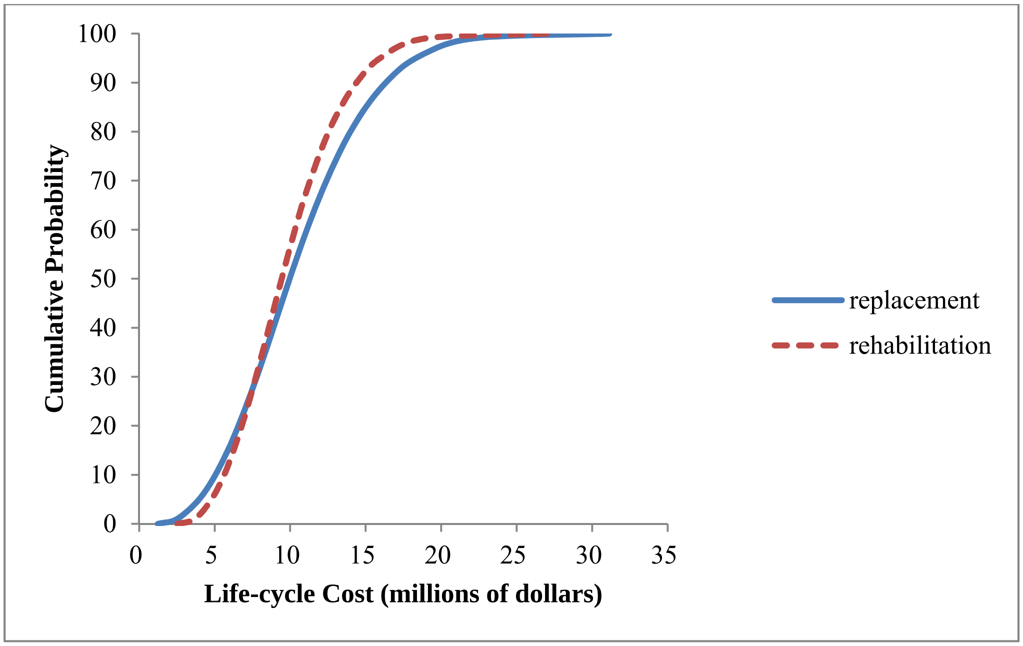


Figure E.81-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 3 (Table 3.6)

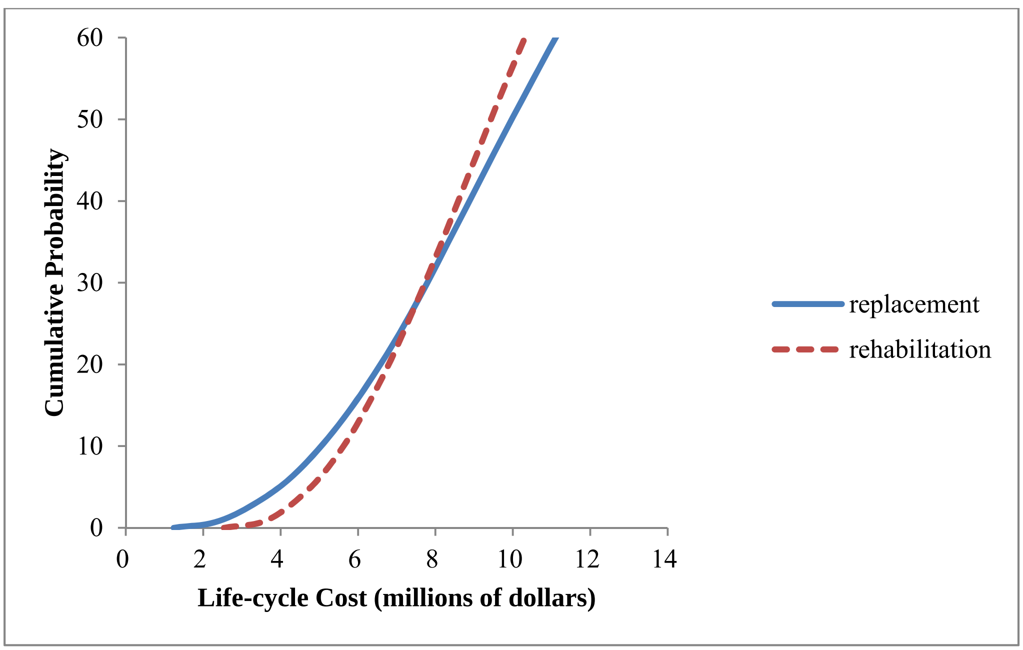


Figure E.82-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 3 (Table 3.6)

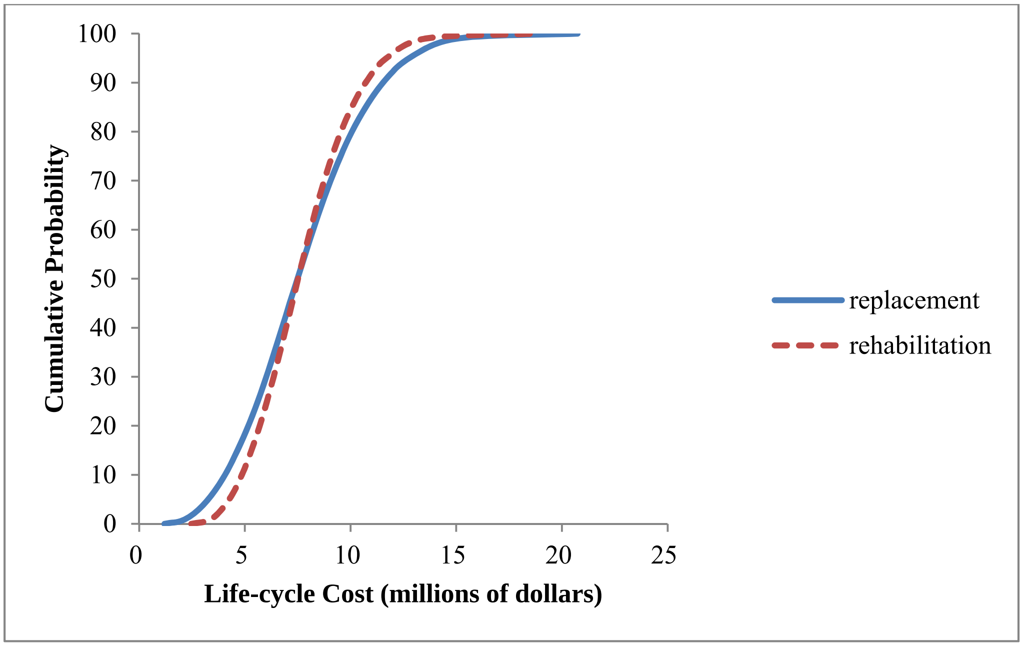


Figure E.83-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 3 (Table 3.6)

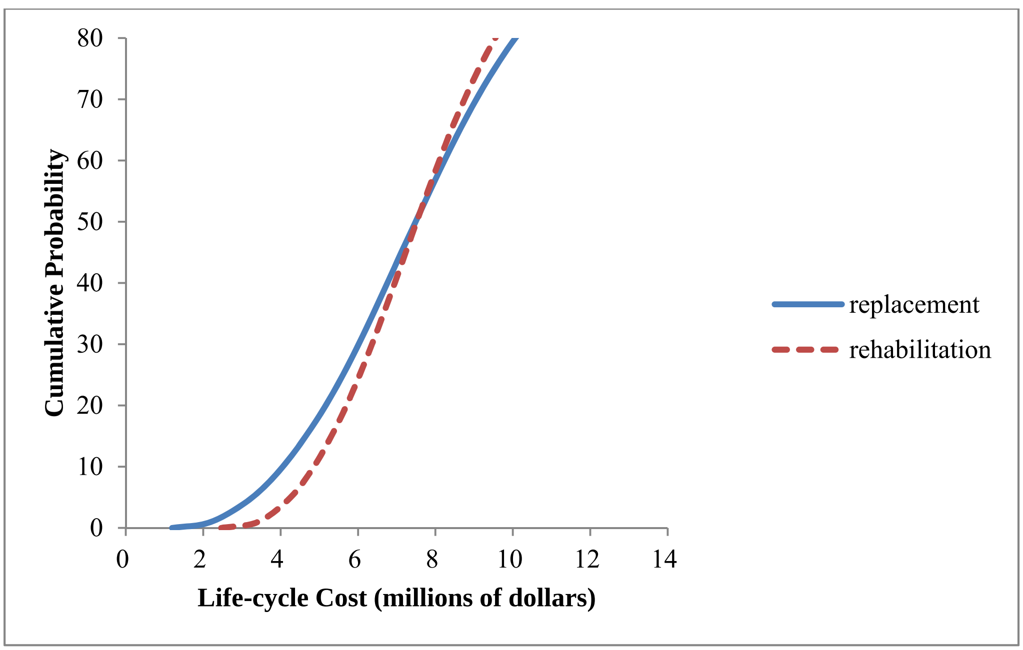


Figure E.84-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 3 (Table 3.6)

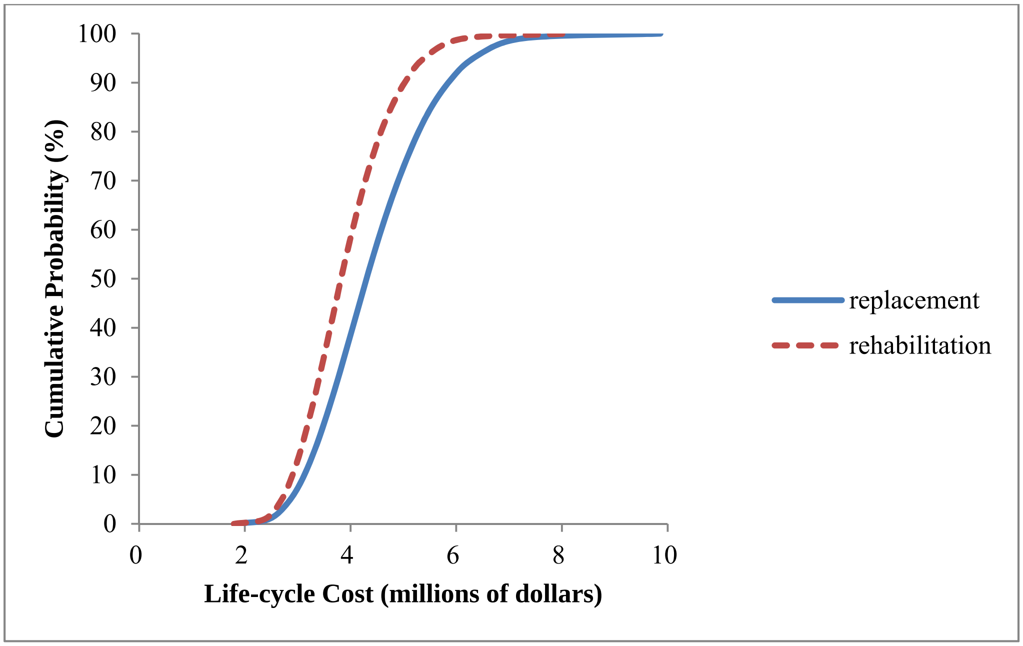


Figure E.85-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 4 (Table 3.6)

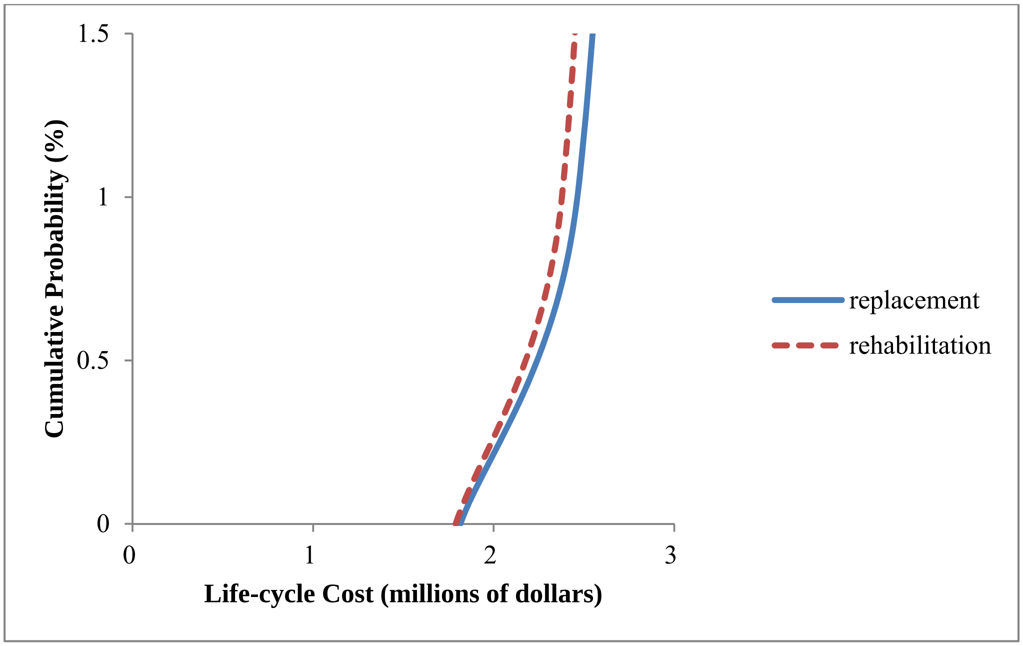


Figure E.86-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 4 (Table 3.6)

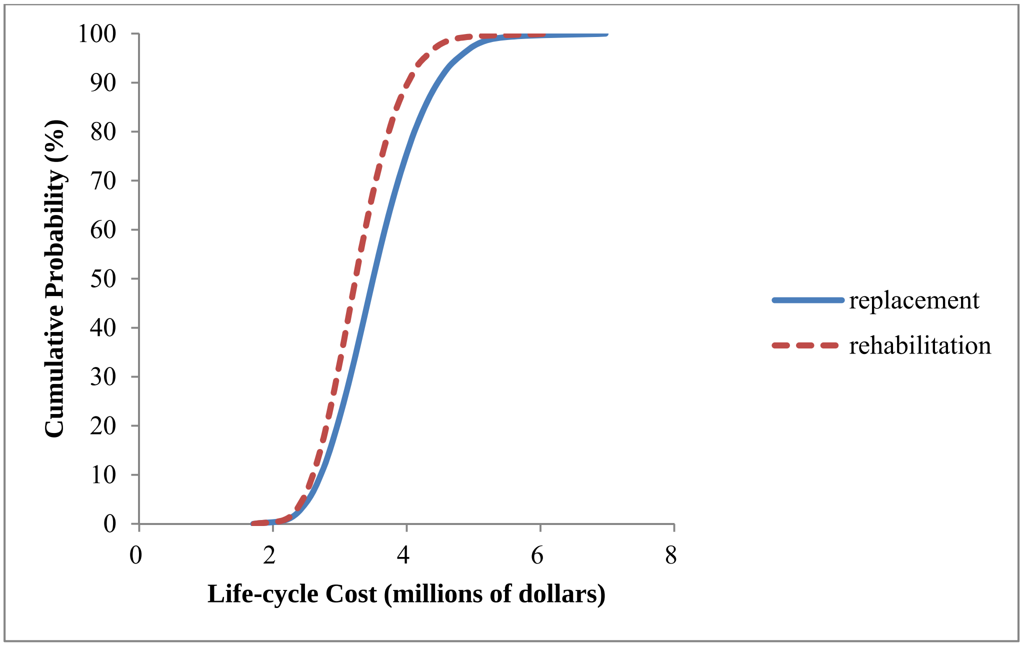


Figure E.87-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 4 (Table 3.6)

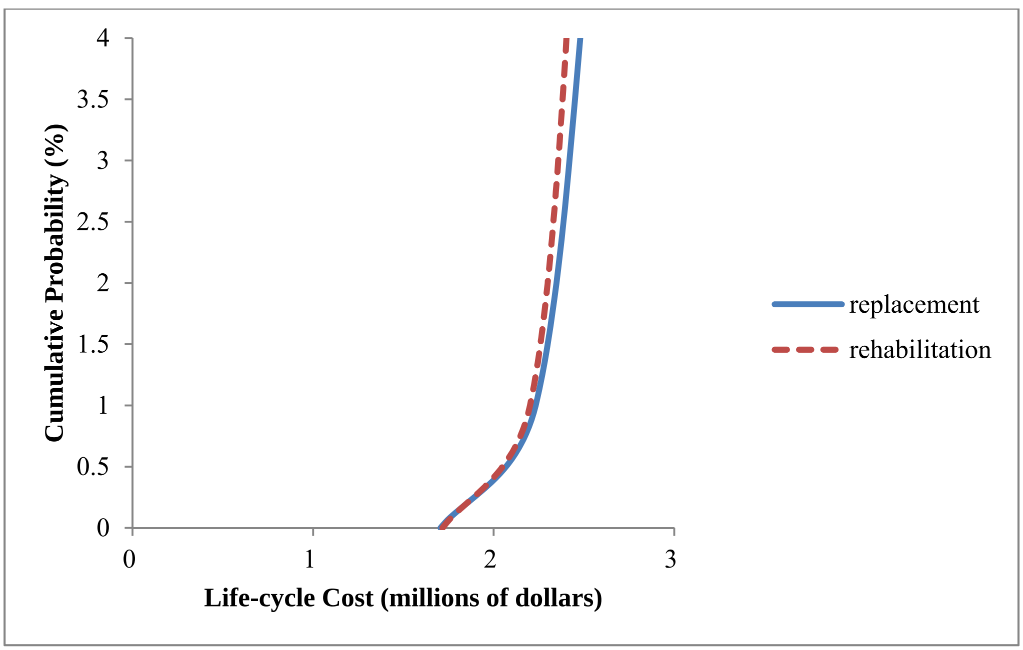


Figure E.88-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 4 (Table 3.6)

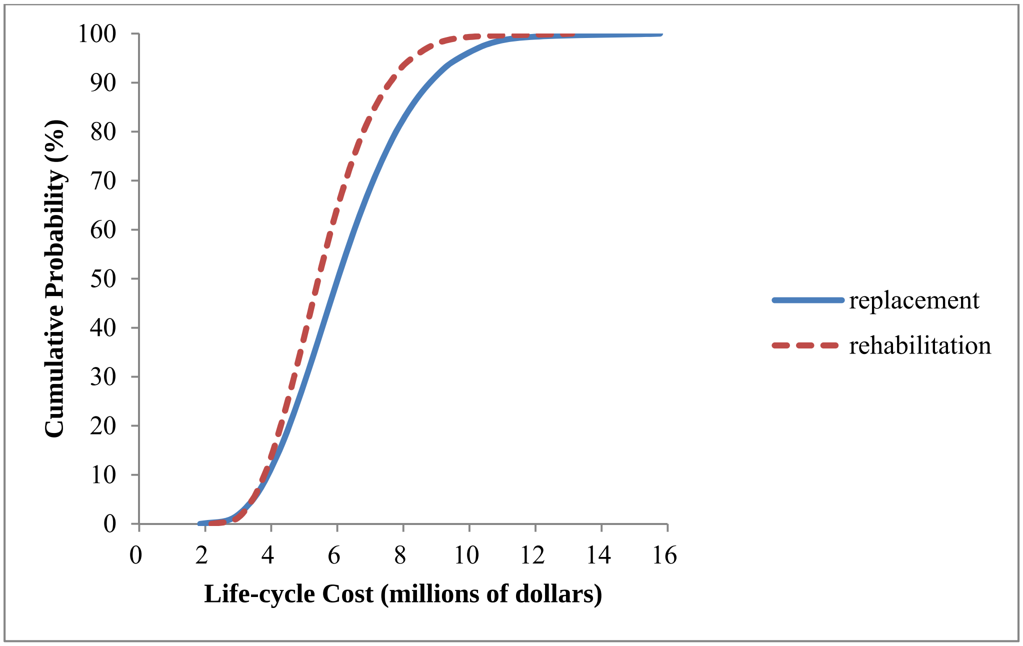


Figure E.89-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 5 (Table 3.6)

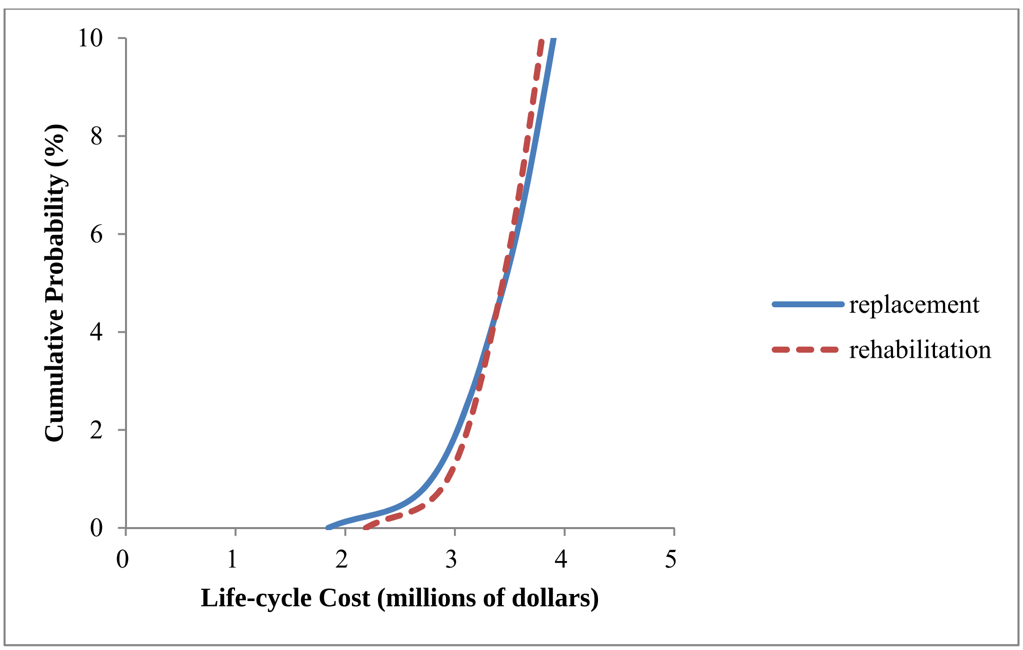


Figure E.90-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 5 (Table 3.6)

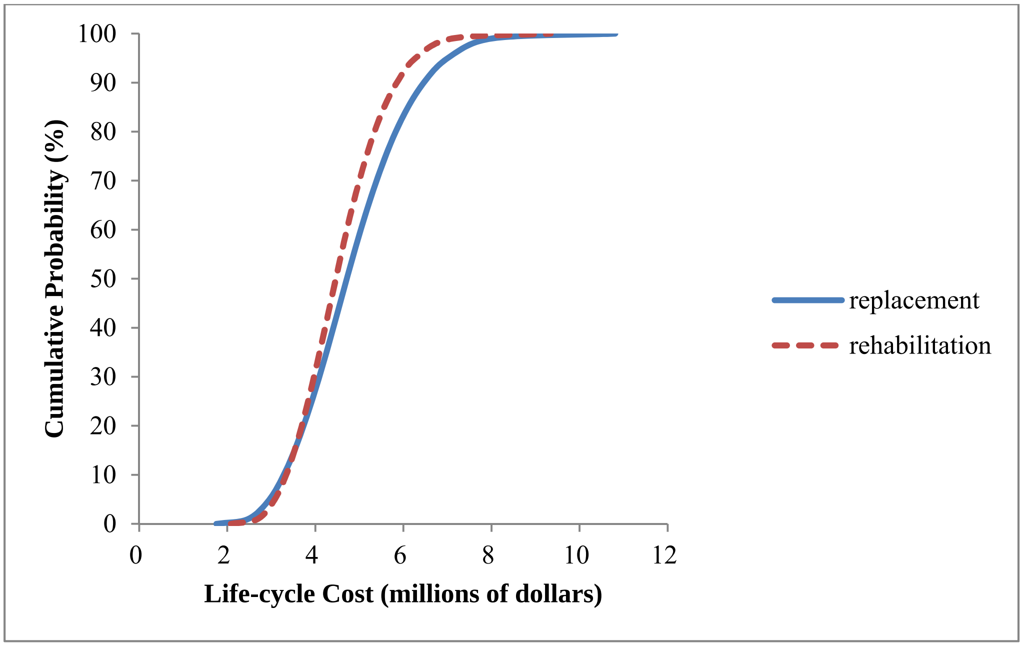


Figure E.91-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 5 (Table 3.6)

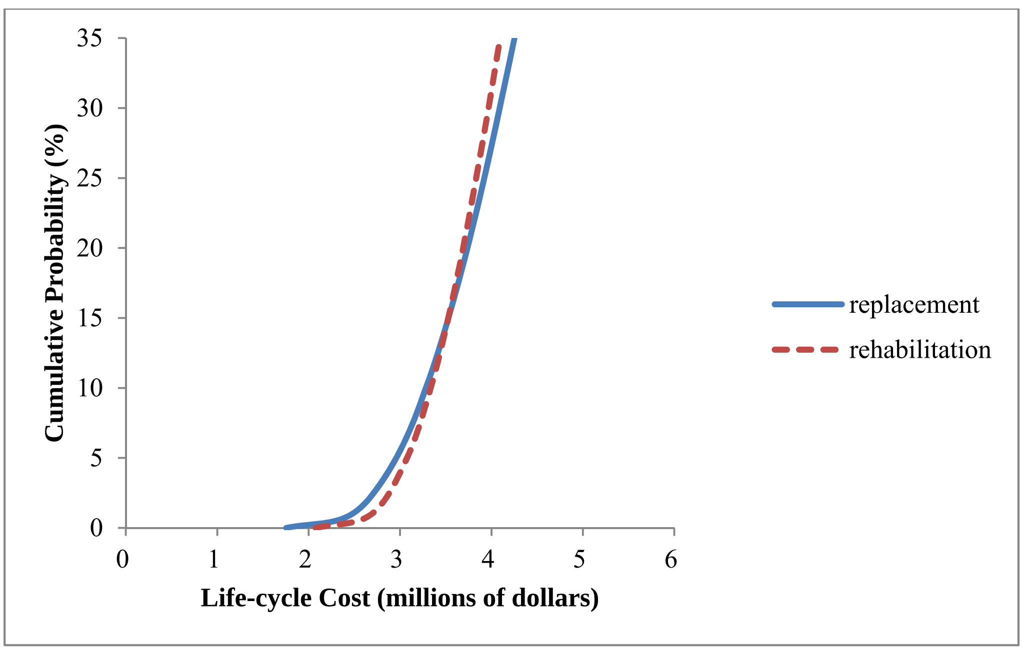


Figure E.92-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 5 (Table 3.6)

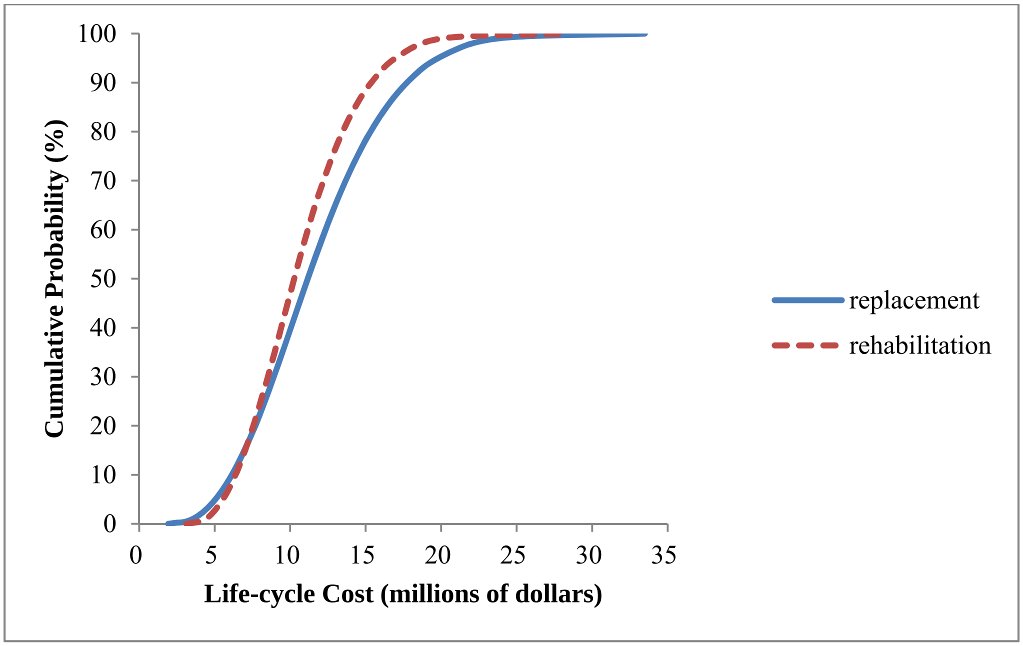


Figure E.93-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 6 (Table 3.6)

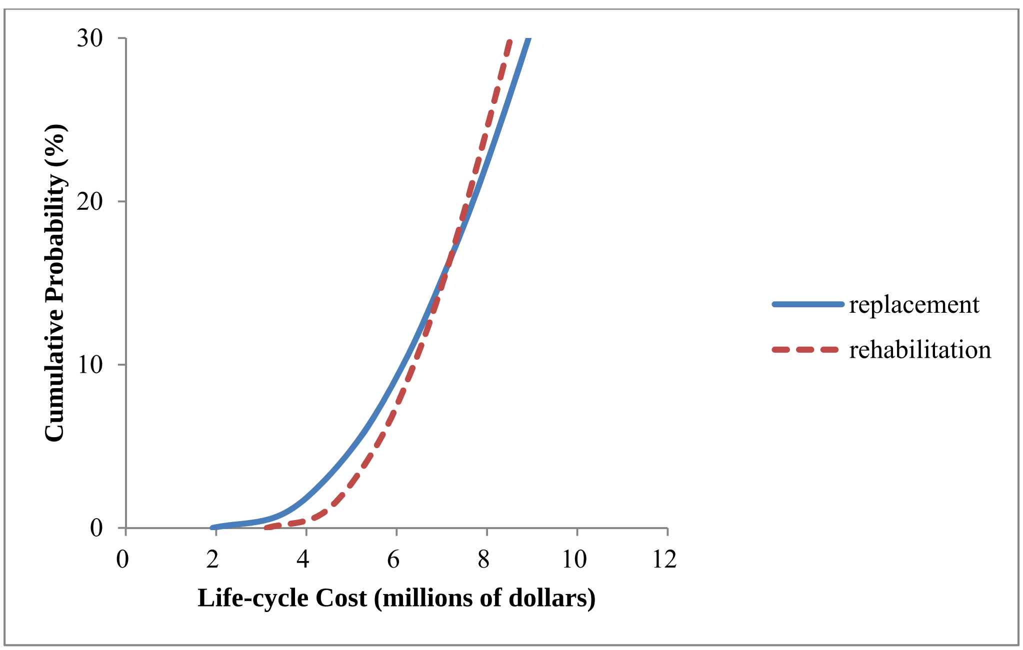


Figure E.94-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 6 (Table 3.6)

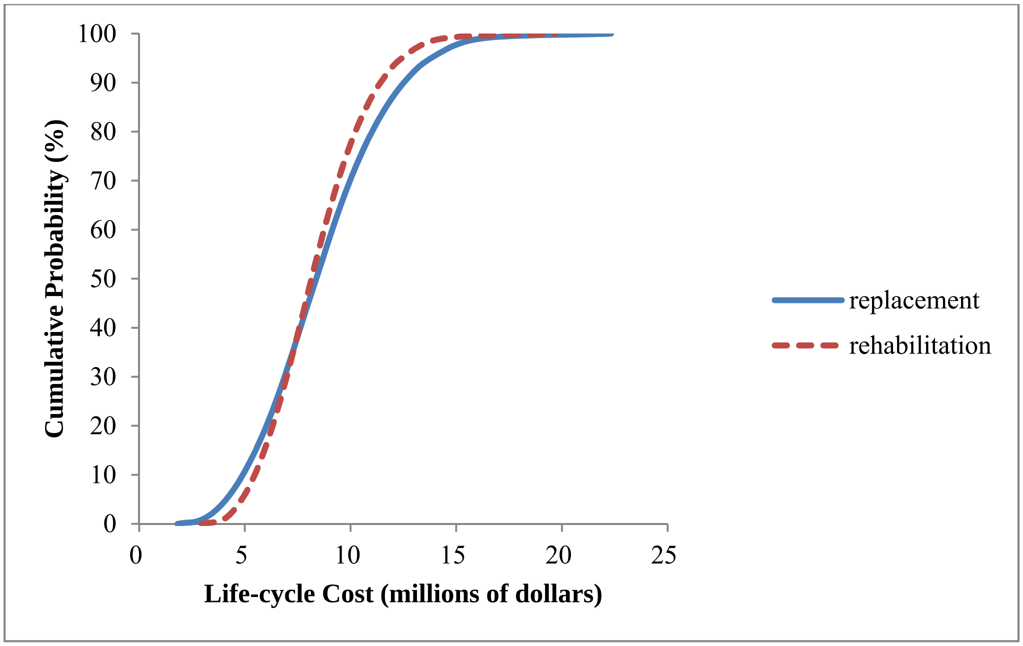


Figure E.95-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 6 (Table 3.6)

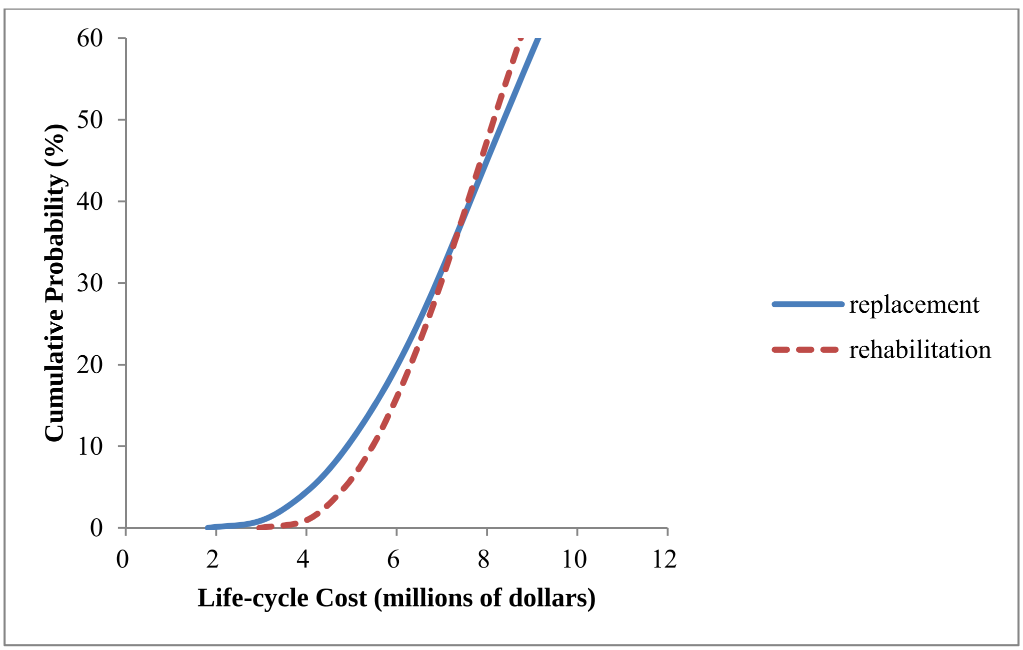


Figure E.96-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 6 (Table 3.6)

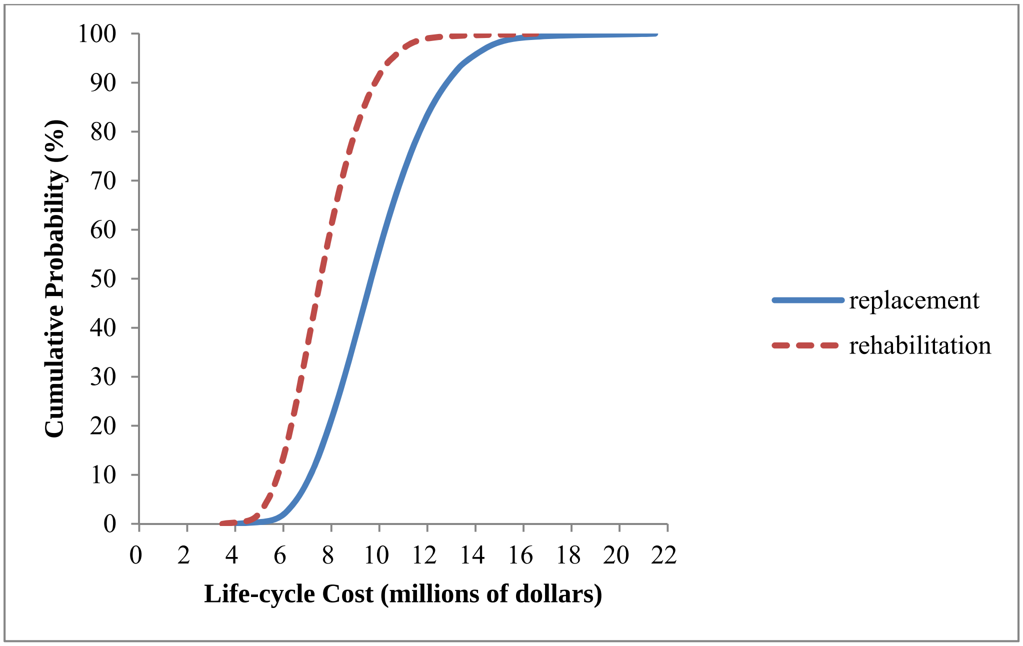


Figure E.97-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 7 (Table 3.6)

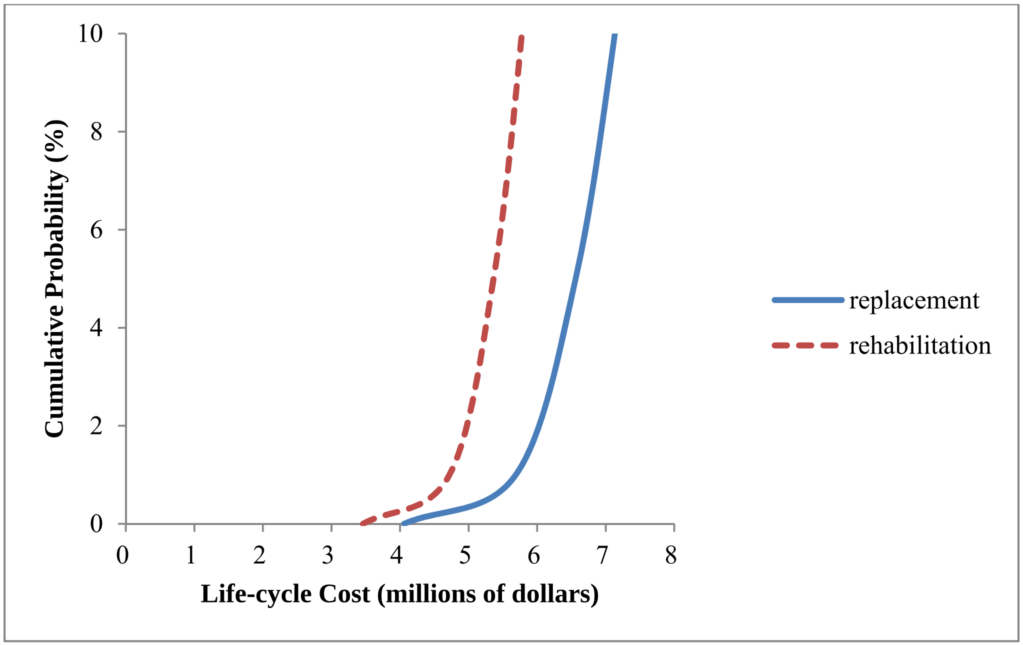


Figure E.98-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 7 (Table 3.6)

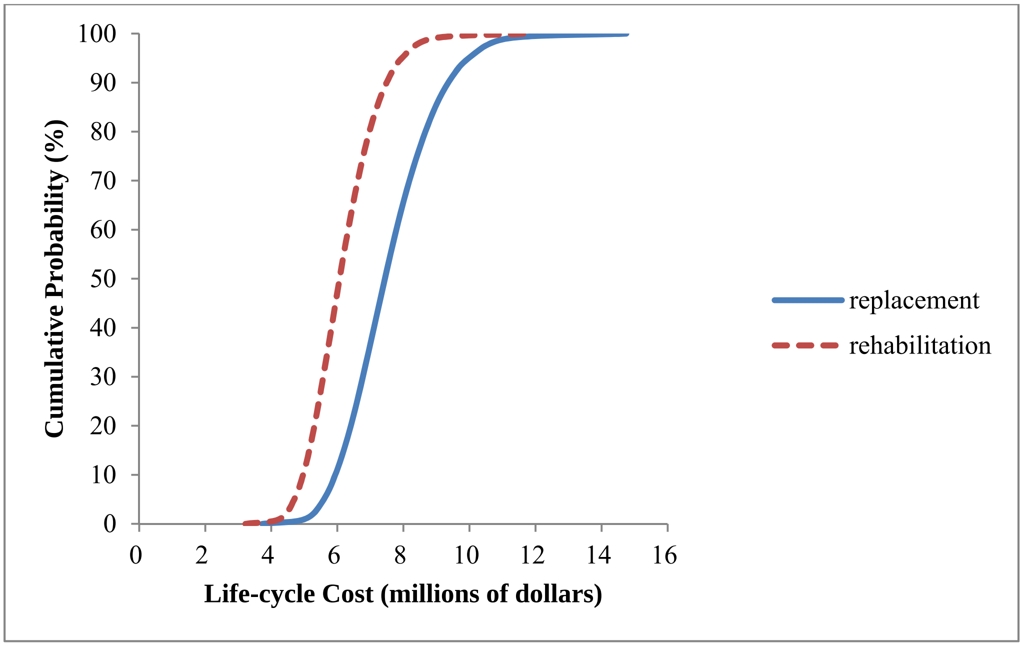


Figure E.99-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 7 (Table 3.6)

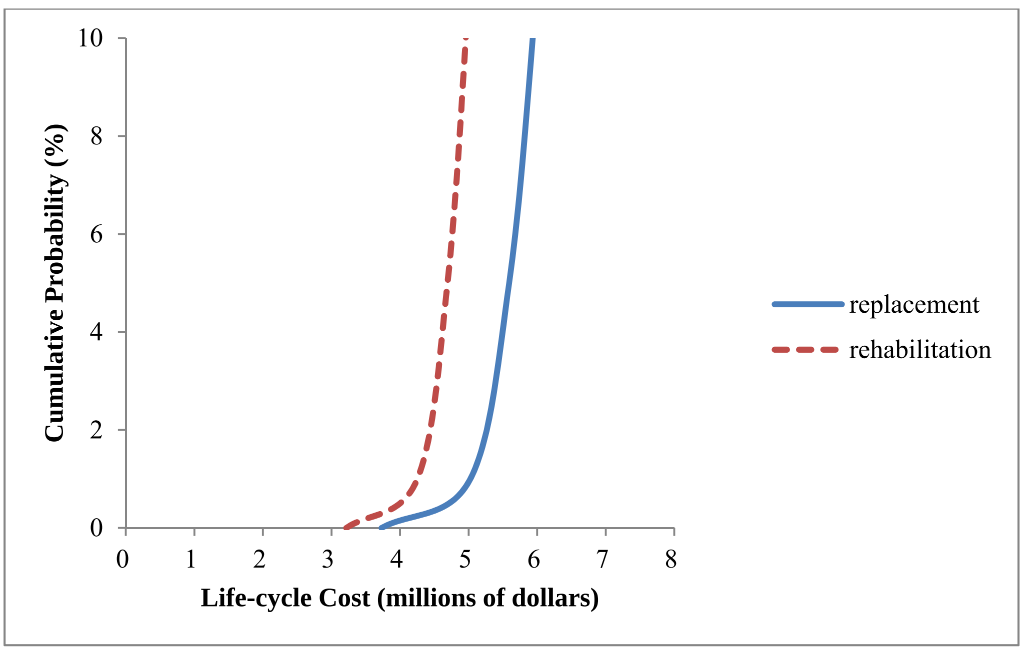


Figure E.100-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 7 (Table 3.6)

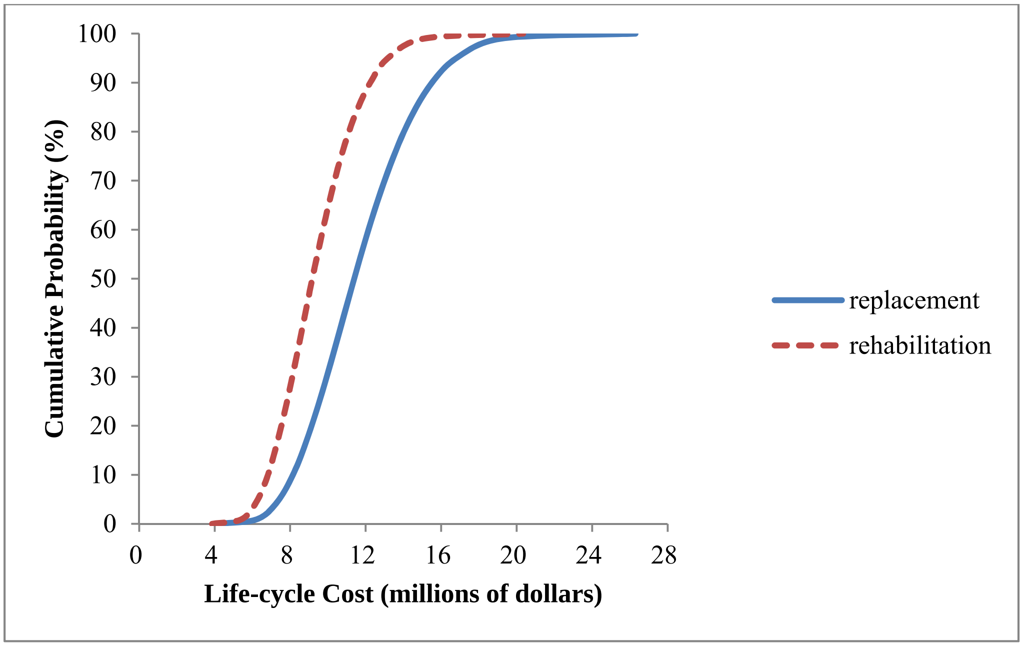


Figure E.101-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 8 (Table 3.6)

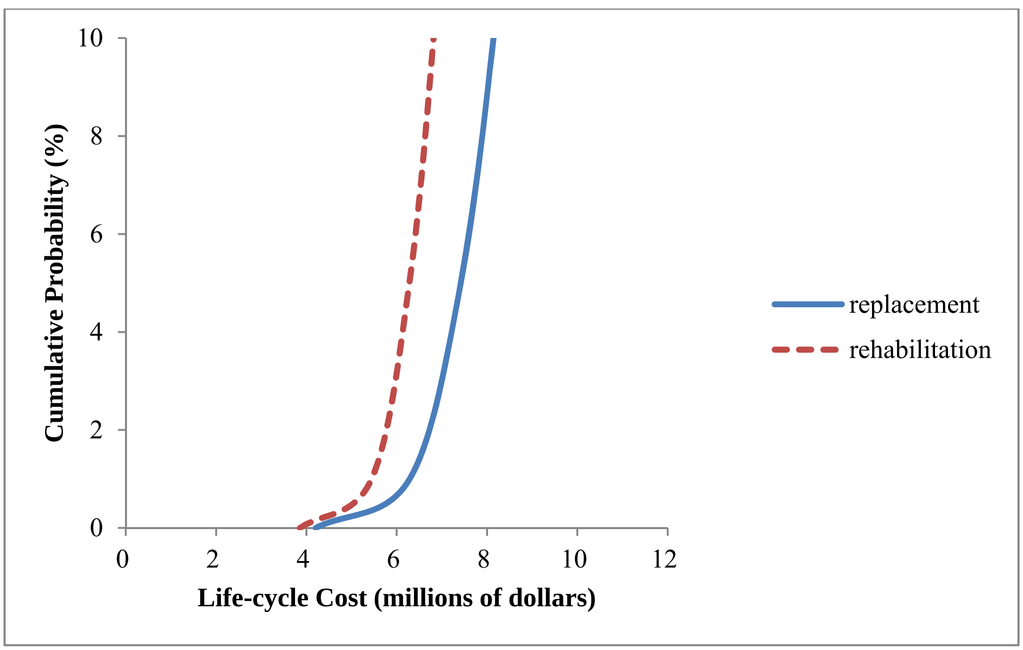


Figure E.102-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 8 (Table 3.6)

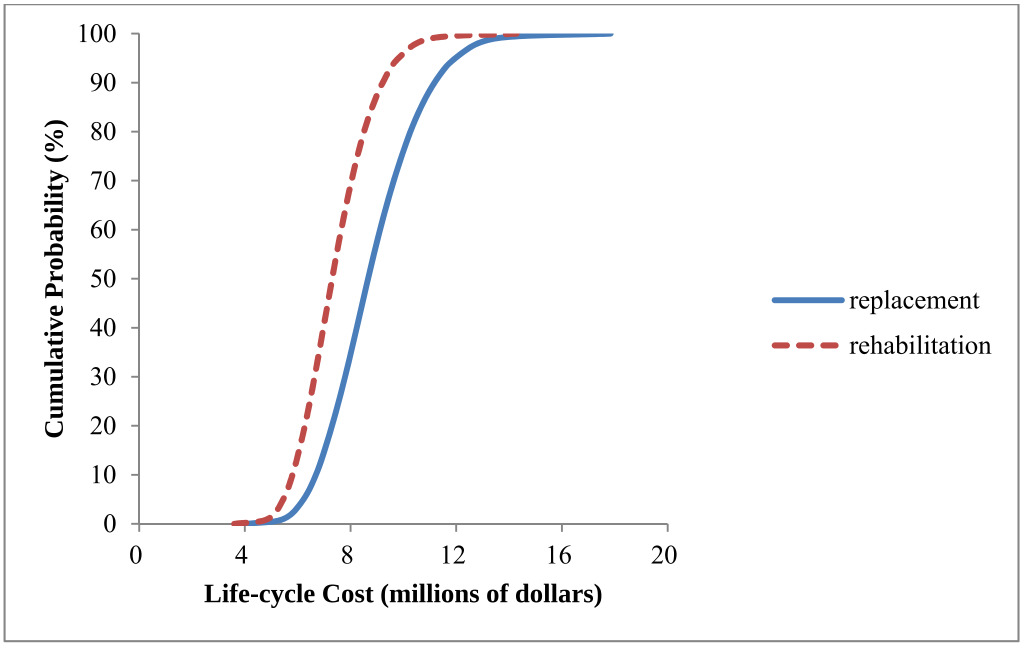


Figure E.103-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 8 (Table 3.6)

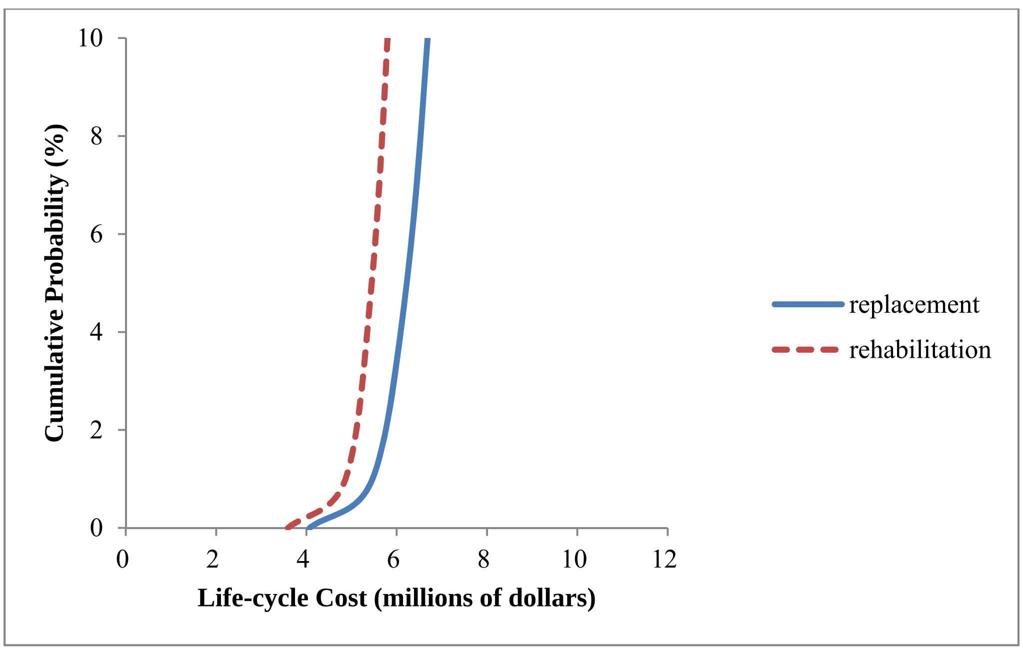


Figure E.104-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 8 (Table 3.6)

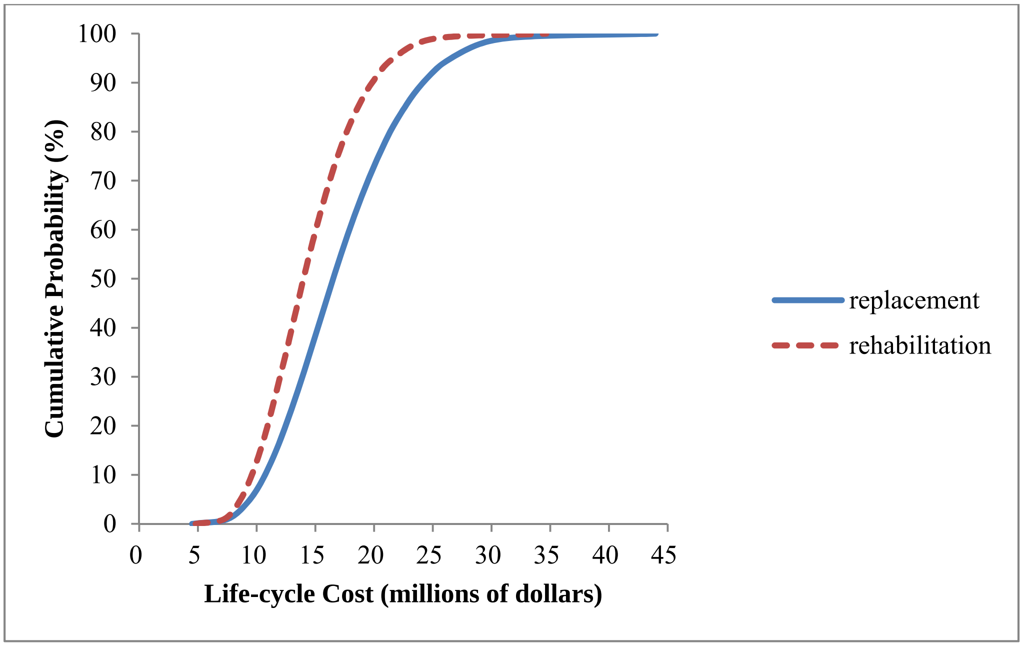


Figure E.105-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 9 (Table 3.6)

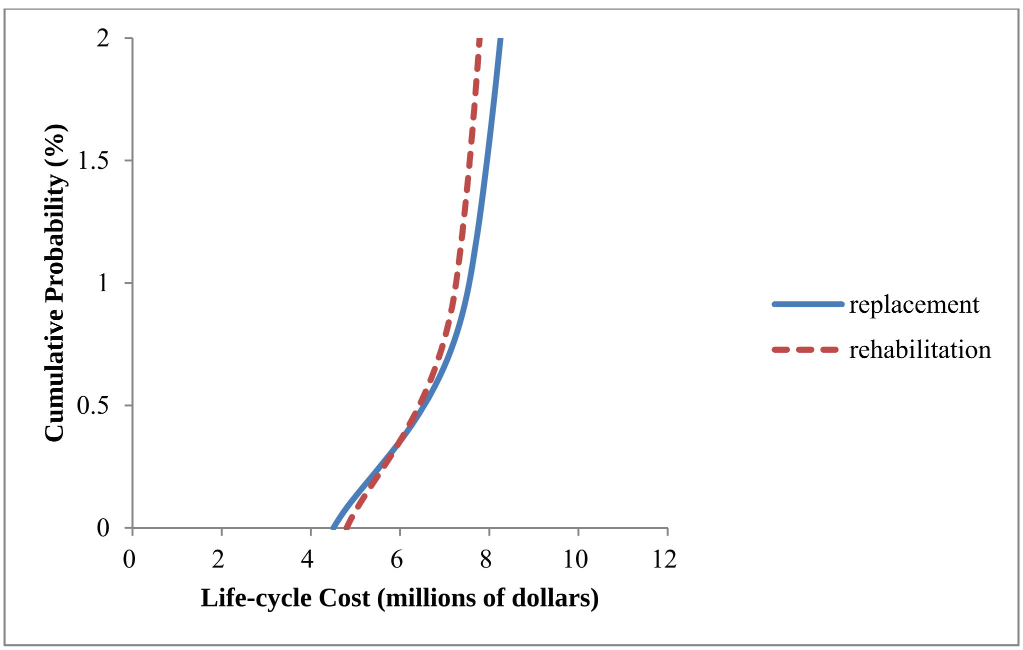


Figure E.106-Ascending cumulative probability distributions for highway bridge with modification 1b ADT case 9 (Table 3.6)

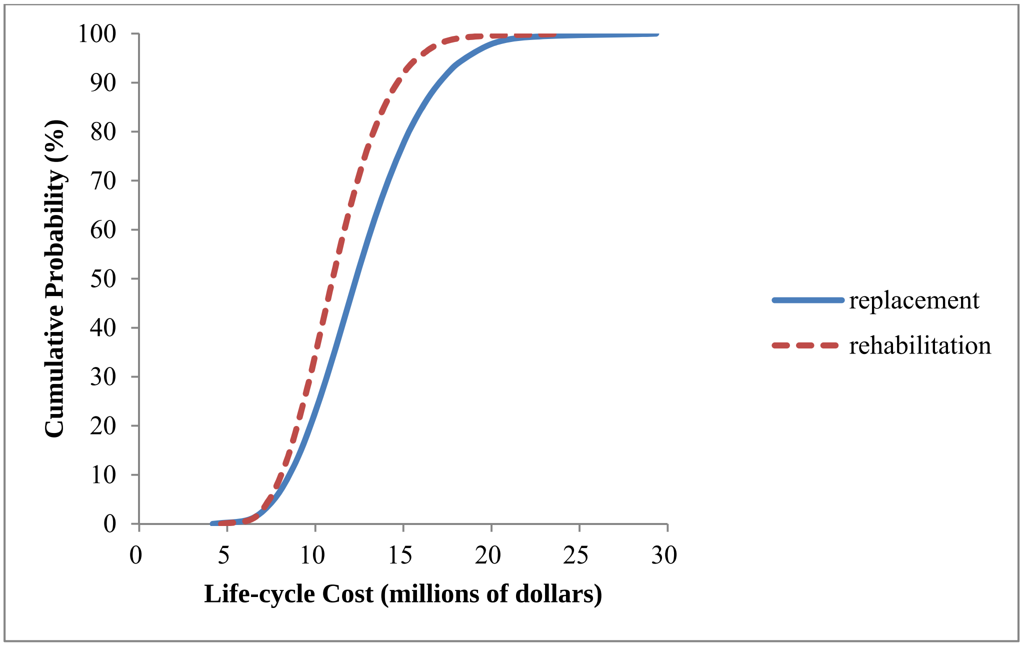


Figure E.107-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 9 (Table 3.6)

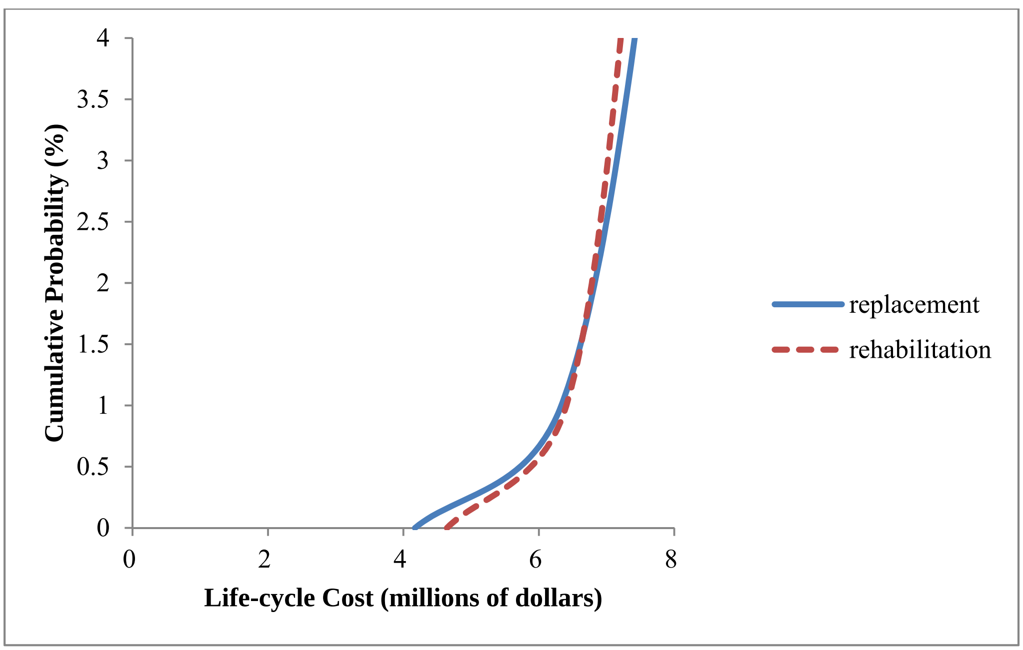


Figure E.108-Ascending cumulative probability distributions for highway bridge with modification 2b ADT case 9 (Table 3.6)

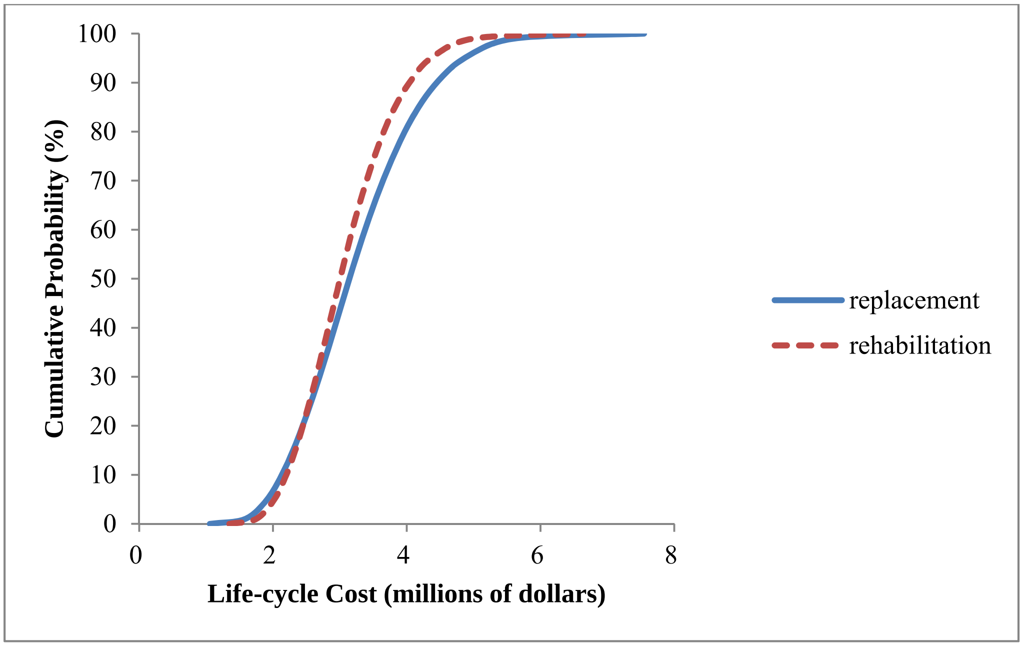


Figure E.109-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 1 (Table 3.6)

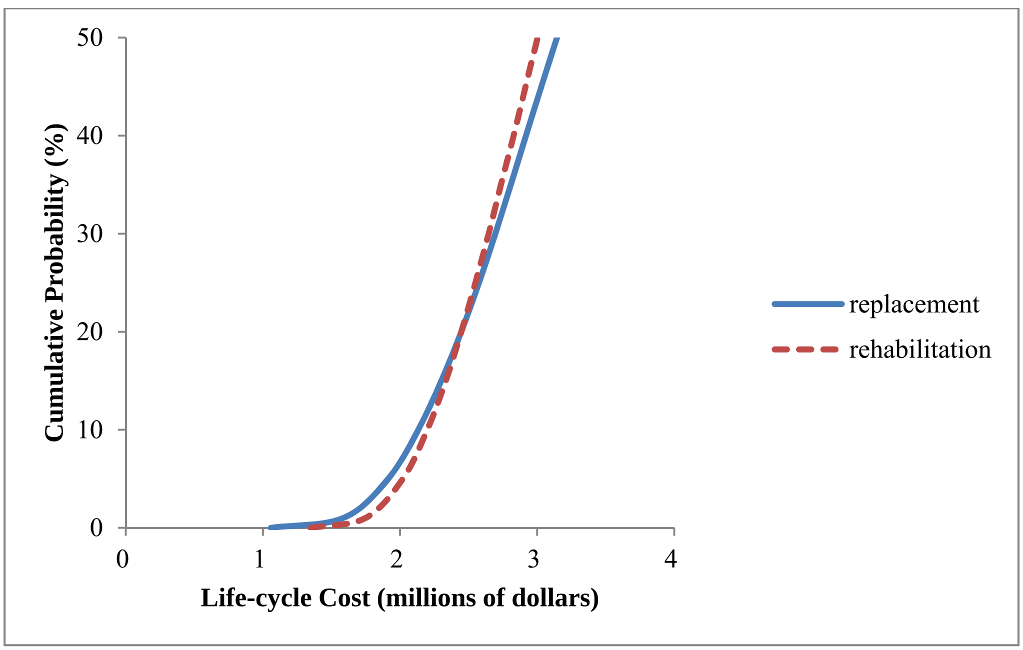


Figure E.110-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 1 (Table 3.6)

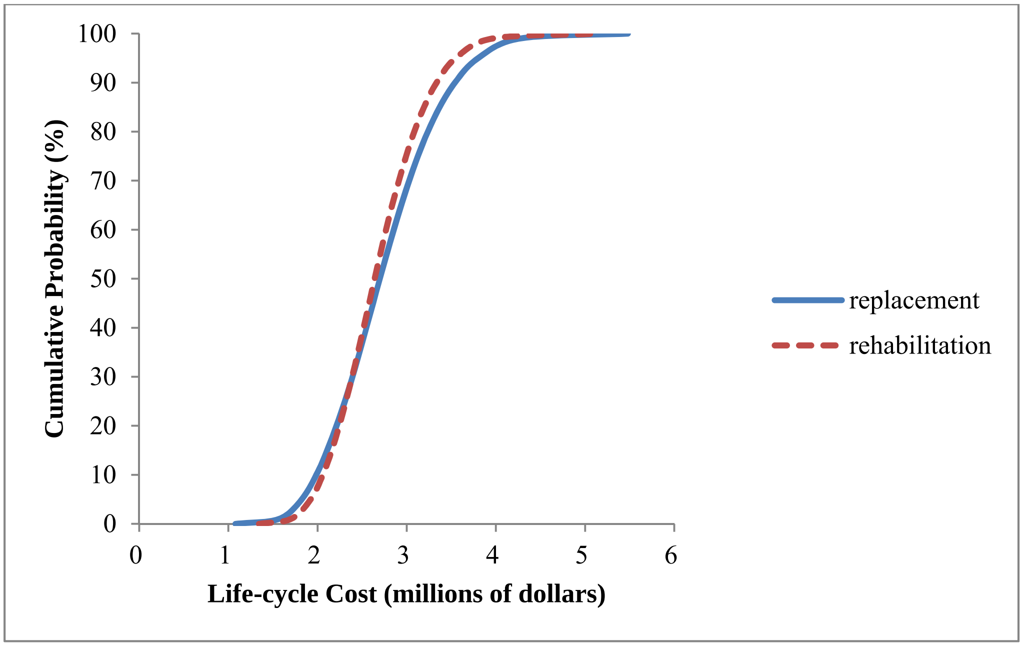


Figure E.111-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 1 (Table 3.6)

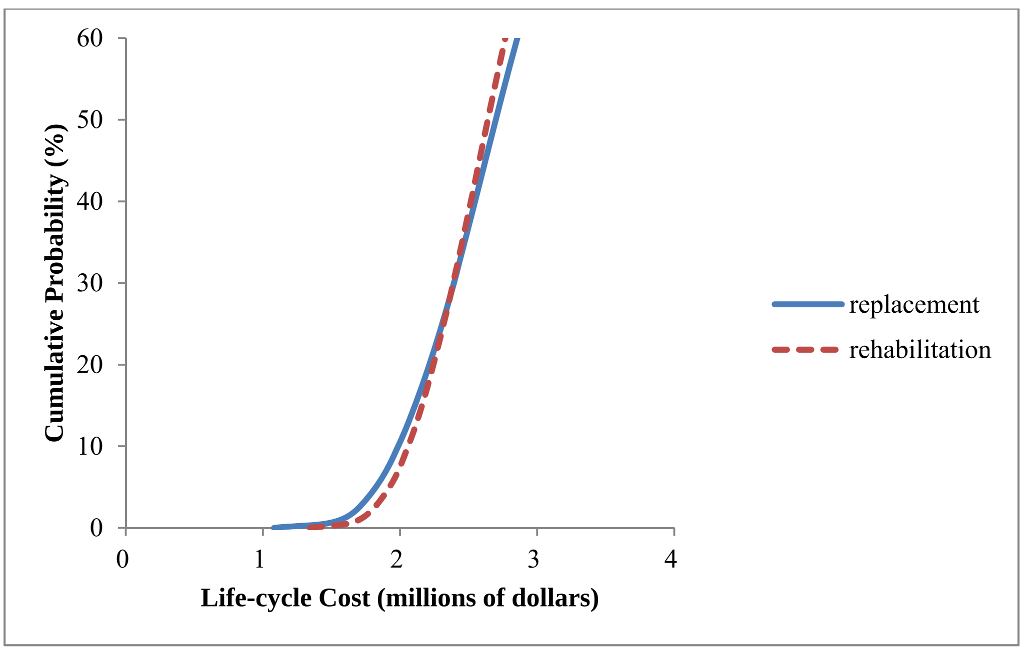


Figure E.112-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 1 (Table 3.6)

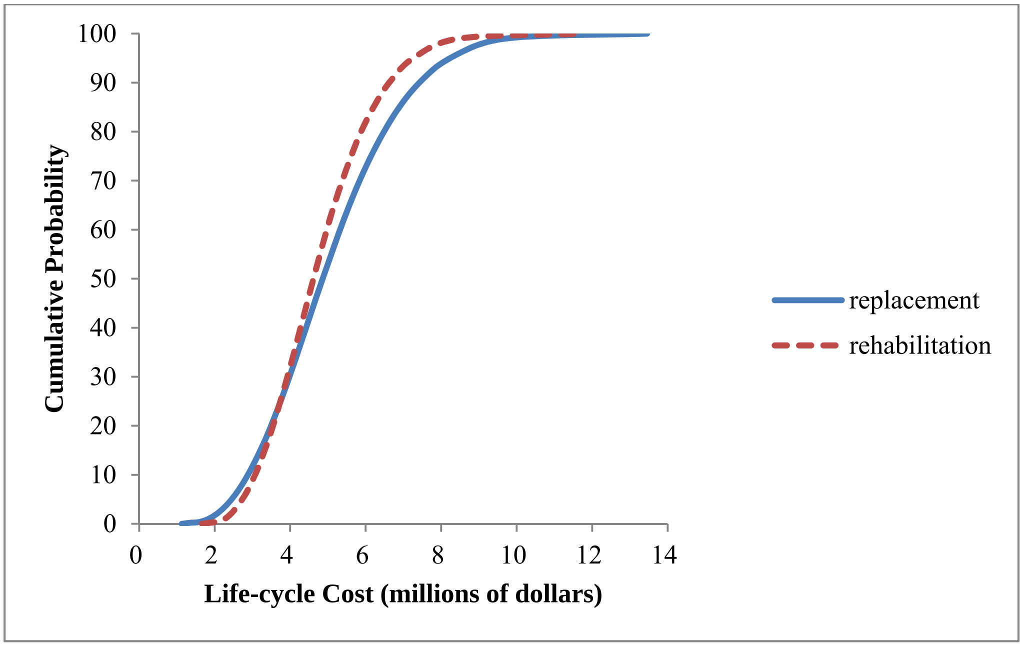


Figure E.113-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 2 (Table 3.6)

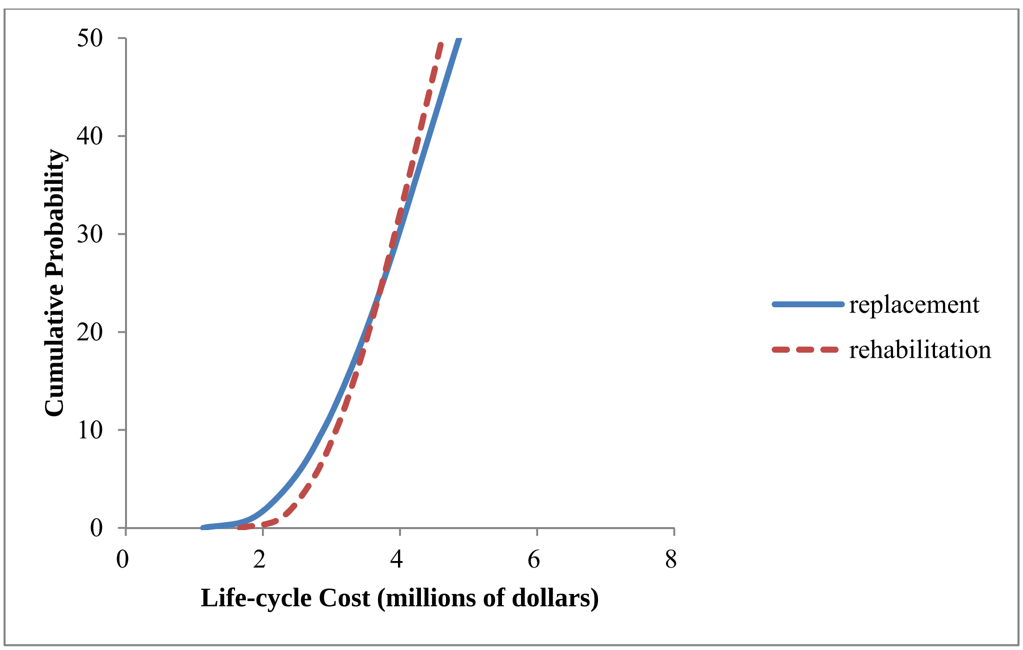


Figure E.114-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 2 (Table 3.6)

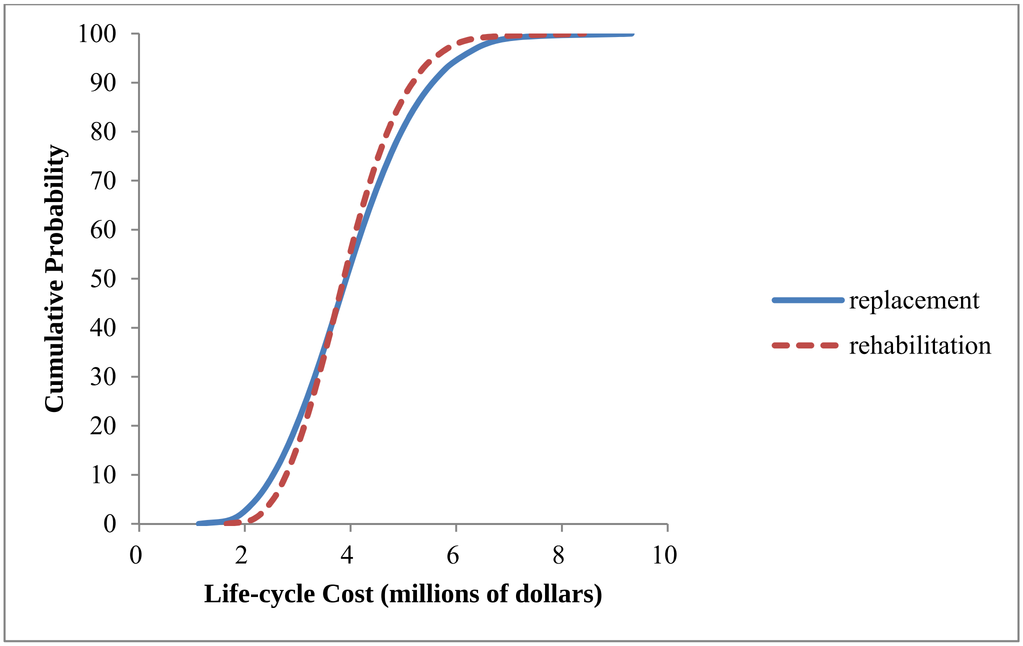


Figure E.115-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 2 (Table 3.6)

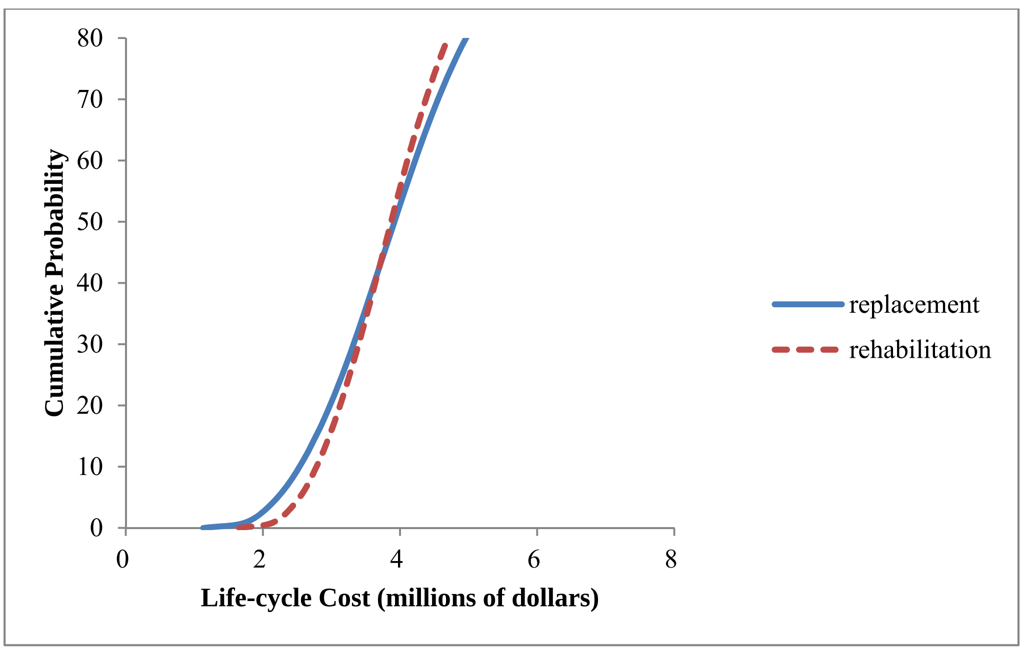


Figure E.116-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 2 (Table 3.6)

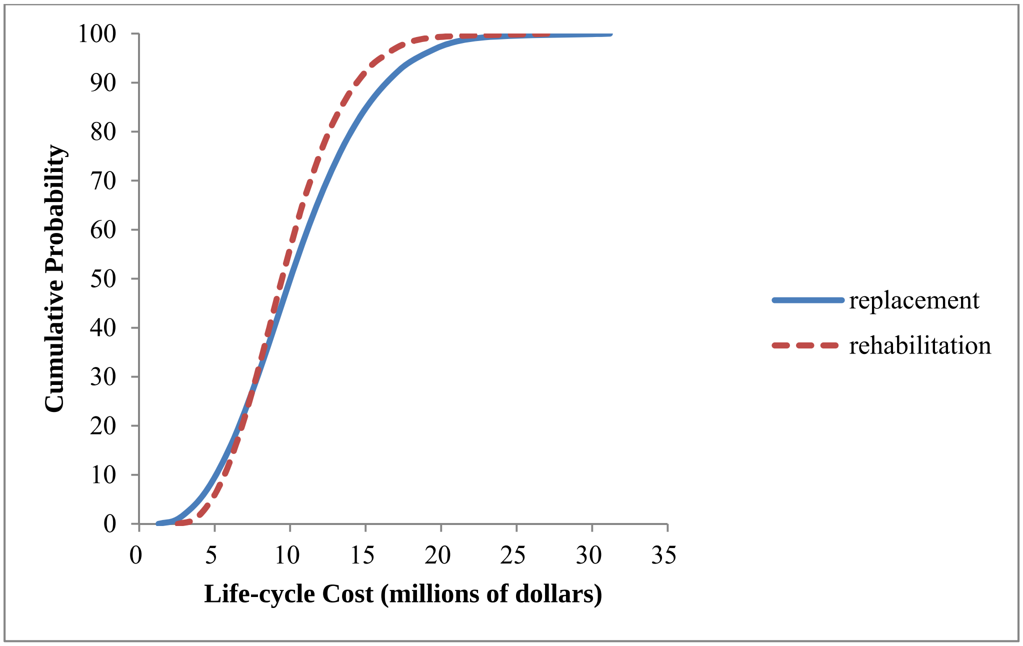


Figure E.117-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 3 (Table 3.6)

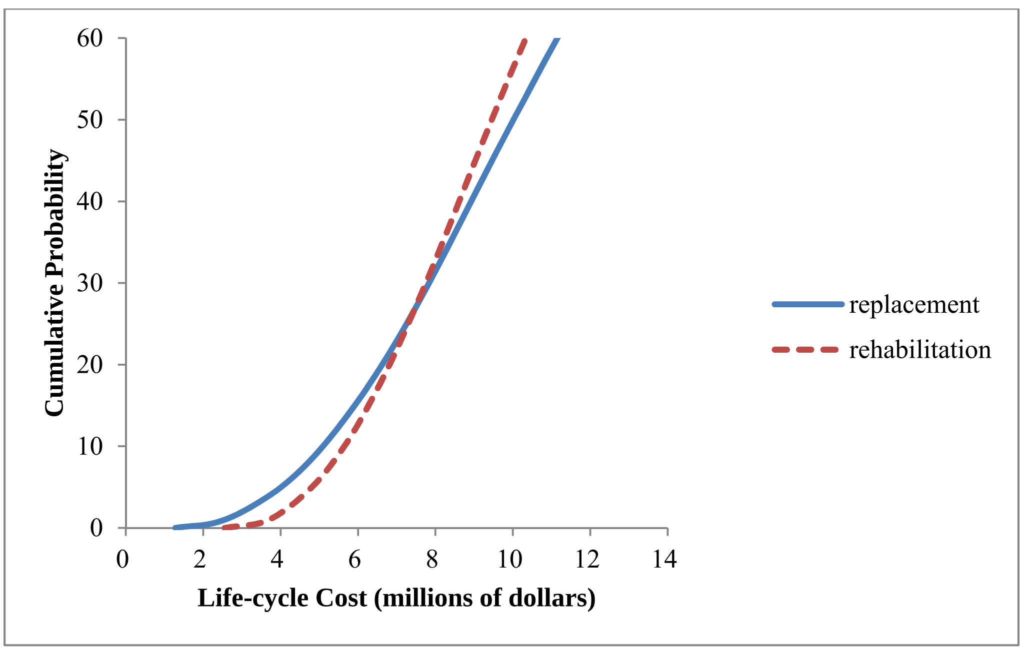


Figure E.118-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 3 (Table 3.6)

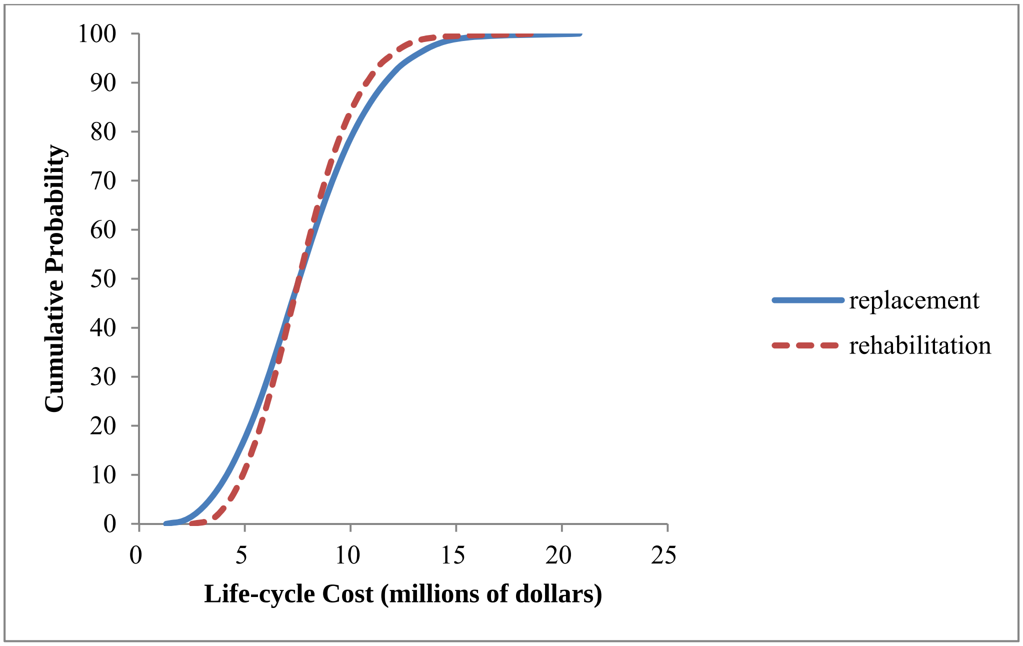


Figure E.119-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 3 (Table 3.6)

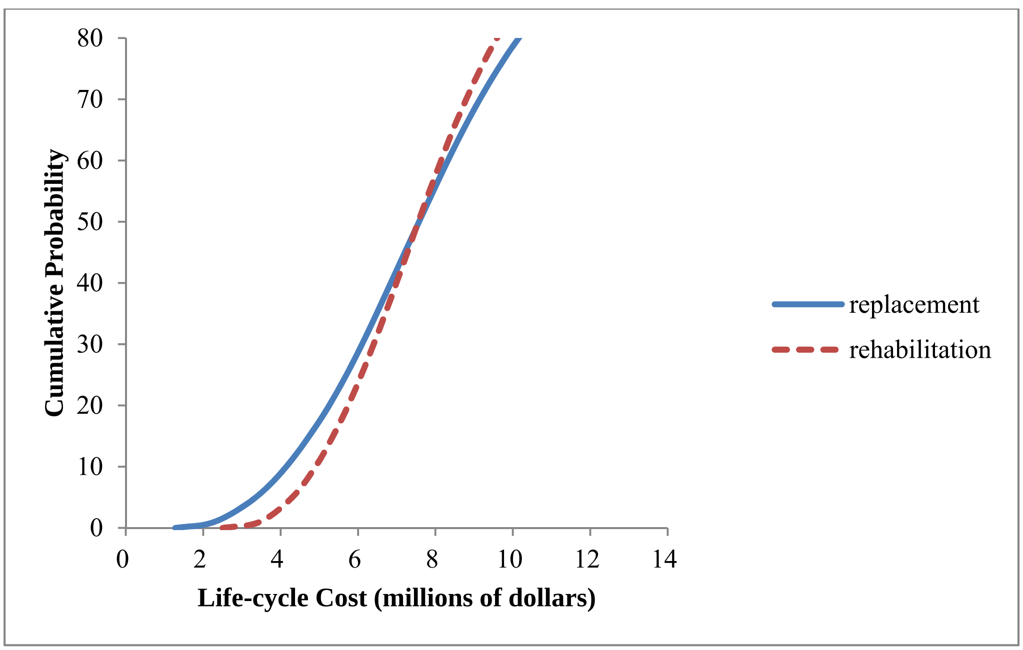


Figure E.120-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 3 (Table 3.6)

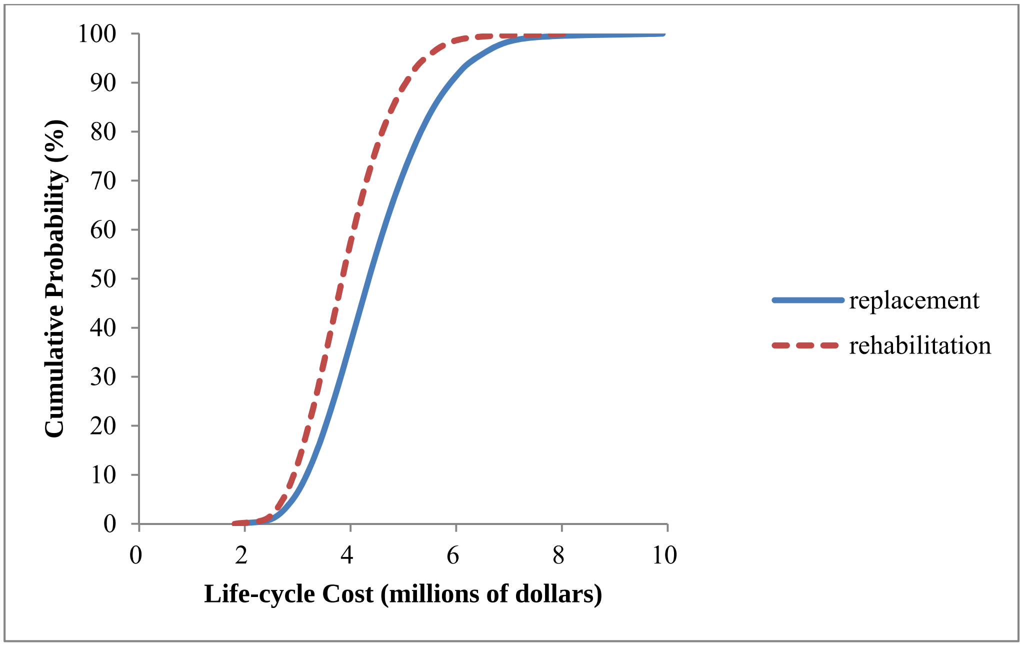


Figure E.121-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 4 (Table 3.6)

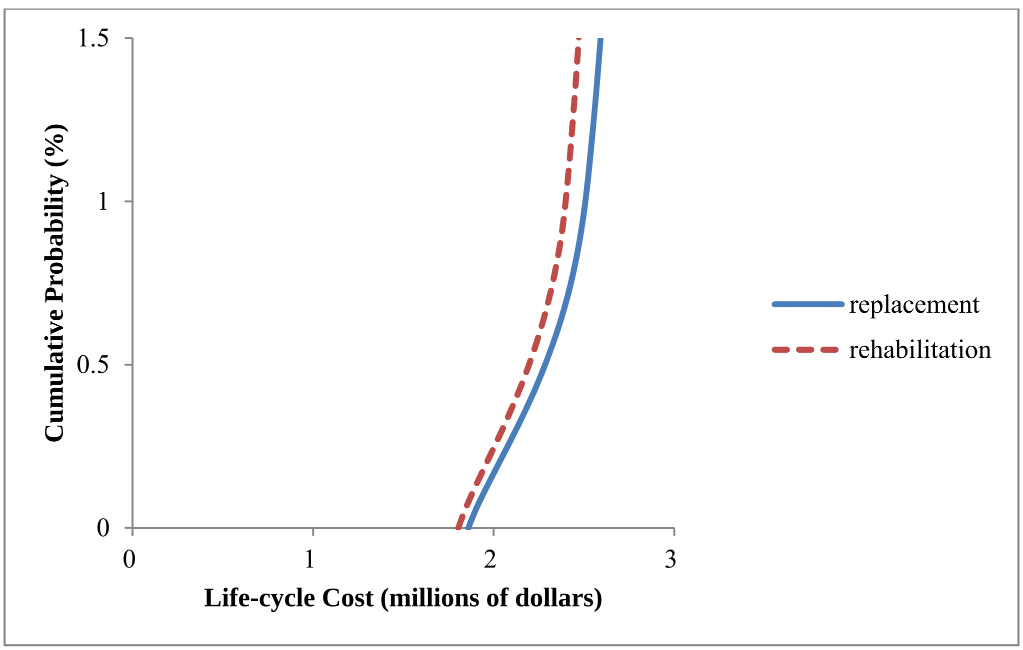


Figure E.122-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 4 (Table 3.6)

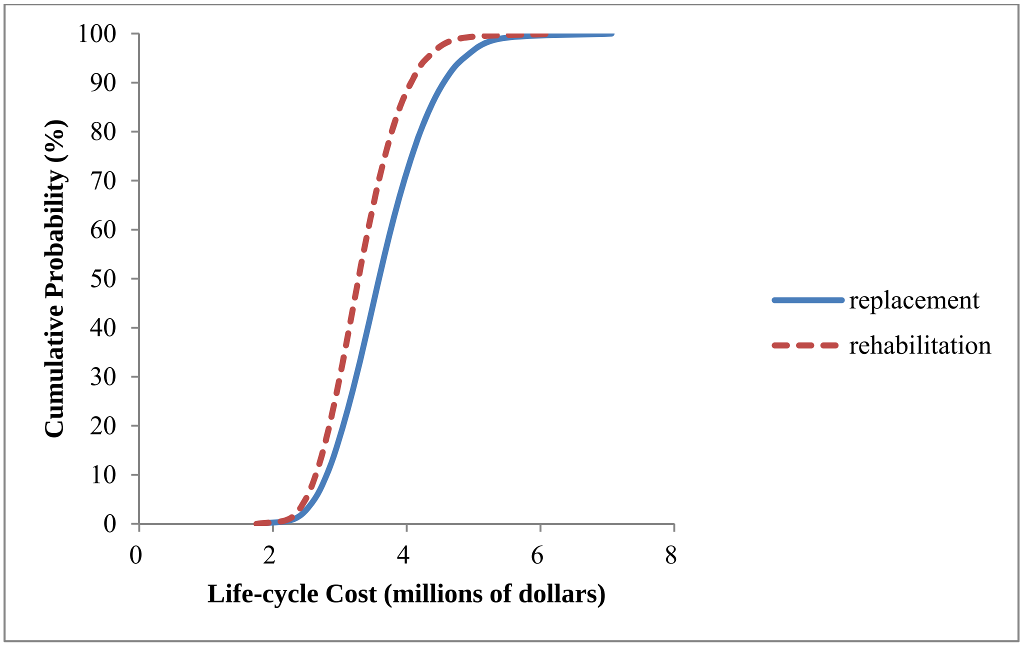


Figure E.123-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 4 (Table 3.6)

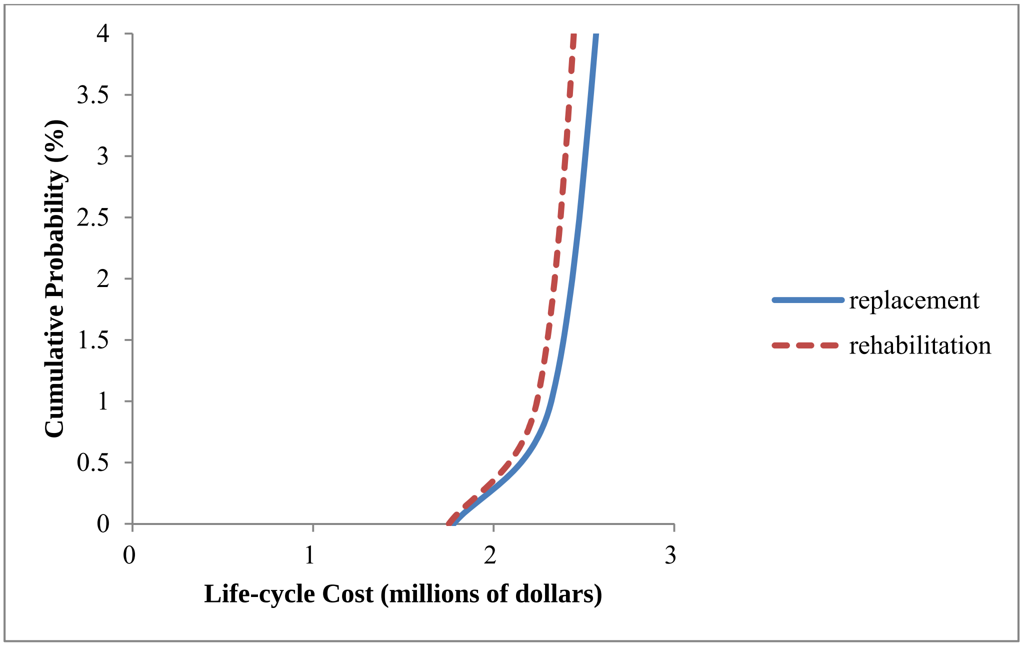


Figure E.124-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 4 (Table 3.6)

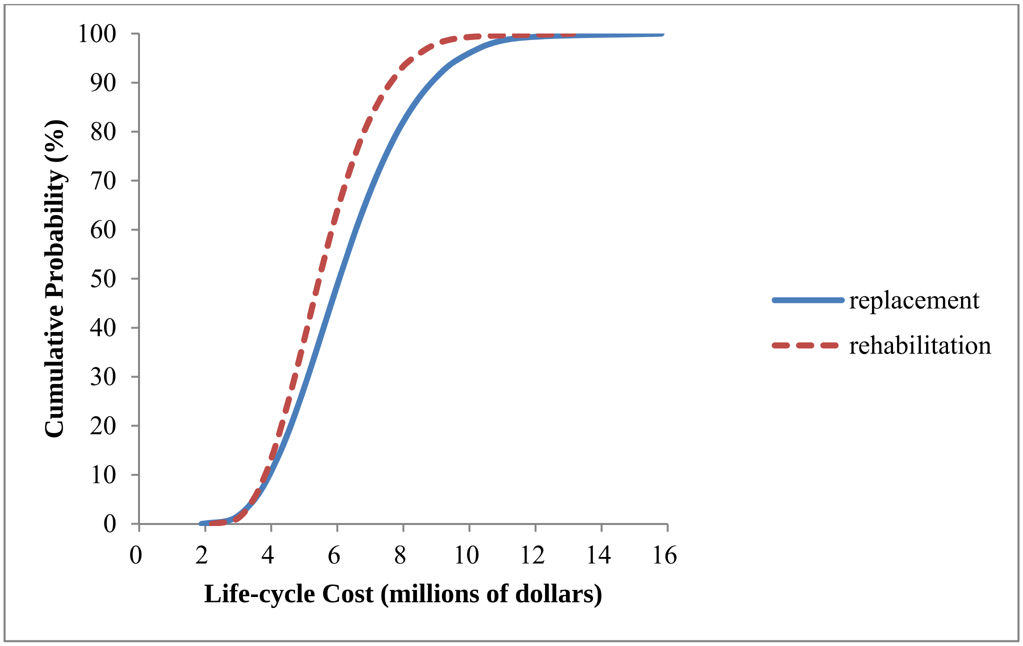


Figure E.125-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 5 (Table 3.6)

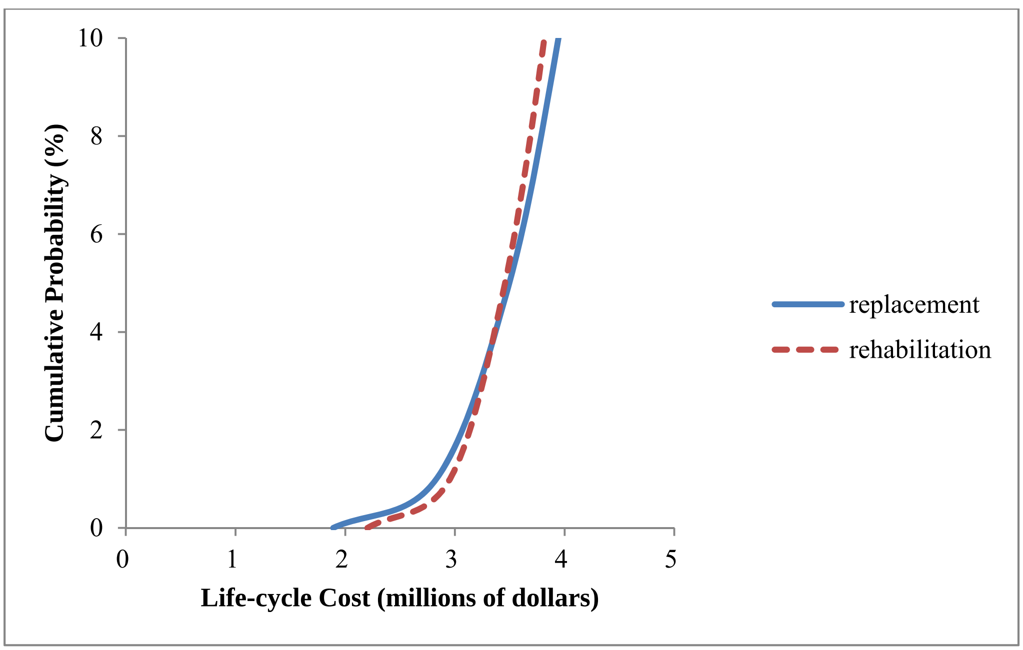


Figure E.126-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 5 (Table 3.6)

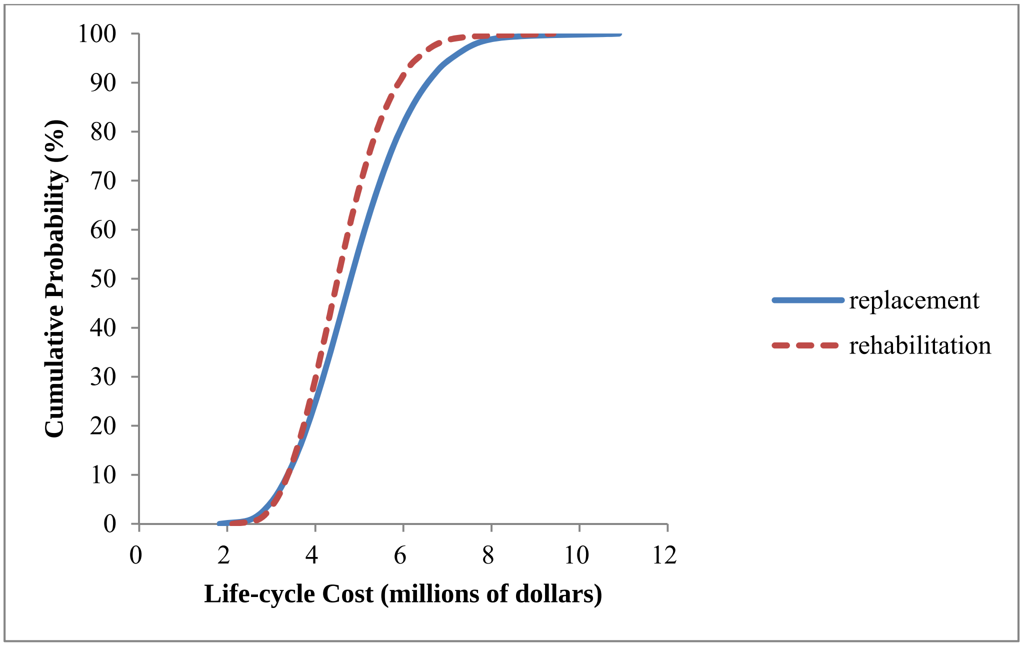


Figure E.127-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 5 (Table 3.6)

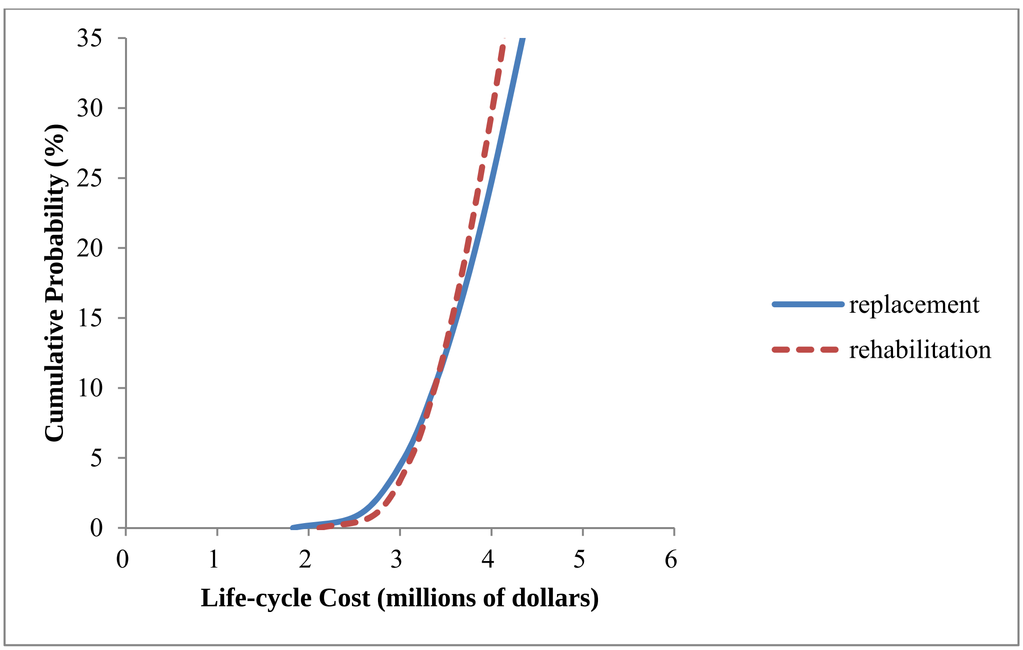


Figure E.128-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 5 (Table 3.6)

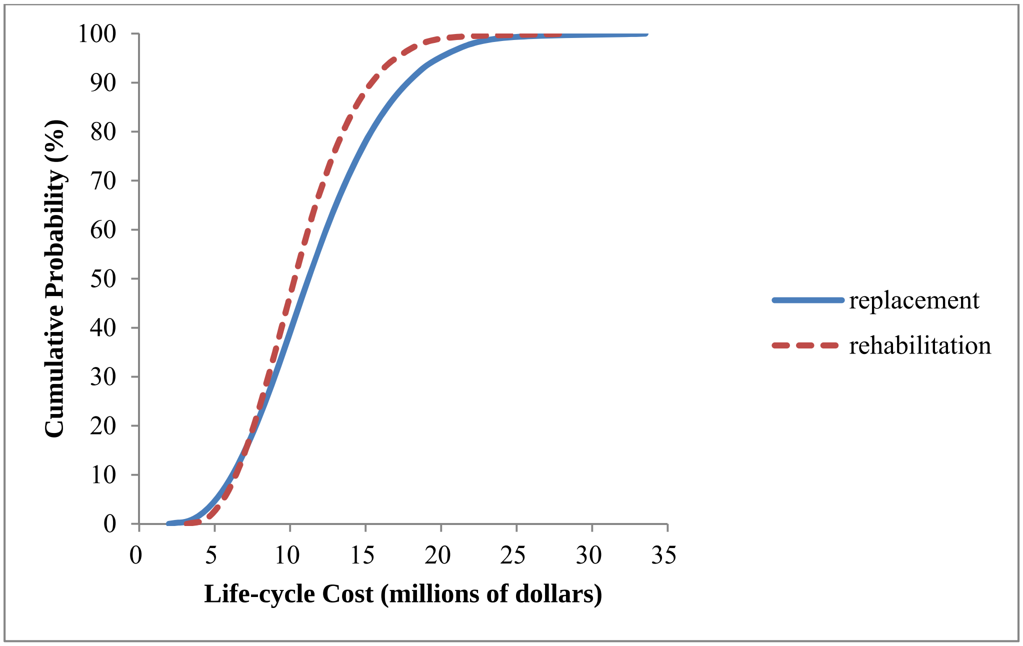


Figure E.129-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 6 (Table 3.6)

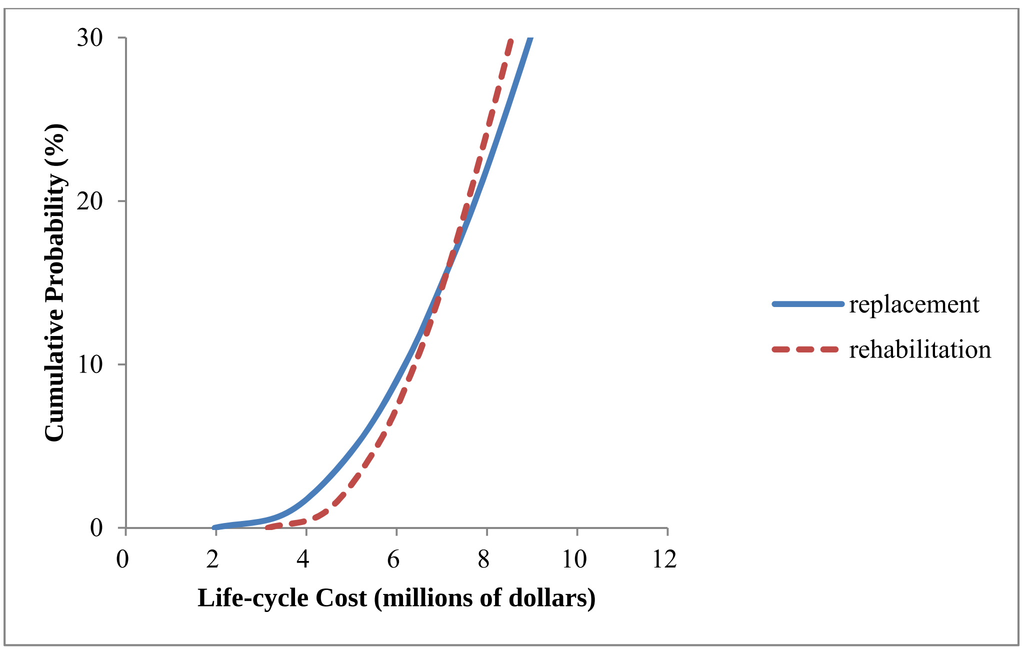


Figure E.130-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 6 (Table 3.6)

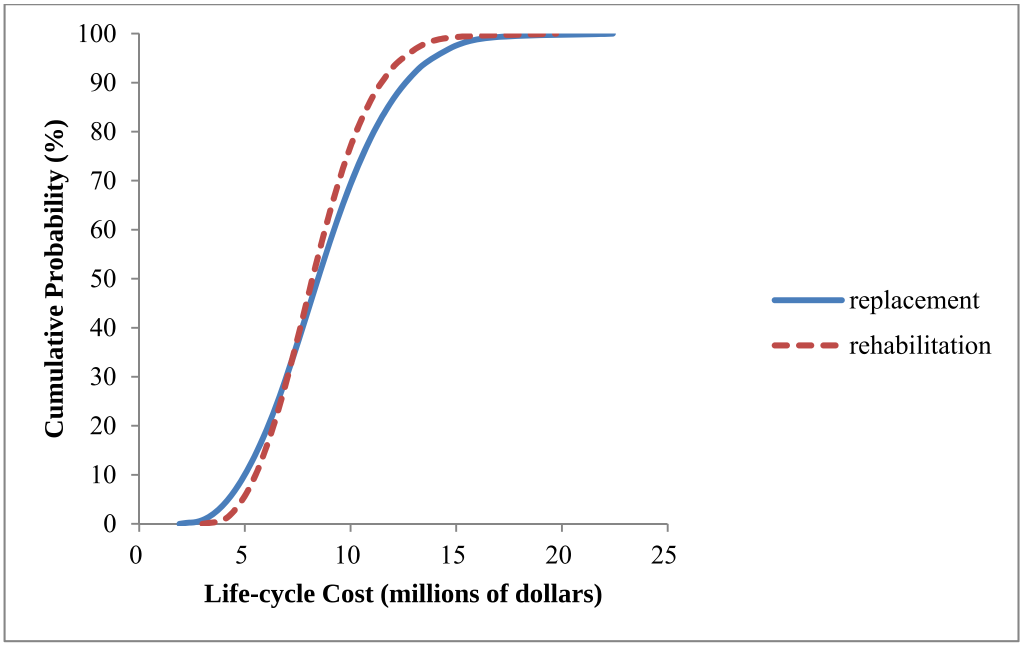


Figure E.131-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 6 (Table 3.6)

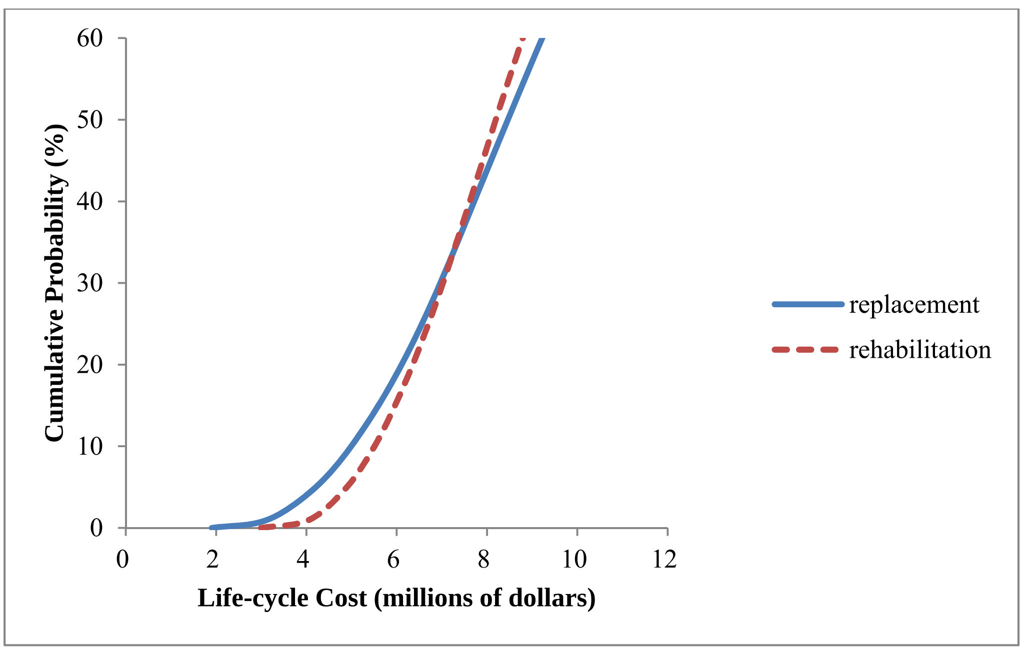


Figure E.132-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 6 (Table 3.6)

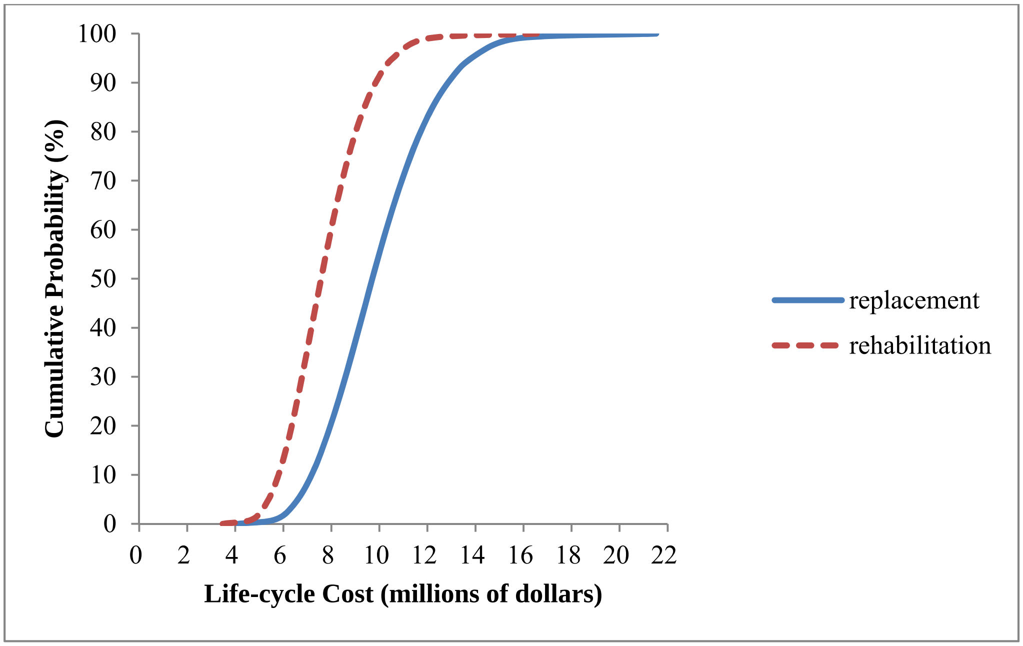


Figure E.133-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 7 (Table 3.6)

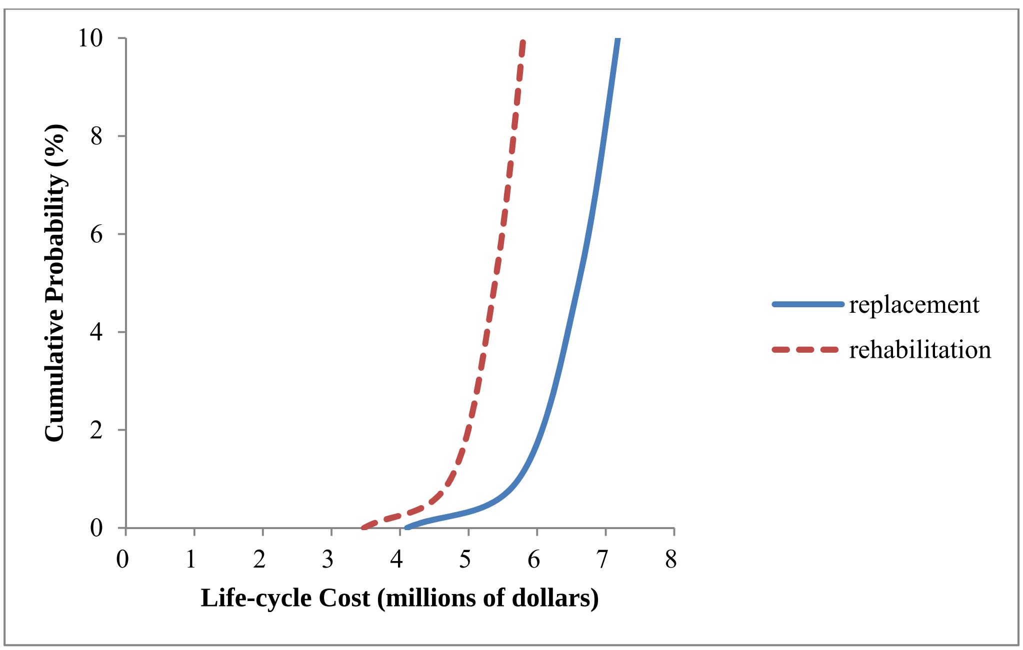


Figure E.134-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 7 (Table 3.6)

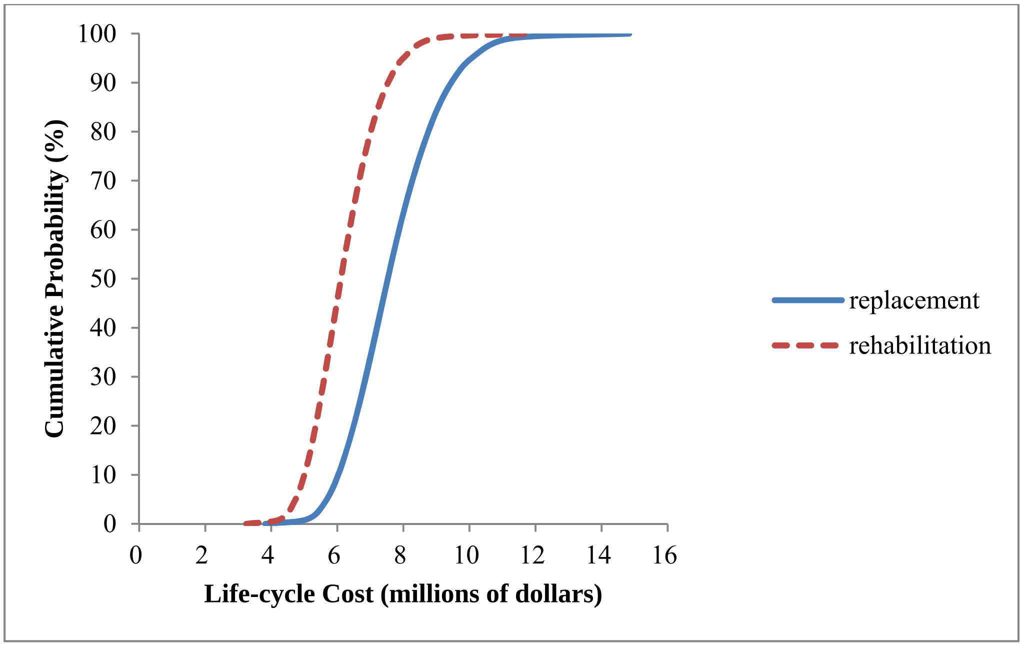


Figure E.135-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 7 (Table 3.6)

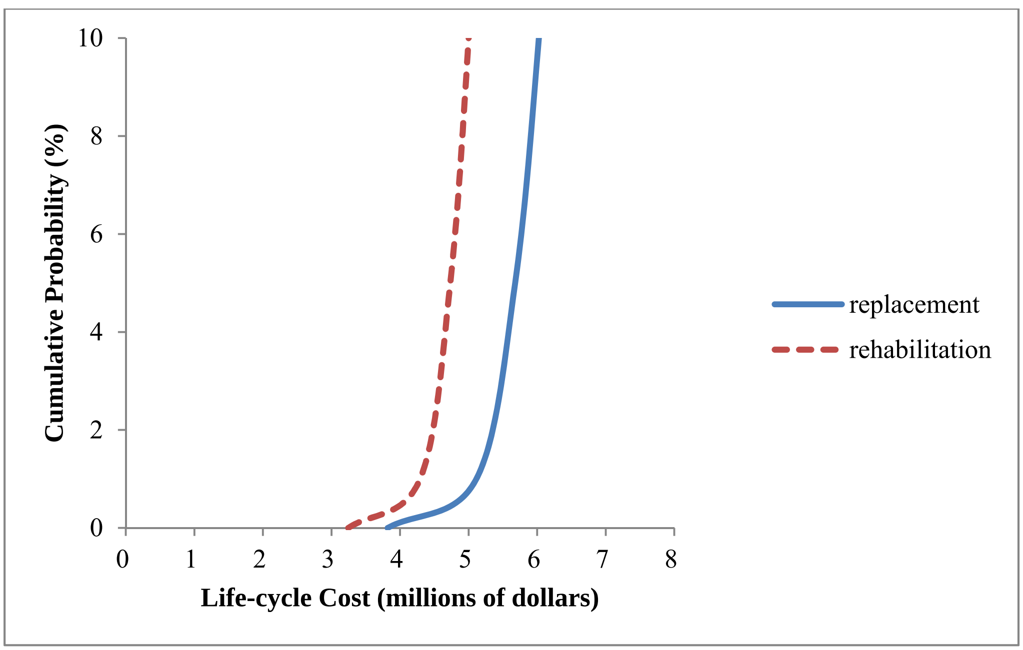


Figure E.136-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 7 (Table 3.6)

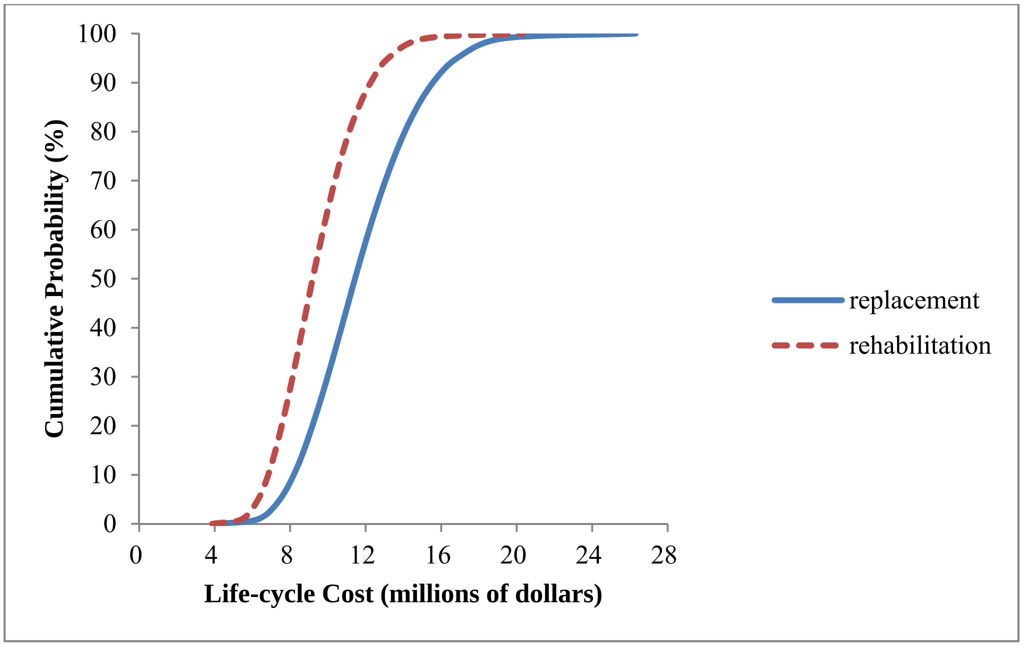


Figure E.137-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 8 (Table 3.6)

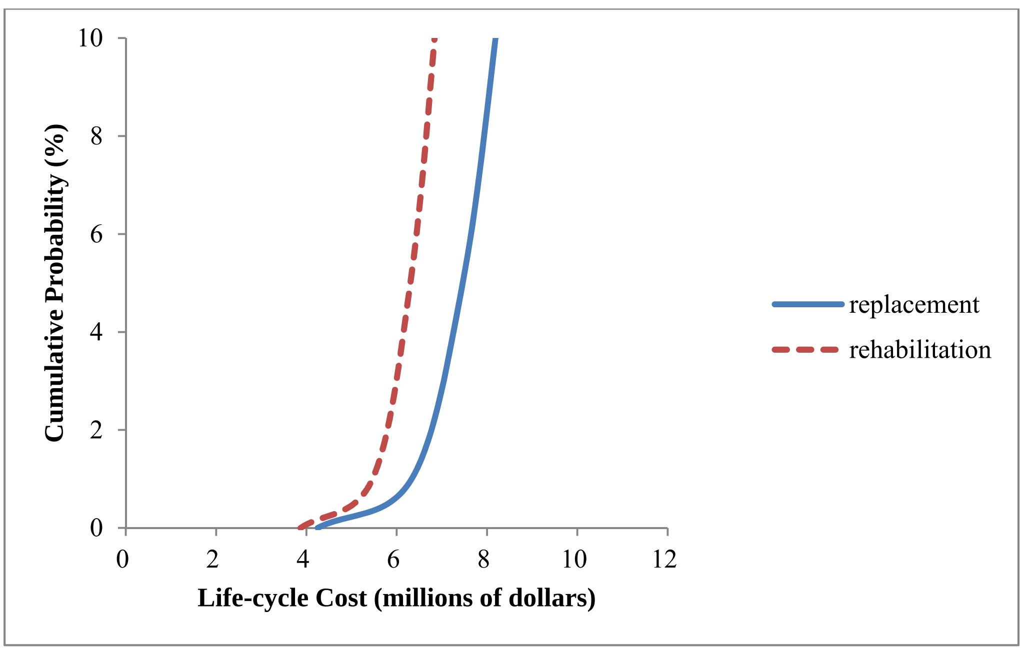


Figure E.138-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 8 (Table 3.6)

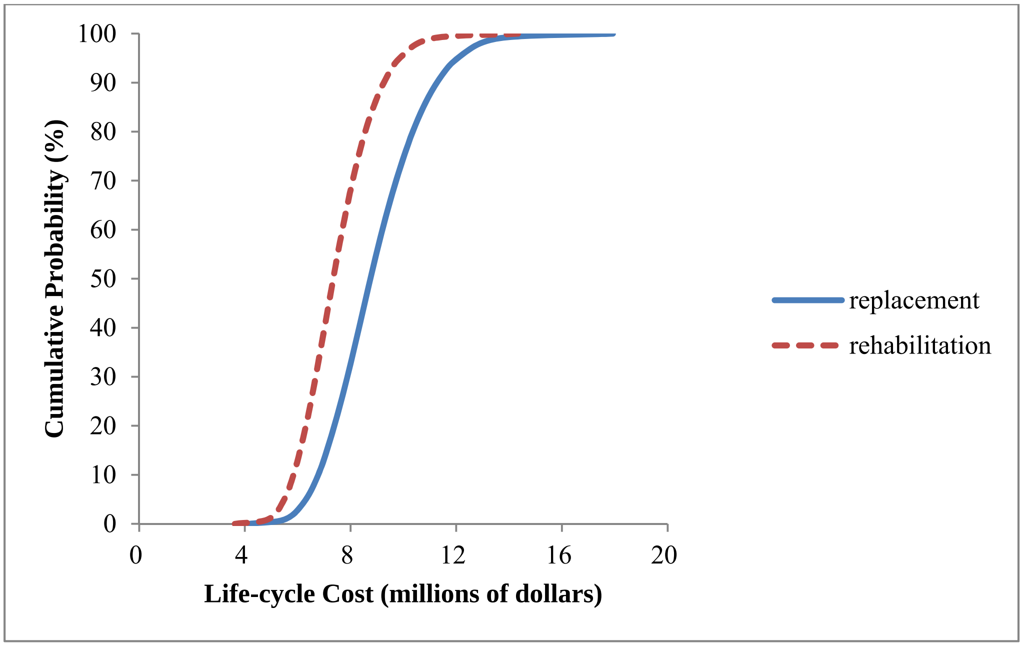


Figure E.139-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 8 (Table 3.6)

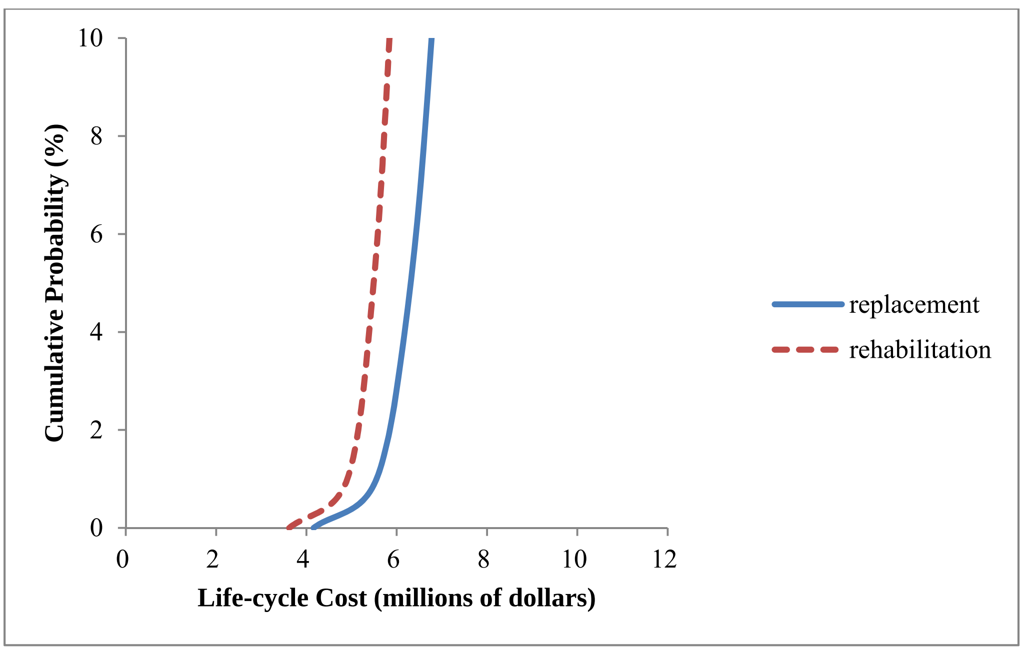


Figure E.140-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 8 (Table 3.6)

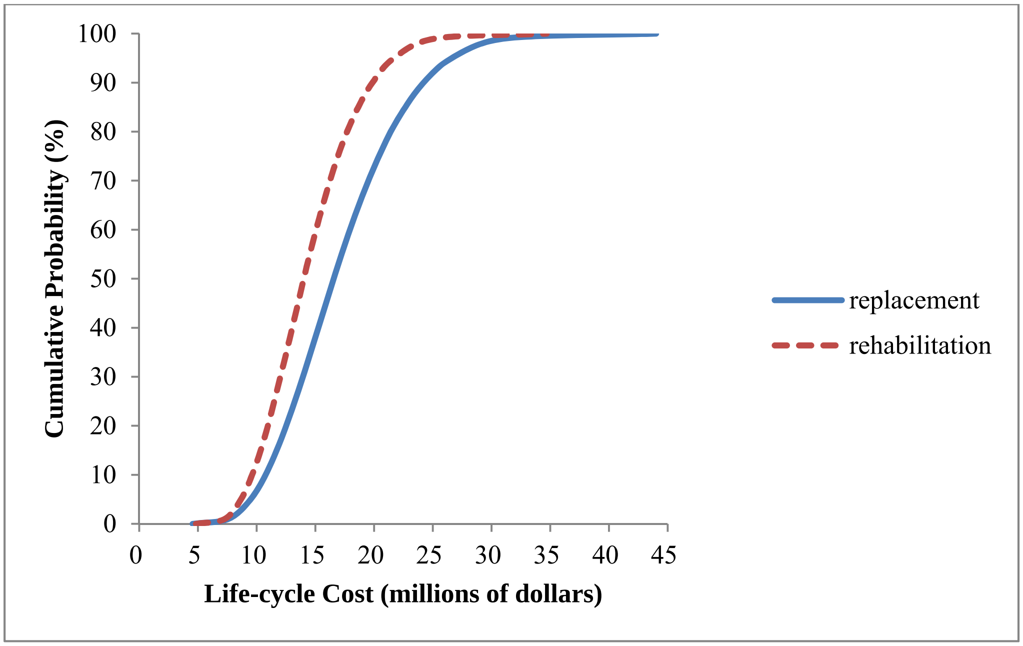


Figure E.141-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 9 (Table 3.6)

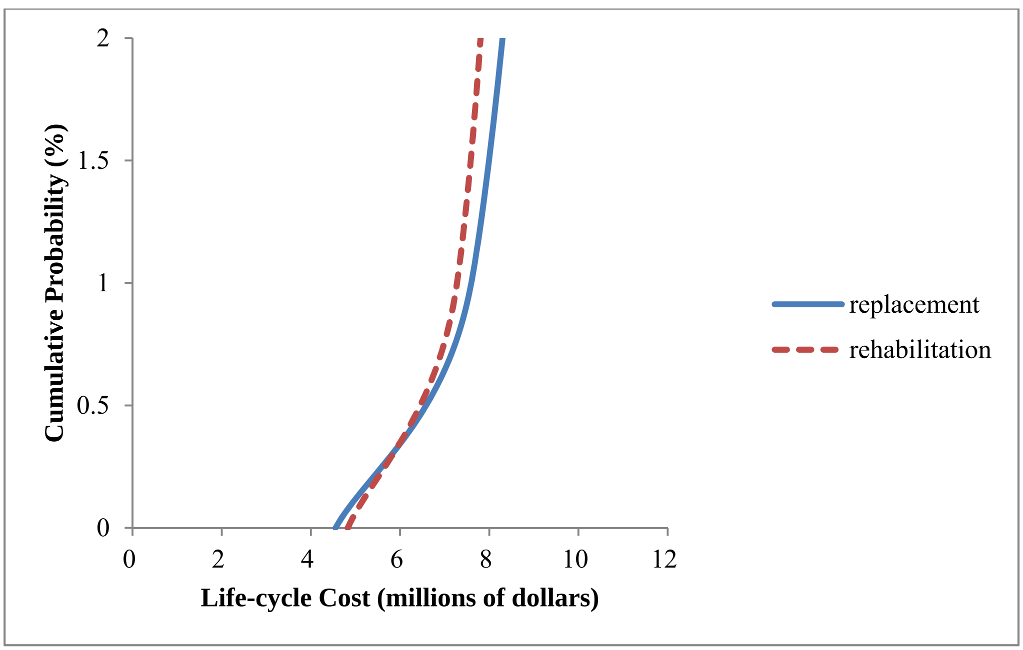


Figure E.142-Ascending cumulative probability distributions for highway bridge with modification 1c ADT case 9 (Table 3.6)

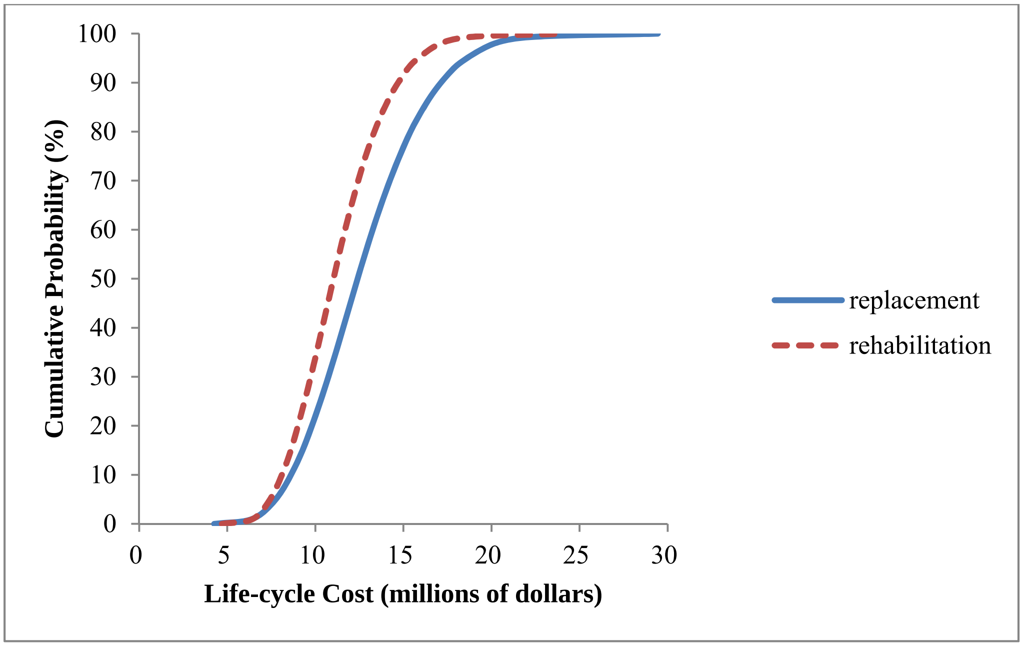


Figure E.143-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 9 (Table 3.6)

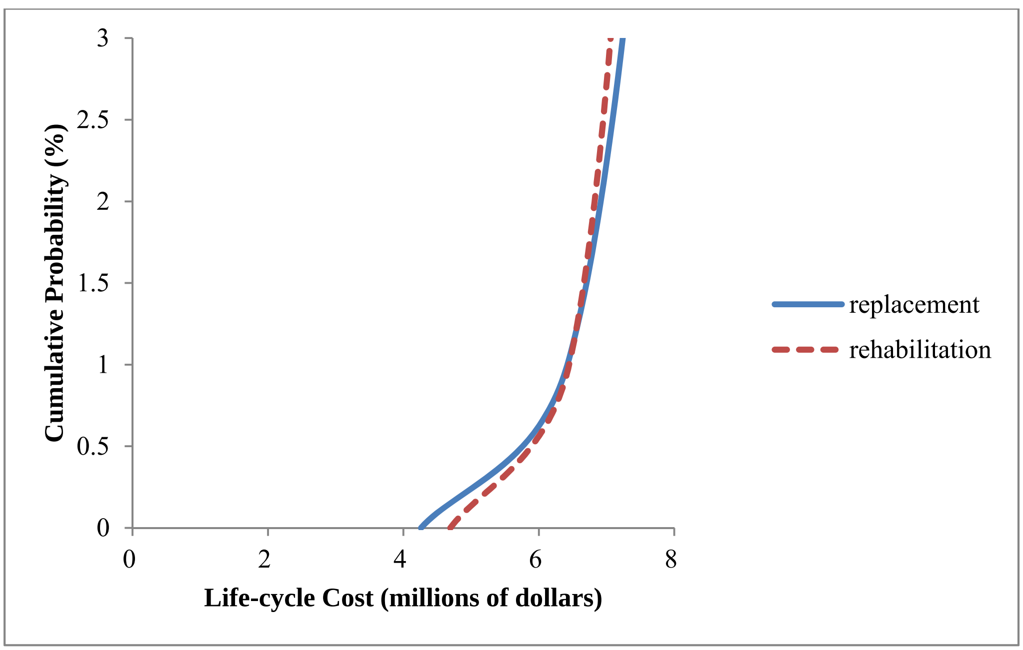


Figure E.144-Ascending cumulative probability distributions for highway bridge with modification 2c ADT case 9 (Table 3.6)

Bridge over Waterway

Table E.73-Risk profile statistics for waterway bridge ADT case 1, 2, 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	784,705	53,116	891,678	786,562	39,006	851,797
Maximum	1,886,683	411,419	2,099,277	2,215,473	286,894	2,349,832
Mean	1,203,246	169,450	1,372,696	1,250,895	116,344	1,367,239
Std Dev	156,504	47,126	164,297	176,045	31,651	182,463
Percentile						
1%	873,490	80,689	1,020,770	918,986	57,861	1,018,704
5%	944,947	99,017	1,103,899	989,239	69,982	1,094,742
10%	998,467	111,184	1,158,942	1,034,196	77,919	1,142,099
15%	1,036,577	120,374	1,198,613	1,067,266	83,794	1,176,580
20%	1,066,694	128,237	1,230,846	1,095,370	88,830	1,206,619
25%	1,093,671	135,326	1,258,182	1,120,827	93,338	1,233,103
30%	1,117,573	141,718	1,283,220	1,145,079	97,624	1,258,271
35%	1,139,495	148,013	1,305,744	1,168,546	101,627	1,282,617
40%	1,160,819	154,002	1,327,379	1,191,641	105,440	1,306,817
45%	1,180,699	159,803	1,348,664	1,213,326	109,287	1,329,282
50%	1,200,602	165,669	1,369,918	1,235,845	113,264	1,352,987
55%	1,221,005	171,626	1,391,100	1,259,393	117,276	1,376,516
60%	1,241,661	177,741	1,412,699	1,283,146	121,493	1,400,997
65%	1,263,269	184,205	1,434,692	1,308,004	125,914	1,426,921
70%	1,285,361	191,190	1,458,179	1,335,033	130,591	1,455,079
75%	1,309,835	199,092	1,483,741	1,364,473	135,889	1,484,959
80%	1,336,248	207,921	1,512,371	1,397,719	141,935	1,519,071
85%	1,367,322	218,579	1,546,293	1,436,754	149,250	1,560,225
90%	1,407,246	232,484	1,587,310	1,488,415	158,699	1,612,862
95%	1,465,450	253,748	1,647,150	1,563,780	173,397	1,690,663
99%	1,574,505	294,779	1,762,279	1,709,471	202,785	1,840,100

Table E.74-Risk profile statistics for waterway bridge ADT case 4, 5, 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	784,705	531,160	1,404,465	786,562	390,063	1,319,945
Maximum	1,886,683	4,114,194	5,397,530	2,215,473	2,868,944	4,402,624
Mean	1,203,246	1,694,502	2,897,748	1,250,895	1,163,436	2,414,331
Std Dev	156,504	471,264	499,374	176,045	316,507	379,687
Percentile						
1%	873,490	806,888	1,916,097	918,986	578,605	1,673,552
5%	944,947	990,171	2,138,400	989,239	699,821	1,844,358
10%	998,467	1,111,839	2,279,085	1,034,196	779,185	1,950,336
15%	1,036,577	1,203,738	2,380,220	1,067,266	837,935	2,026,018
20%	1,066,694	1,282,370	2,465,145	1,095,370	888,295	2,086,786
25%	1,093,671	1,353,263	2,539,292	1,120,827	933,381	2,141,249
30%	1,117,573	1,417,176	2,607,928	1,145,079	976,236	2,193,665
35%	1,139,495	1,480,126	2,673,755	1,168,546	1,016,274	2,242,670
40%	1,160,819	1,540,020	2,737,070	1,191,641	1,054,397	2,290,398
45%	1,180,699	1,598,028	2,801,269	1,213,326	1,092,866	2,336,830
50%	1,200,602	1,656,693	2,864,064	1,235,845	1,132,640	2,384,659
55%	1,221,005	1,716,256	2,927,224	1,259,393	1,172,760	2,431,600
60%	1,241,661	1,777,412	2,992,245	1,283,146	1,214,929	2,482,383
65%	1,263,269	1,842,052	3,061,717	1,308,004	1,259,139	2,534,923
70%	1,285,361	1,911,902	3,134,515	1,335,033	1,305,909	2,590,858
75%	1,309,835	1,990,920	3,215,510	1,364,473	1,358,891	2,655,160
80%	1,336,248	2,079,215	3,308,260	1,397,719	1,419,350	2,725,250
85%	1,367,322	2,185,789	3,418,098	1,436,754	1,492,501	2,808,542
90%	1,407,246	2,324,844	3,560,087	1,488,415	1,586,986	2,915,979
95%	1,465,450	2,537,476	3,781,195	1,563,780	1,733,969	3,088,225
99%	1,574,505	2,947,792	4,205,849	1,709,471	2,027,848	3,425,844

Table E.75-Risk profile statistics for waterway bridge ADT case 7, 8, 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	784,705	2,655,799	3,565,685	786,562	1,950,313	3,105,571
Maximum	1,886,683	20,570,971	21,854,307	2,215,473	14,344,720	15,829,508
Mean	1,203,246	8,472,510	9,675,756	1,250,895	5,817,179	7,068,074
Std Dev	156,504	2,356,318	2,364,463	176,045	1,582,536	1,612,570
Percentile						
1%	873,490	4,034,439	5,207,906	918,986	2,893,025	4,069,846
5%	944,947	4,950,856	6,132,518	989,239	3,499,104	4,703,621
10%	998,467	5,559,193	6,744,633	1,034,196	3,895,925	5,110,781
15%	1,036,577	6,018,690	7,220,006	1,067,266	4,189,675	5,413,799
20%	1,066,694	6,411,848	7,609,122	1,095,370	4,441,475	5,666,699
25%	1,093,671	6,766,314	7,962,096	1,120,827	4,666,907	5,898,997
30%	1,117,573	7,085,878	8,281,463	1,145,079	4,881,179	6,112,208
35%	1,139,495	7,400,629	8,603,959	1,168,546	5,081,368	6,319,369
40%	1,160,819	7,700,099	8,902,410	1,191,641	5,271,986	6,517,858
45%	1,180,699	7,990,138	9,192,793	1,213,326	5,464,328	6,708,379
50%	1,200,602	8,283,463	9,487,001	1,235,845	5,663,198	6,908,288
55%	1,221,005	8,581,282	9,788,007	1,259,393	5,863,799	7,118,068
60%	1,241,661	8,887,059	10,098,029	1,283,146	6,074,643	7,328,280
65%	1,263,269	9,210,260	10,418,757	1,308,004	6,295,693	7,553,893
70%	1,285,361	9,559,512	10,768,974	1,335,033	6,529,546	7,799,913
75%	1,309,835	9,954,600	11,164,774	1,364,473	6,794,455	8,067,118
80%	1,336,248	10,396,073	11,610,581	1,397,719	7,096,749	8,370,980
85%	1,367,322	10,928,945	12,136,716	1,436,754	7,462,507	8,743,362
90%	1,407,246	11,624,219	12,844,990	1,488,415	7,934,928	9,224,814
95%	1,465,450	12,687,378	13,901,461	1,563,780	8,669,846	9,968,150
99%	1,574,505	14,738,961	15,955,857	1,709,471	10,139,242	11,465,950

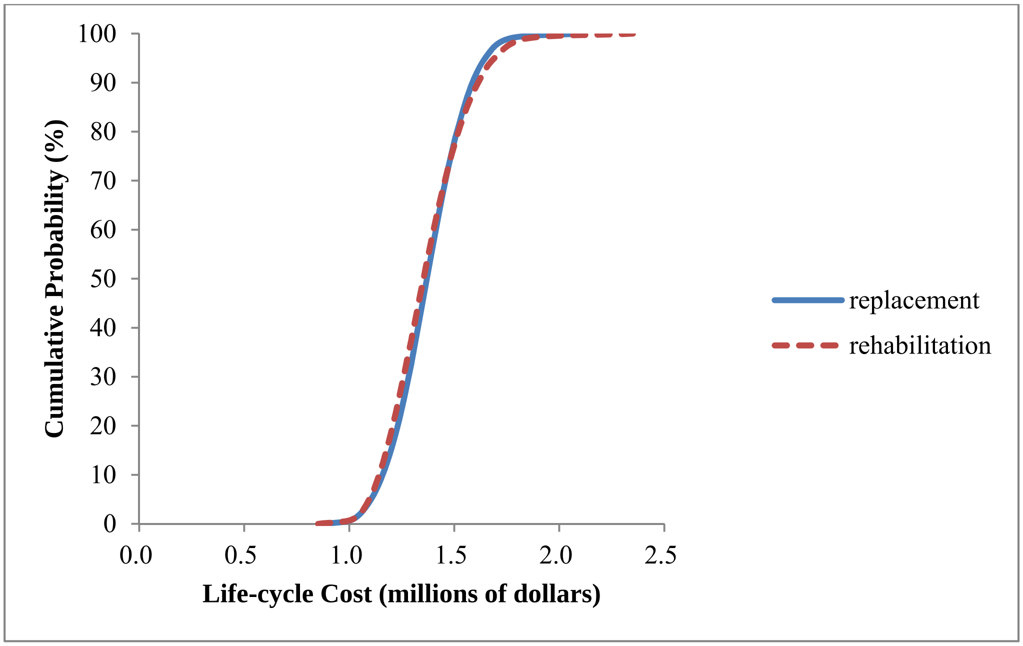


Figure E.145-Ascending cumulative probability distributions for waterway bridge ADT case 1, 2, 3 (Table 3.6)

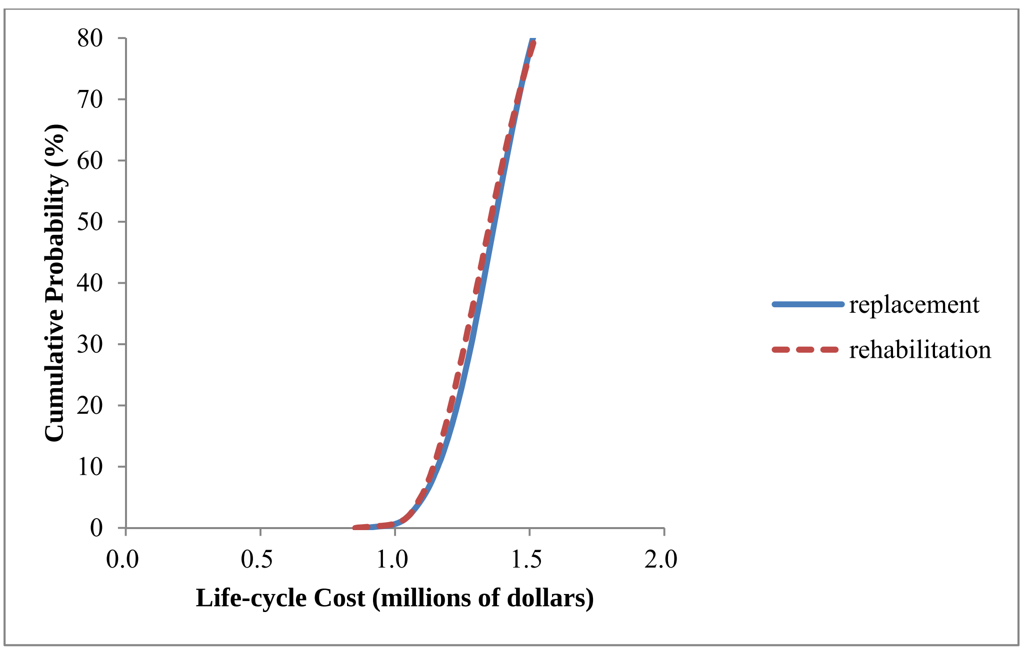


Figure E.146-Ascending cumulative probability distributions for waterway bridge ADT Case 1, 2, 3 (Table 3.6)

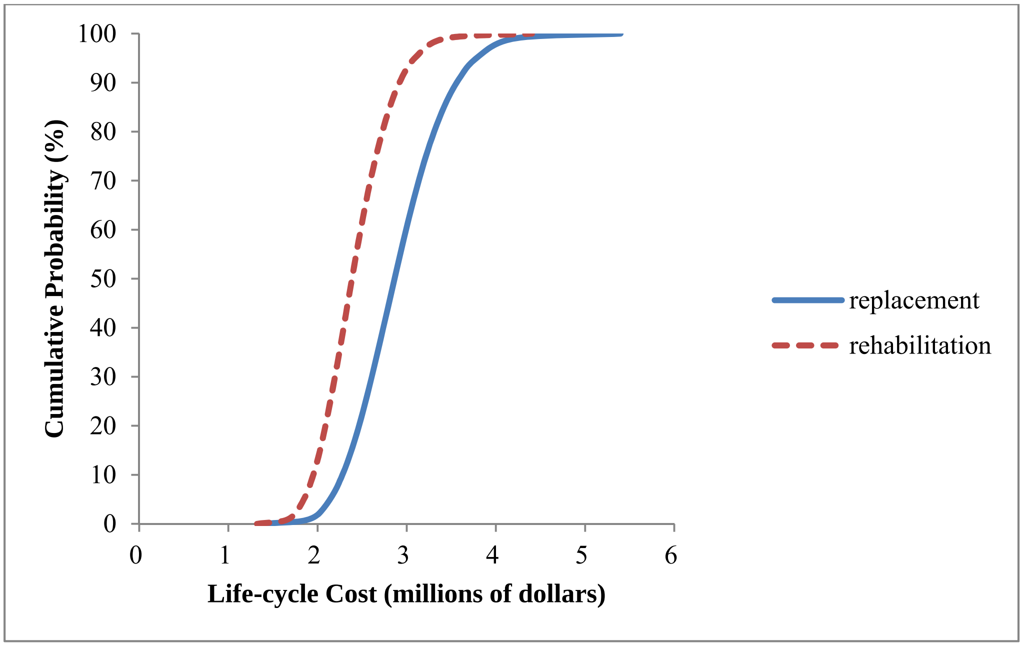


Figure E.147-Ascending cumulative probability distributions for waterway bridge ADT case 4, 5, 6 (Table 3.6)

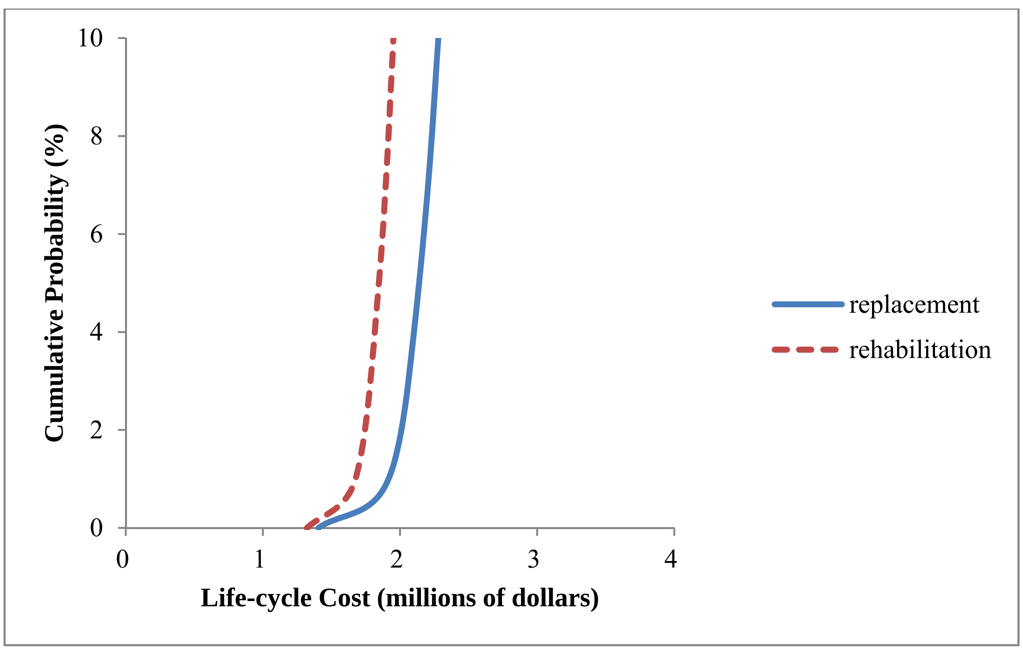


Figure E.148-Ascending cumulative probability distributions for waterway bridge ADT case 4, 5, 6 (Table 3.6)

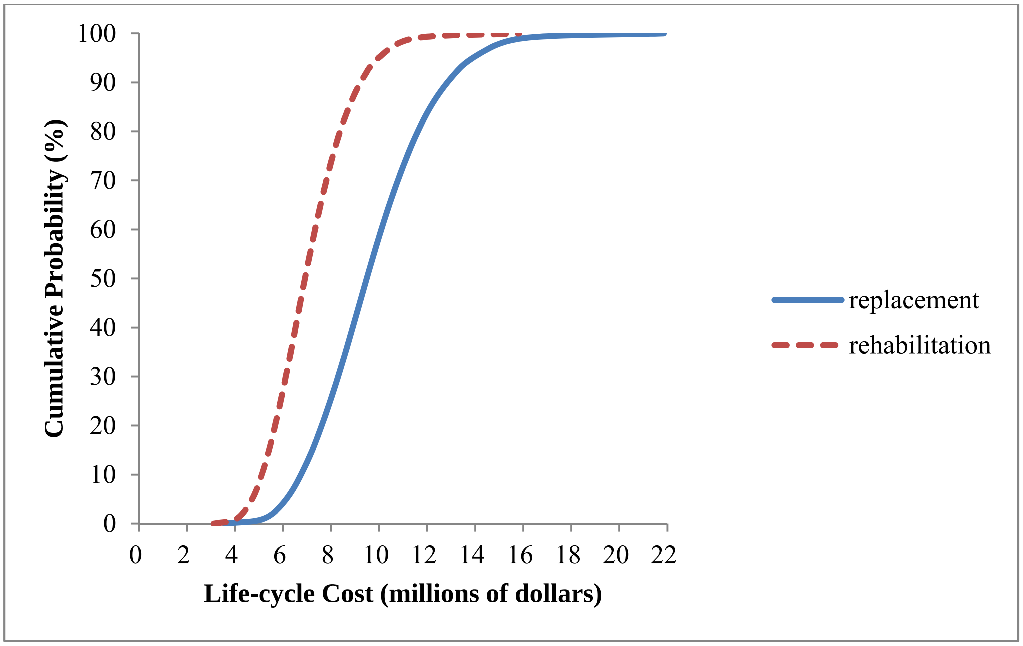


Figure E.149-Ascending cumulative probability distributions for waterway bridge ADT case 7, 8, 9 (Table 3.6)

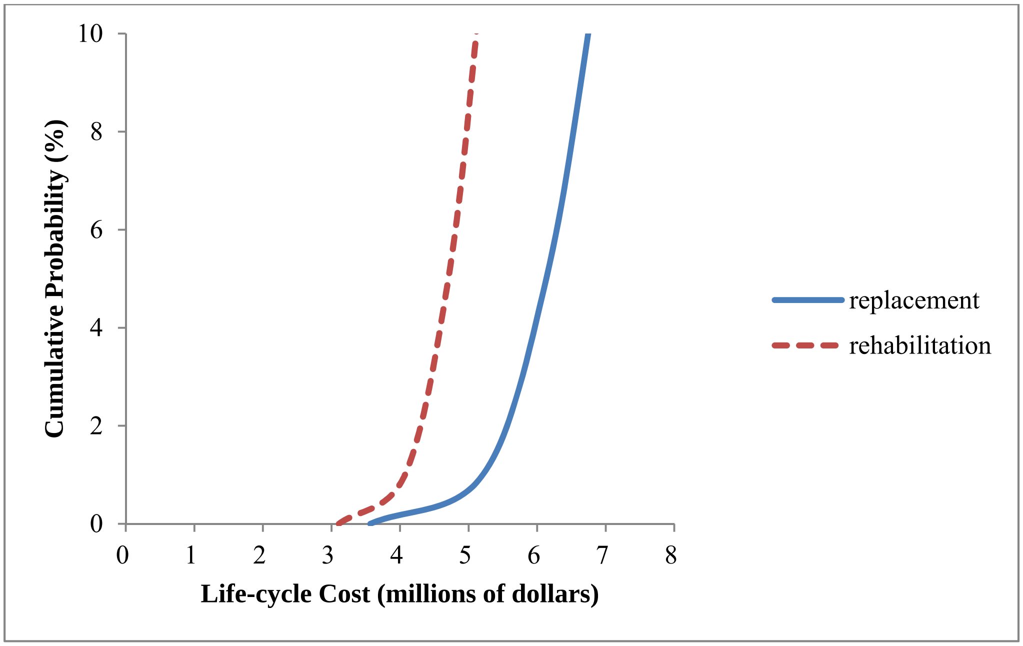


Figure E.150-Ascending cumulative probability distributions for waterway bridge ADT case 7, 8, 9 (Table 3.6)

Bridge over Waterway with Modified Bridge Construction Time and Cost

Table E.76-Risk profile statistics for waterway bridge with modification 1a ADT case 1, 2, 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	784,705	50,462	878,697	786,562	37,023	844,252
Maximum	1,886,683	318,976	2,045,934	2,215,473	223,416	2,322,575
Mean	1,203,246	135,950	1,339,196	1,250,895	94,874	1,345,769
Std Dev	156,504	34,486	161,082	176,045	23,339	180,518
Percentile						
1%	873,490	72,026	995,642	918,986	52,318	1,003,432
5%	944,947	85,399	1,075,061	989,239	61,317	1,076,928
10%	998,467	94,017	1,129,640	1,034,196	66,938	1,123,153
15%	1,036,577	100,444	1,167,716	1,067,266	71,083	1,157,207
20%	1,066,694	105,939	1,199,980	1,095,370	74,662	1,186,684
25%	1,093,671	110,844	1,226,823	1,120,827	77,922	1,212,716
30%	1,117,573	115,419	1,251,272	1,145,079	80,938	1,237,875
35%	1,139,495	119,871	1,273,624	1,168,546	83,790	1,261,860
40%	1,160,819	124,157	1,294,753	1,191,641	86,603	1,285,743
45%	1,180,699	128,404	1,315,628	1,213,326	89,350	1,308,208
50%	1,200,602	132,696	1,336,446	1,235,845	92,258	1,331,598
55%	1,221,005	136,998	1,357,312	1,259,393	95,266	1,354,812
60%	1,241,661	141,479	1,378,422	1,283,146	98,393	1,379,027
65%	1,263,269	146,278	1,400,320	1,308,004	101,615	1,404,645
70%	1,285,361	151,486	1,423,473	1,335,033	105,134	1,432,535
75%	1,309,835	157,321	1,448,159	1,364,473	109,127	1,462,076
80%	1,336,248	163,969	1,476,105	1,397,719	113,660	1,496,003
85%	1,367,322	171,806	1,508,923	1,436,754	119,076	1,536,803
90%	1,407,246	182,362	1,549,870	1,488,415	126,197	1,588,580
95%	1,465,450	198,289	1,608,450	1,563,780	137,366	1,666,087
99%	1,574,505	229,168	1,720,538	1,709,471	159,461	1,813,068

Table E.77-Risk profile statistics for waterway bridge with modification 1a ADT case 4, 5, 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	784,705	504,623	1,367,381	786,562	370,228	1,293,643
Maximum	1,886,683	3,189,762	4,473,098	2,215,473	2,234,163	3,773,227
Mean	1,203,246	1,359,503	2,562,749	1,250,895	948,737	2,199,632
Std Dev	156,504	344,861	382,190	176,045	233,395	309,790
Percentile						
1%	873,490	720,262	1,800,877	918,986	523,176	1,591,370
5%	944,947	853,994	1,983,348	989,239	613,168	1,734,404
10%	998,467	940,172	2,092,779	1,034,196	669,378	1,820,516
15%	1,036,577	1,004,441	2,169,886	1,067,266	710,829	1,881,749
20%	1,066,694	1,059,391	2,233,208	1,095,370	746,623	1,932,811
25%	1,093,671	1,108,442	2,289,556	1,120,827	779,219	1,977,809
30%	1,117,573	1,154,192	2,342,139	1,145,079	809,378	2,019,624
35%	1,139,495	1,198,711	2,391,608	1,168,546	837,903	2,059,645
40%	1,160,819	1,241,574	2,439,186	1,191,641	866,029	2,098,634
45%	1,180,699	1,284,045	2,486,845	1,213,326	893,501	2,136,824
50%	1,200,602	1,326,962	2,535,272	1,235,845	922,582	2,175,215
55%	1,221,005	1,369,979	2,584,441	1,259,393	952,662	2,215,582
60%	1,241,661	1,414,791	2,634,951	1,283,146	983,933	2,255,127
65%	1,263,269	1,462,780	2,687,483	1,308,004	1,016,153	2,298,383
70%	1,285,361	1,514,857	2,742,879	1,335,033	1,051,340	2,345,443
75%	1,309,835	1,573,207	2,804,908	1,364,473	1,091,270	2,396,356
80%	1,336,248	1,639,689	2,876,218	1,397,719	1,136,595	2,453,672
85%	1,367,322	1,718,057	2,960,598	1,436,754	1,190,760	2,521,701
90%	1,407,246	1,823,621	3,069,533	1,488,415	1,261,972	2,609,220
95%	1,465,450	1,982,885	3,236,658	1,563,780	1,373,657	2,748,404
99%	1,574,505	2,291,682	3,569,357	1,709,471	1,594,609	3,017,879

Table E.78-Risk profile statistics for waterway bridge with modification 1a ADT case 7, 8, 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	784,705	2,523,113	3,400,785	786,562	1,851,139	2,954,448
Maximum	1,886,683	15,948,811	17,232,147	2,215,473	11,170,816	12,678,953
Mean	1,203,246	6,797,514	8,000,760	1,250,895	4,743,686	5,994,581
Std Dev	156,504	1,724,305	1,735,211	176,045	1,166,973	1,202,224
Percentile						
1%	873,490	3,601,310	4,757,595	918,986	2,615,882	3,775,001
5%	944,947	4,269,971	5,447,293	989,239	3,065,840	4,251,908
10%	998,467	4,700,861	5,892,111	1,034,196	3,346,888	4,553,437
15%	1,036,577	5,022,204	6,217,744	1,067,266	3,554,144	4,769,096
20%	1,066,694	5,296,956	6,492,414	1,095,370	3,733,115	4,953,753
25%	1,093,671	5,542,211	6,736,375	1,120,827	3,896,095	5,123,665
30%	1,117,573	5,770,960	6,968,443	1,145,079	4,046,891	5,279,485
35%	1,139,495	5,993,554	7,192,082	1,168,546	4,189,513	5,427,788
40%	1,160,819	6,207,871	7,410,809	1,191,641	4,330,147	5,570,745
45%	1,180,699	6,420,223	7,622,902	1,213,326	4,467,506	5,716,492
50%	1,200,602	6,634,811	7,838,297	1,235,845	4,612,910	5,866,043
55%	1,221,005	6,849,893	8,056,223	1,259,393	4,763,310	6,018,669
60%	1,241,661	7,073,957	8,285,443	1,283,146	4,919,666	6,176,606
65%	1,263,269	7,313,899	8,520,860	1,308,004	5,080,763	6,346,734
70%	1,285,361	7,574,285	8,786,388	1,335,033	5,256,700	6,532,484
75%	1,309,835	7,866,035	9,077,445	1,364,473	5,456,352	6,729,995
80%	1,336,248	8,198,443	9,414,293	1,397,719	5,682,976	6,960,087
85%	1,367,322	8,590,287	9,807,257	1,436,754	5,953,798	7,241,111
90%	1,407,246	9,118,105	10,340,163	1,488,415	6,309,862	7,605,528
95%	1,465,450	9,914,427	11,131,725	1,563,780	6,868,283	8,174,185
99%	1,574,505	11,458,411	12,688,674	1,709,471	7,973,047	9,313,334

Table E.79-Risk profile statistics for waterway bridge with modification 1b ADT case 1, 2, 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	814,445	50,462	908,436	803,479	37,023	856,142
Maximum	1,931,128	318,976	2,090,379	2,242,801	223,416	2,349,903
Mean	1,247,349	135,950	1,383,299	1,272,992	94,874	1,367,866
Std Dev	157,159	34,486	161,720	177,439	23,339	181,981
Percentile						
1%	910,355	72,026	1,033,715	937,342	52,318	1,021,347
5%	987,360	85,399	1,117,199	1,008,814	61,317	1,096,408
10%	1,042,592	94,017	1,173,545	1,054,312	66,938	1,143,348
15%	1,080,966	100,444	1,211,972	1,087,896	71,083	1,177,845
20%	1,111,106	105,939	1,244,323	1,116,296	74,662	1,207,596
25%	1,138,098	110,844	1,271,247	1,141,945	77,922	1,233,993
30%	1,162,017	115,419	1,295,700	1,166,642	80,938	1,259,188
35%	1,183,939	119,871	1,318,069	1,190,207	83,790	1,283,446
40%	1,205,263	124,157	1,339,191	1,213,547	86,603	1,307,543
45%	1,225,144	128,404	1,360,066	1,235,535	89,350	1,330,272
50%	1,245,047	132,696	1,380,890	1,258,215	92,258	1,353,794
55%	1,265,450	136,998	1,401,756	1,281,871	95,266	1,377,149
60%	1,286,106	141,479	1,422,866	1,305,830	98,393	1,401,702
65%	1,307,713	146,278	1,444,765	1,330,715	101,615	1,427,359
70%	1,329,806	151,486	1,467,918	1,357,969	105,134	1,455,444
75%	1,354,279	157,321	1,492,603	1,387,360	109,127	1,485,031
80%	1,380,693	163,969	1,520,550	1,420,865	113,660	1,519,330
85%	1,411,766	171,806	1,553,368	1,460,507	119,076	1,560,504
90%	1,451,690	182,362	1,594,315	1,512,227	126,197	1,612,240
95%	1,509,895	198,289	1,652,895	1,587,923	137,366	1,690,023
99%	1,618,949	229,168	1,764,982	1,734,741	159,461	1,838,539

Table E.80-Risk profile statistics for waterway bridge with modification 1b ADT case 4, 5, 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	814,445	504,623	1,408,298	803,479	370,228	1,312,095
Maximum	1,931,128	3,189,762	4,517,543	2,242,801	2,234,163	3,799,729
Mean	1,247,349	1,359,503	2,606,852	1,272,992	948,737	2,221,730
Std Dev	157,159	344,861	382,464	177,439	233,395	311,185
Percentile						
1%	910,355	720,262	1,842,715	937,342	523,176	1,610,334
5%	987,360	853,994	2,026,660	1,008,814	613,168	1,754,317
10%	1,042,592	940,172	2,136,318	1,054,312	669,378	1,840,943
15%	1,080,966	1,004,441	2,213,706	1,087,896	710,829	1,902,220
20%	1,111,106	1,059,391	2,277,286	1,116,296	746,623	1,953,307
25%	1,138,098	1,108,442	2,333,615	1,141,945	779,219	1,999,003
30%	1,162,017	1,154,192	2,386,331	1,166,642	809,378	2,040,882
35%	1,183,939	1,198,711	2,435,742	1,190,207	837,903	2,081,244
40%	1,205,263	1,241,574	2,483,476	1,213,547	866,029	2,120,216
45%	1,225,144	1,284,045	2,530,965	1,235,535	893,501	2,158,819
50%	1,245,047	1,326,962	2,579,477	1,258,215	922,582	2,197,247
55%	1,265,450	1,369,979	2,628,681	1,281,871	952,662	2,237,712
60%	1,286,106	1,414,791	2,679,162	1,305,830	983,933	2,277,386
65%	1,307,713	1,462,780	2,731,749	1,330,715	1,016,153	2,321,023
70%	1,329,806	1,514,857	2,787,158	1,357,969	1,051,340	2,368,419
75%	1,354,279	1,573,207	2,849,166	1,387,360	1,091,270	2,419,301
80%	1,380,693	1,639,689	2,920,544	1,420,865	1,136,595	2,477,126
85%	1,411,766	1,718,057	3,004,902	1,460,507	1,190,760	2,545,269
90%	1,451,690	1,823,621	3,113,742	1,512,227	1,261,972	2,632,848
95%	1,509,895	1,982,885	3,281,090	1,587,923	1,373,657	2,772,554
99%	1,618,949	2,291,682	3,613,802	1,734,741	1,594,609	3,043,057

Table E.81-Risk profile statistics for waterway bridge with modification 1b ADT case 7, 8, 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	814,445	2,523,113	3,445,229	803,479	1,851,139	2,971,340
Maximum	1,931,128	15,948,811	17,276,592	2,242,801	11,170,816	12,705,455
Mean	1,247,349	6,797,514	8,044,863	1,272,992	4,743,686	6,016,678
Std Dev	157,159	1,724,305	1,735,276	177,439	1,166,973	1,203,206
Percentile						
1%	910,355	3,601,310	4,801,679	937,342	2,615,882	3,794,834
5%	987,360	4,269,971	5,491,229	1,008,814	3,065,840	4,273,246
10%	1,042,592	4,700,861	5,936,345	1,054,312	3,346,888	4,574,195
15%	1,080,966	5,022,204	6,261,742	1,087,896	3,554,144	4,790,036
20%	1,111,106	5,296,956	6,536,457	1,116,296	3,733,115	4,974,944
25%	1,138,098	5,542,211	6,780,449	1,141,945	3,896,095	5,145,445
30%	1,162,017	5,770,960	7,012,545	1,166,642	4,046,891	5,300,820
35%	1,183,939	5,993,554	7,236,223	1,190,207	4,189,513	5,449,547
40%	1,205,263	6,207,871	7,455,047	1,213,547	4,330,147	5,592,891
45%	1,225,144	6,420,223	7,667,158	1,235,535	4,467,506	5,738,158
50%	1,245,047	6,634,811	7,882,593	1,258,215	4,612,910	5,887,744
55%	1,265,450	6,849,893	8,100,204	1,281,871	4,763,310	6,040,812
60%	1,286,106	7,073,957	8,329,510	1,305,830	4,919,666	6,199,064
65%	1,307,713	7,313,899	8,565,004	1,330,715	5,080,763	6,369,028
70%	1,329,806	7,574,285	8,830,672	1,357,969	5,256,700	6,554,640
75%	1,354,279	7,866,035	9,121,479	1,387,360	5,456,352	6,752,595
80%	1,380,693	8,198,443	9,458,364	1,420,865	5,682,976	6,982,787
85%	1,411,766	8,590,287	9,851,033	1,460,507	5,953,798	7,265,447
90%	1,451,690	9,118,105	10,384,198	1,512,227	6,309,862	7,629,221
95%	1,509,895	9,914,427	11,176,042	1,587,923	6,868,283	8,198,402
99%	1,618,949	11,458,411	12,733,119	1,734,741	7,973,047	9,341,598

Table E.82-Risk profile statistics for waterway bridge with modification 1c ADT case 1, 2, 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	844,185	50,462	938,176	815,708	37,023	868,033
Maximum	1,975,490	318,976	2,134,741	2,270,078	223,416	2,377,180
Mean	1,291,442	135,950	1,427,392	1,295,084	94,874	1,389,958
Std Dev	157,697	34,486	162,244	178,841	23,339	183,451
Percentile						
1%	947,834	72,026	1,072,240	956,108	52,318	1,039,688
5%	1,030,505	85,399	1,160,063	1,028,309	61,317	1,115,854
10%	1,086,610	94,017	1,217,487	1,074,461	66,938	1,163,499
15%	1,125,246	100,444	1,256,192	1,108,358	71,083	1,198,351
20%	1,155,457	105,939	1,288,657	1,137,138	74,662	1,228,490
25%	1,182,460	110,844	1,315,609	1,163,136	77,922	1,255,202
30%	1,206,379	115,419	1,340,053	1,188,173	80,938	1,280,621
35%	1,228,301	119,871	1,362,431	1,211,917	83,790	1,305,009
40%	1,249,625	124,157	1,383,542	1,235,386	86,603	1,329,146
45%	1,269,506	128,404	1,404,428	1,257,768	89,350	1,352,301
50%	1,289,409	132,696	1,425,252	1,280,426	92,258	1,375,904
55%	1,309,812	136,998	1,446,118	1,304,081	95,266	1,399,247
60%	1,330,468	141,479	1,467,228	1,328,370	98,393	1,424,195
65%	1,352,075	146,278	1,489,127	1,353,555	101,615	1,450,083
70%	1,374,167	151,486	1,512,280	1,380,785	105,134	1,478,135
75%	1,398,641	157,321	1,536,965	1,410,323	109,127	1,508,107
80%	1,425,054	163,969	1,564,912	1,443,877	113,660	1,542,537
85%	1,456,128	171,806	1,597,730	1,484,062	119,076	1,584,119
90%	1,496,052	182,362	1,638,677	1,536,174	126,197	1,636,298
95%	1,554,257	198,289	1,697,256	1,612,251	137,366	1,714,758
99%	1,663,311	229,168	1,809,344	1,760,364	159,461	1,864,628

Table E.83-Risk profile statistics for waterway bridge with modification 1c ADT case 4, 5, 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	844,185	504,623	1,452,660	815,708	370,228	1,325,058
Maximum	1,975,490	3,189,762	4,561,905	2,270,078	2,234,163	3,826,182
Mean	1,291,442	1,359,503	2,650,945	1,295,084	948,737	2,243,822
Std Dev	157,697	344,861	382,693	178,841	233,395	312,586
Percentile						
1%	947,834	720,262	1,885,296	956,108	523,176	1,629,933
5%	1,030,505	853,994	2,069,895	1,028,309	613,168	1,774,224
10%	1,086,610	940,172	2,179,969	1,074,461	669,378	1,860,886
15%	1,125,246	1,004,441	2,257,723	1,108,358	710,829	1,922,803
20%	1,155,457	1,059,391	2,321,350	1,137,138	746,623	1,974,241
25%	1,182,460	1,108,442	2,377,727	1,163,136	779,219	2,020,011
30%	1,206,379	1,154,192	2,430,359	1,188,173	809,378	2,062,161
35%	1,228,301	1,198,711	2,479,922	1,211,917	837,903	2,102,555
40%	1,249,625	1,241,574	2,527,637	1,235,386	866,029	2,141,639
45%	1,269,506	1,284,045	2,575,203	1,257,768	893,501	2,180,679
50%	1,289,409	1,326,962	2,623,694	1,280,426	922,582	2,219,270
55%	1,309,812	1,369,979	2,672,880	1,304,081	952,662	2,259,868
60%	1,330,468	1,414,791	2,723,477	1,328,370	983,933	2,299,902
65%	1,352,075	1,462,780	2,776,029	1,353,555	1,016,153	2,343,527
70%	1,374,167	1,514,857	2,831,443	1,380,785	1,051,340	2,391,253
75%	1,398,641	1,573,207	2,893,452	1,410,323	1,091,270	2,442,514
80%	1,425,054	1,639,689	2,964,732	1,443,877	1,136,595	2,500,408
85%	1,456,128	1,718,057	3,049,147	1,484,062	1,190,760	2,568,741
90%	1,496,052	1,823,621	3,158,091	1,536,174	1,261,972	2,656,862
95%	1,554,257	1,982,885	3,325,260	1,612,251	1,373,657	2,797,479
99%	1,663,311	2,291,682	3,658,164	1,760,364	1,594,609	3,068,157

Table E.84-Risk profile statistics for waterway bridge with modification 1c ADT case 7, 8, 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	844,185	2,523,113	3,489,591	815,708	1,851,139	2,988,201
Maximum	1,975,490	15,948,811	17,320,953	2,270,078	11,170,816	12,731,907
Mean	1,291,442	6,797,514	8,088,956	1,295,084	4,743,686	6,038,771
Std Dev	157,697	1,724,305	1,735,333	178,841	1,166,973	1,204,191
Percentile						
1%	947,834	3,601,310	4,845,478	956,108	2,615,882	3,815,402
5%	1,030,505	4,269,971	5,534,964	1,028,309	3,065,840	4,293,929
10%	1,086,610	4,700,861	5,980,510	1,074,461	3,346,888	4,594,950
15%	1,125,246	5,022,204	6,306,051	1,108,358	3,554,144	4,811,630
20%	1,155,457	5,296,956	6,580,191	1,137,138	3,733,115	4,996,409
25%	1,182,460	5,542,211	6,824,662	1,163,136	3,896,095	5,166,636
30%	1,206,379	5,770,960	7,056,622	1,188,173	4,046,891	5,322,168
35%	1,228,301	5,993,554	7,280,243	1,211,917	4,189,513	5,471,363
40%	1,249,625	6,207,871	7,499,256	1,235,386	4,330,147	5,614,406
45%	1,269,506	6,420,223	7,711,190	1,257,768	4,467,506	5,760,322
50%	1,289,409	6,634,811	7,926,715	1,280,426	4,612,910	5,909,693
55%	1,309,812	6,849,893	8,144,472	1,304,081	4,763,310	6,063,023
60%	1,330,468	7,073,957	8,373,729	1,328,370	4,919,666	6,220,997
65%	1,352,075	7,313,899	8,609,177	1,353,555	5,080,763	6,391,481
70%	1,374,167	7,574,285	8,874,549	1,380,785	5,256,700	6,577,295
75%	1,398,641	7,866,035	9,165,665	1,410,323	5,456,352	6,775,681
80%	1,425,054	8,198,443	9,502,627	1,443,877	5,682,976	7,005,468
85%	1,456,128	8,590,287	9,895,395	1,484,062	5,953,798	7,289,360
90%	1,496,052	9,118,105	10,428,502	1,536,174	6,309,862	7,652,709
95%	1,554,257	9,914,427	11,219,729	1,612,251	6,868,283	8,221,137
99%	1,663,311	11,458,411	12,773,673	1,760,364	7,973,047	9,366,168

Table E.85-Risk profile statistics for waterway bridge with modification 2a ADT case 1, 2, 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	784,705	45,949	859,920	786,562	34,432	836,343
Maximum	1,886,683	216,853	1,988,698	2,215,473	153,217	2,293,340
Mean	1,203,246	100,290	1,303,536	1,250,895	72,019	1,322,914
Std Dev	156,504	21,120	158,712	176,045	14,550	178,854
Percentile						
1%	873,490	61,426	968,061	918,986	45,570	984,594
5%	944,947	69,841	1,042,670	989,239	51,326	1,056,620
10%	998,467	74,952	1,096,395	1,034,196	54,800	1,102,368
15%	1,036,577	78,775	1,134,441	1,067,266	57,305	1,136,131
20%	1,066,694	82,011	1,166,032	1,095,370	59,484	1,165,066
25%	1,093,671	84,916	1,192,744	1,120,827	61,483	1,190,834
30%	1,117,573	87,607	1,216,565	1,145,079	63,302	1,215,615
35%	1,139,495	90,260	1,238,994	1,168,546	65,052	1,239,876
40%	1,160,819	92,868	1,259,737	1,191,641	66,752	1,263,093
45%	1,180,699	95,461	1,280,255	1,213,326	68,500	1,285,692
50%	1,200,602	98,045	1,300,966	1,235,845	70,264	1,308,333
55%	1,221,005	100,641	1,321,292	1,259,393	72,130	1,331,773
60%	1,241,661	103,397	1,342,273	1,283,146	74,061	1,355,893
65%	1,263,269	106,406	1,363,672	1,308,004	76,105	1,381,257
70%	1,285,361	109,571	1,387,266	1,335,033	78,334	1,408,731
75%	1,309,835	113,240	1,411,186	1,364,473	80,831	1,438,135
80%	1,336,248	117,309	1,438,297	1,397,719	83,672	1,471,716
85%	1,367,322	122,286	1,470,588	1,436,754	87,100	1,511,936
90%	1,407,246	128,886	1,511,022	1,488,415	91,559	1,563,631
95%	1,465,450	138,838	1,569,277	1,563,780	98,669	1,640,693
99%	1,574,505	158,060	1,679,685	1,709,471	112,620	1,787,086

Table E.86-Risk profile statistics for waterway bridge with modification 2a ADT case 4, 5, 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	784,705	459,493	1,329,434	786,562	344,323	1,222,185
Maximum	1,886,683	2,168,532	3,471,023	2,215,473	1,532,168	3,155,651
Mean	1,203,246	1,002,901	2,206,147	1,250,895	720,187	1,971,082
Std Dev	156,504	211,204	267,580	176,045	145,501	244,984
Percentile						
1%	873,490	614,263	1,652,597	918,986	455,701	1,484,464
5%	944,947	698,406	1,792,727	989,239	513,261	1,599,599
10%	998,467	749,517	1,873,505	1,034,196	547,997	1,668,806
15%	1,036,577	787,753	1,930,772	1,067,266	573,054	1,718,006
20%	1,066,694	820,113	1,977,010	1,095,370	594,840	1,758,253
25%	1,093,671	849,160	2,017,401	1,120,827	614,832	1,795,811
30%	1,117,573	876,067	2,055,018	1,145,079	633,024	1,829,819
35%	1,139,495	902,595	2,089,796	1,168,546	650,522	1,861,001
40%	1,160,819	928,677	2,123,745	1,191,641	667,523	1,892,244
45%	1,180,699	954,605	2,157,465	1,213,326	684,998	1,922,740
50%	1,200,602	980,450	2,191,485	1,235,845	702,639	1,953,652
55%	1,221,005	1,006,408	2,224,884	1,259,393	721,300	1,985,052
60%	1,241,661	1,033,966	2,259,707	1,283,146	740,608	2,017,136
65%	1,263,269	1,064,055	2,296,040	1,308,004	761,048	2,051,227
70%	1,285,361	1,095,710	2,334,639	1,335,033	783,338	2,088,616
75%	1,309,835	1,132,398	2,377,762	1,364,473	808,306	2,128,712
80%	1,336,248	1,173,087	2,426,109	1,397,719	836,723	2,174,004
85%	1,367,322	1,222,864	2,484,964	1,436,754	870,998	2,227,706
90%	1,407,246	1,288,855	2,559,643	1,488,415	915,589	2,296,077
95%	1,465,450	1,388,383	2,671,593	1,563,780	986,693	2,401,356
99%	1,574,505	1,580,604	2,893,080	1,709,471	1,126,196	2,604,266

Table E.87-Risk profile statistics for waterway bridge with modification 2a ADT case 7, 8, 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	784,705	2,297,467	3,232,298	786,562	1,721,617	2,797,876
Maximum	1,886,683	10,842,662	12,125,998	2,215,473	7,660,839	9,189,605
Mean	1,203,246	5,014,507	6,217,753	1,250,895	3,600,933	4,851,828
Std Dev	156,504	1,056,021	1,073,389	176,045	727,503	774,292
Percentile						
1%	873,490	3,071,315	4,216,187	918,986	2,278,503	3,410,110
5%	944,947	3,492,029	4,657,607	989,239	2,566,305	3,732,198
10%	998,467	3,747,585	4,927,894	1,034,196	2,739,985	3,926,433
15%	1,036,577	3,938,764	5,127,752	1,067,266	2,865,271	4,066,385
20%	1,066,694	4,100,565	5,288,688	1,095,370	2,974,201	4,187,635
25%	1,093,671	4,245,799	5,437,469	1,120,827	3,074,159	4,293,871
30%	1,117,573	4,380,337	5,576,315	1,145,079	3,165,121	4,392,024
35%	1,139,495	4,512,976	5,710,067	1,168,546	3,252,612	4,485,442
40%	1,160,819	4,643,384	5,844,339	1,191,641	3,337,615	4,579,187
45%	1,180,699	4,773,025	5,976,721	1,213,326	3,424,988	4,674,102
50%	1,200,602	4,902,250	6,108,769	1,235,845	3,513,196	4,768,216
55%	1,221,005	5,032,041	6,243,040	1,259,393	3,606,499	4,865,763
60%	1,241,661	5,169,828	6,381,822	1,283,146	3,703,042	4,969,404
65%	1,263,269	5,320,276	6,531,544	1,308,004	3,805,242	5,078,406
70%	1,285,361	5,478,550	6,697,417	1,335,033	3,916,688	5,197,719
75%	1,309,835	5,661,988	6,878,859	1,364,473	4,041,531	5,326,433
80%	1,336,248	5,865,433	7,086,533	1,397,719	4,183,616	5,474,104
85%	1,367,322	6,114,321	7,337,039	1,436,754	4,354,989	5,652,049
90%	1,407,246	6,444,277	7,665,598	1,488,415	4,577,947	5,886,920
95%	1,465,450	6,941,916	8,167,642	1,563,780	4,933,467	6,248,513
99%	1,574,505	7,903,018	9,150,922	1,709,471	5,630,981	6,986,954

Table E.88-Risk profile statistics for waterway bridge with modification 2b ADT case 1, 2, 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	844,185	45,949	919,400	815,708	34,432	860,124
Maximum	1,975,490	216,853	2,077,505	2,270,078	153,217	2,347,945
Mean	1,291,442	100,290	1,391,732	1,295,084	72,019	1,367,103
Std Dev	157,697	21,120	159,889	178,841	14,550	181,760
Percentile						
1%	947,834	61,426	1,042,838	956,108	45,570	1,020,654
5%	1,030,505	69,841	1,127,323	1,028,309	51,326	1,095,908
10%	1,086,610	74,952	1,184,418	1,074,461	54,800	1,142,439
15%	1,125,246	78,775	1,223,027	1,108,358	57,305	1,177,174
20%	1,155,457	82,011	1,254,765	1,137,138	59,484	1,206,732
25%	1,182,460	84,916	1,281,533	1,163,136	61,483	1,233,258
30%	1,206,379	87,607	1,305,350	1,188,173	63,302	1,258,600
35%	1,228,301	90,260	1,327,800	1,211,917	65,052	1,282,931
40%	1,249,625	92,868	1,348,543	1,235,386	66,752	1,306,464
45%	1,269,506	95,461	1,369,061	1,257,768	68,500	1,329,802
50%	1,289,409	98,045	1,389,773	1,280,426	70,264	1,352,683
55%	1,309,812	100,641	1,410,098	1,304,081	72,130	1,376,461
60%	1,330,468	103,397	1,431,080	1,328,370	74,061	1,400,978
65%	1,352,075	106,406	1,452,478	1,353,555	76,105	1,426,684
70%	1,374,167	109,571	1,476,072	1,380,785	78,334	1,454,494
75%	1,398,641	113,240	1,499,992	1,410,323	80,831	1,484,098
80%	1,425,054	117,309	1,527,104	1,443,877	83,672	1,518,448
85%	1,456,128	122,286	1,559,395	1,484,062	87,100	1,559,118
90%	1,496,052	128,886	1,599,829	1,536,174	91,559	1,611,614
95%	1,554,257	138,838	1,658,083	1,612,251	98,669	1,689,328
99%	1,663,311	158,060	1,768,491	1,760,364	112,620	1,838,009

Table E.89-Risk profile statistics for waterway bridge with modification 2b ADT case 4, 5, 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	844,185	459,493	1,414,713	815,708	344,323	1,245,966
Maximum	1,975,490	2,168,532	3,559,829	2,270,078	1,532,168	3,211,298
Mean	1,291,442	1,002,901	2,294,343	1,295,084	720,187	2,015,271
Std Dev	157,697	211,204	268,288	178,841	145,501	248,120
Percentile						
1%	947,834	614,263	1,735,549	956,108	455,701	1,522,149
5%	1,030,505	698,406	1,879,361	1,028,309	513,261	1,638,921
10%	1,086,610	749,517	1,960,829	1,074,461	547,997	1,708,892
15%	1,125,246	787,753	2,018,429	1,108,358	573,054	1,759,037
20%	1,155,457	820,113	2,064,920	1,137,138	594,840	1,799,803
25%	1,182,460	849,160	2,105,756	1,163,136	614,832	1,837,570
30%	1,206,379	876,067	2,143,213	1,188,173	633,024	1,872,192
35%	1,228,301	902,595	2,178,261	1,211,917	650,522	1,903,718
40%	1,249,625	928,677	2,212,229	1,235,386	667,523	1,935,768
45%	1,269,506	954,605	2,245,993	1,257,768	684,998	1,966,372
50%	1,289,409	980,450	2,280,017	1,280,426	702,639	1,997,782
55%	1,309,812	1,006,408	2,313,450	1,304,081	721,300	2,029,464
60%	1,330,468	1,033,966	2,348,335	1,328,370	740,608	2,062,097
65%	1,352,075	1,064,055	2,384,731	1,353,555	761,048	2,096,651
70%	1,374,167	1,095,710	2,423,175	1,380,785	783,338	2,134,411
75%	1,398,641	1,132,398	2,466,418	1,410,323	808,306	2,174,809
80%	1,425,054	1,173,087	2,514,841	1,443,877	836,723	2,220,930
85%	1,456,128	1,222,864	2,573,751	1,484,062	870,998	2,274,986
90%	1,496,052	1,288,855	2,648,409	1,536,174	915,589	2,344,216
95%	1,554,257	1,388,383	2,760,328	1,612,251	986,693	2,450,573
99%	1,663,311	1,580,604	2,981,886	1,760,364	1,126,196	2,655,872

Table E.90-Risk profile statistics for waterway bridge with modification 2b ADT Case 7, 8, 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	844,185	2,297,467	3,321,104	815,708	1,721,617	2,831,629
Maximum	1,975,490	10,842,662	12,214,804	2,270,078	7,660,839	9,242,559
Mean	1,291,442	5,014,507	6,305,949	1,295,084	3,600,933	4,896,017
Std Dev	157,697	1,056,021	1,073,575	178,841	727,503	776,718
Percentile						
1%	947,834	3,071,315	4,304,327	956,108	2,278,503	3,451,207
5%	1,030,505	3,492,029	4,744,706	1,028,309	2,566,305	3,772,223
10%	1,086,610	3,747,585	5,016,132	1,074,461	2,739,985	3,967,527
15%	1,125,246	3,938,764	5,215,765	1,108,358	2,865,271	4,107,815
20%	1,155,457	4,100,565	5,376,692	1,137,138	2,974,201	4,229,460
25%	1,182,460	4,245,799	5,525,769	1,163,136	3,074,159	4,336,340
30%	1,206,379	4,380,337	5,664,613	1,188,173	3,165,121	4,434,409
35%	1,228,301	4,512,976	5,797,975	1,211,917	3,252,612	4,528,767
40%	1,249,625	4,643,384	5,932,466	1,235,386	3,337,615	4,622,710
45%	1,269,506	4,773,025	6,064,869	1,257,768	3,424,988	4,718,106
50%	1,289,409	4,902,250	6,196,795	1,280,426	3,513,196	4,812,761
55%	1,309,812	5,032,041	6,331,335	1,304,081	3,606,499	4,910,798
60%	1,330,468	5,169,828	6,469,970	1,328,370	3,703,042	5,014,422
65%	1,352,075	5,320,276	6,619,538	1,353,555	3,805,242	5,123,340
70%	1,374,167	5,478,550	6,785,726	1,380,785	3,916,688	5,243,263
75%	1,398,641	5,661,988	6,967,174	1,410,323	4,041,531	5,371,613
80%	1,425,054	5,865,433	7,174,693	1,443,877	4,183,616	5,520,330
85%	1,456,128	6,114,321	7,425,733	1,484,062	4,354,989	5,698,947
90%	1,496,052	6,444,277	7,753,532	1,536,174	4,577,947	5,933,554
95%	1,554,257	6,941,916	8,256,361	1,612,251	4,933,467	6,297,195
99%	1,663,311	7,903,018	9,239,728	1,760,364	5,630,981	7,034,622

Table E.91-Risk profile statistics for waterway bridge with modification 2c ADT case 1, 2, 3 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	909,896	45,949	985,120	839,311	34,432	883,904
Maximum	2,064,296	216,853	2,166,311	2,324,683	153,217	2,402,550
Mean	1,379,872	100,290	1,480,162	1,339,390	72,019	1,411,409
Std Dev	158,496	21,120	160,679	181,686	14,550	184,711
Percentile						
1%	1,023,595	61,426	1,120,739	993,354	45,570	1,058,336
5%	1,118,214	69,841	1,214,863	1,067,949	51,326	1,135,029
10%	1,175,202	74,952	1,272,967	1,114,835	54,800	1,183,164
15%	1,214,014	78,775	1,311,795	1,149,658	57,305	1,218,281
20%	1,244,247	82,011	1,343,561	1,179,435	59,484	1,248,831
25%	1,271,267	84,916	1,370,329	1,205,478	61,483	1,275,533
30%	1,295,186	87,607	1,394,156	1,231,215	63,302	1,301,452
35%	1,317,108	90,260	1,416,607	1,255,319	65,052	1,326,321
40%	1,338,432	92,868	1,437,350	1,278,975	66,752	1,350,260
45%	1,358,312	95,461	1,457,868	1,301,968	68,500	1,373,933
50%	1,378,215	98,045	1,478,579	1,324,922	70,264	1,397,287
55%	1,398,619	100,641	1,498,905	1,348,819	72,130	1,421,200
60%	1,419,274	103,397	1,519,886	1,373,112	74,061	1,446,199
65%	1,440,882	106,406	1,541,285	1,398,954	76,105	1,472,385
70%	1,462,974	109,571	1,564,879	1,426,604	78,334	1,500,249
75%	1,487,448	113,240	1,588,799	1,456,370	80,831	1,530,237
80%	1,513,861	117,309	1,615,910	1,490,684	83,672	1,565,132
85%	1,544,935	122,286	1,648,202	1,531,113	87,100	1,606,617
90%	1,584,859	128,886	1,688,635	1,584,222	91,559	1,659,381
95%	1,643,063	138,838	1,746,890	1,660,925	98,669	1,738,614
99%	1,752,118	158,060	1,857,298	1,810,143	112,620	1,890,035

Table E.92-Risk profile statistics for waterway bridge with modification 2c ADT case 4, 5, 6 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	909,896	459,493	1,498,659	839,311	344,323	1,269,747
Maximum	2,064,296	2,168,532	3,648,636	2,324,683	1,532,168	3,266,945
Mean	1,379,872	1,002,901	2,382,773	1,339,390	720,187	2,059,577
Std Dev	158,496	211,204	268,762	181,686	145,501	251,286
Percentile						
1%	1,023,595	614,263	1,820,420	993,354	455,701	1,559,675
5%	1,118,214	698,406	1,966,727	1,067,949	513,261	1,678,130
10%	1,175,202	749,517	2,048,974	1,114,835	547,997	1,748,955
15%	1,214,014	787,753	2,106,578	1,149,658	573,054	1,800,121
20%	1,244,247	820,113	2,153,405	1,179,435	594,840	1,841,607
25%	1,271,267	849,160	2,194,148	1,205,478	614,832	1,879,366
30%	1,295,186	876,067	2,231,724	1,231,215	633,024	1,914,385
35%	1,317,108	902,595	2,266,838	1,255,319	650,522	1,946,249
40%	1,338,432	928,677	2,300,814	1,278,975	667,523	1,979,189
45%	1,358,312	954,605	2,334,662	1,301,968	684,998	2,010,053
50%	1,378,215	980,450	2,368,618	1,324,922	702,639	2,042,135
55%	1,398,619	1,006,408	2,402,189	1,348,819	721,300	2,074,291
60%	1,419,274	1,033,966	2,437,081	1,373,112	740,608	2,107,216
65%	1,440,882	1,064,055	2,473,374	1,398,954	761,048	2,142,198
70%	1,462,974	1,095,710	2,511,913	1,426,604	783,338	2,180,131
75%	1,487,448	1,132,398	2,555,127	1,456,370	808,306	2,221,227
80%	1,513,861	1,173,087	2,603,640	1,490,684	836,723	2,267,773
85%	1,544,935	1,222,864	2,662,542	1,531,113	870,998	2,322,614
90%	1,584,859	1,288,855	2,737,216	1,584,222	915,589	2,393,079
95%	1,643,063	1,388,383	2,849,134	1,660,925	986,693	2,499,746
99%	1,752,118	1,580,604	3,070,693	1,810,143	1,126,196	2,707,795

Table E.93-Risk profile statistics for waterway bridge with modification 2c ADT case 7, 8, 9 (Table 3.6)

Basic Statistic	Life-cycle Costs, Dollars					
	Replacement Alternative			Rehabilitation Alternative		
	Agency	User	Total	Agency	User	Total
Minimum	844,185	2,523,113	3,489,591	815,708	1,851,139	2,988,201
Maximum	1,975,490	15,948,811	17,320,953	2,270,078	11,170,816	12,731,907
Mean	1,291,442	6,797,514	8,088,956	1,295,084	4,743,686	6,038,771
Std Dev	157,697	1,724,305	1,735,333	178,841	1,166,973	1,204,191
Percentile						
1%	947,834	3,601,310	4,845,478	956,108	2,615,882	3,815,402
5%	1,030,505	4,269,971	5,534,964	1,028,309	3,065,840	4,293,929
10%	1,086,610	4,700,861	5,980,510	1,074,461	3,346,888	4,594,950
15%	1,125,246	5,022,204	6,306,051	1,108,358	3,554,144	4,811,630
20%	1,155,457	5,296,956	6,580,191	1,137,138	3,733,115	4,996,409
25%	1,182,460	5,542,211	6,824,662	1,163,136	3,896,095	5,166,636
30%	1,206,379	5,770,960	7,056,622	1,188,173	4,046,891	5,322,168
35%	1,228,301	5,993,554	7,280,243	1,211,917	4,189,513	5,471,363
40%	1,249,625	6,207,871	7,499,256	1,235,386	4,330,147	5,614,406
45%	1,269,506	6,420,223	7,711,190	1,257,768	4,467,506	5,760,322
50%	1,289,409	6,634,811	7,926,715	1,280,426	4,612,910	5,909,693
55%	1,309,812	6,849,893	8,144,472	1,304,081	4,763,310	6,063,023
60%	1,330,468	7,073,957	8,373,729	1,328,370	4,919,666	6,220,997
65%	1,352,075	7,313,899	8,609,177	1,353,555	5,080,763	6,391,481
70%	1,374,167	7,574,285	8,874,549	1,380,785	5,256,700	6,577,295
75%	1,398,641	7,866,035	9,165,665	1,410,323	5,456,352	6,775,681
80%	1,425,054	8,198,443	9,502,627	1,443,877	5,682,976	7,005,468
85%	1,456,128	8,590,287	9,895,395	1,484,062	5,953,798	7,289,360
90%	1,496,052	9,118,105	10,428,502	1,536,174	6,309,862	7,652,709
95%	1,554,257	9,914,427	11,219,729	1,612,251	6,868,283	8,221,137
99%	1,663,311	11,458,411	12,773,673	1,760,364	7,973,047	9,366,168

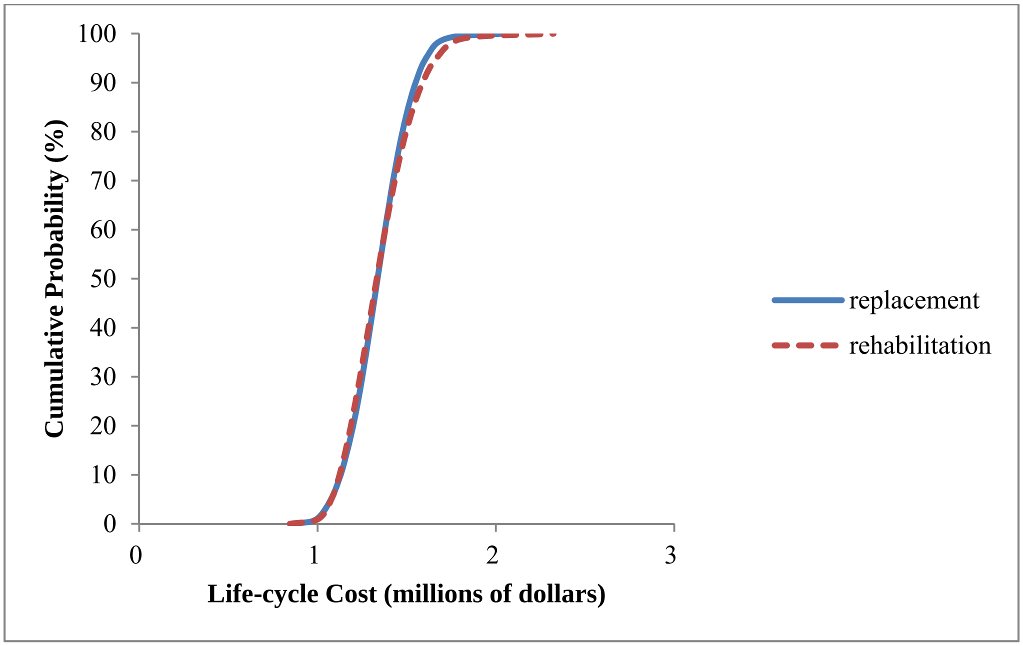


Figure E.151-Ascending cumulative probability distributions for waterway bridge with modification 1a ADT case 1, 2, 3 (Table 3.6)

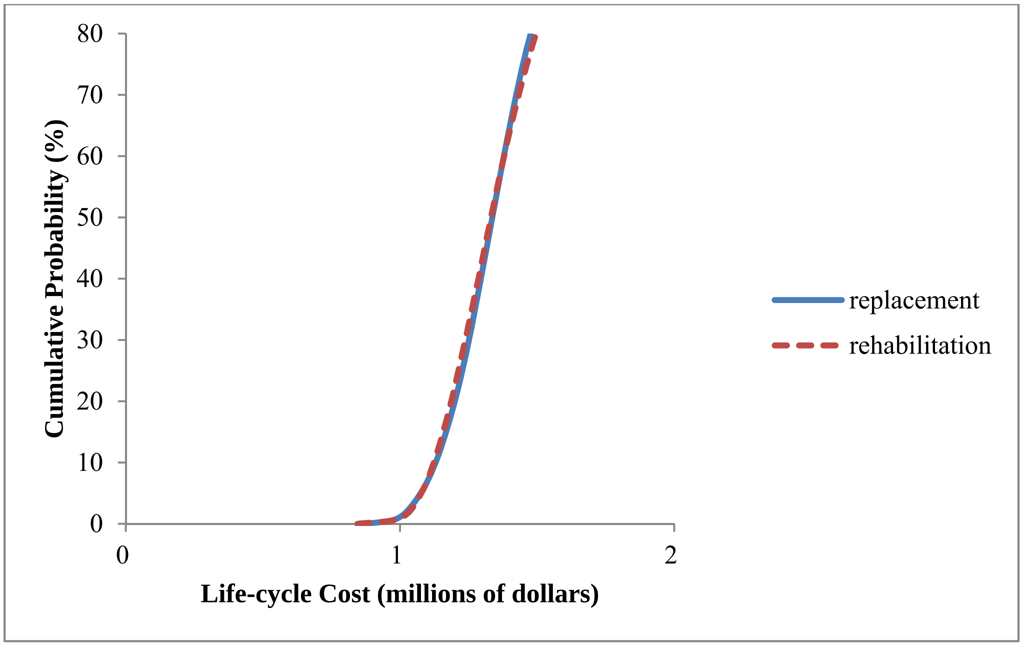


Figure E.152-Ascending cumulative probability distributions for waterway bridge with modification 1a ADT case 1, 2, 3 (Table 3.6)

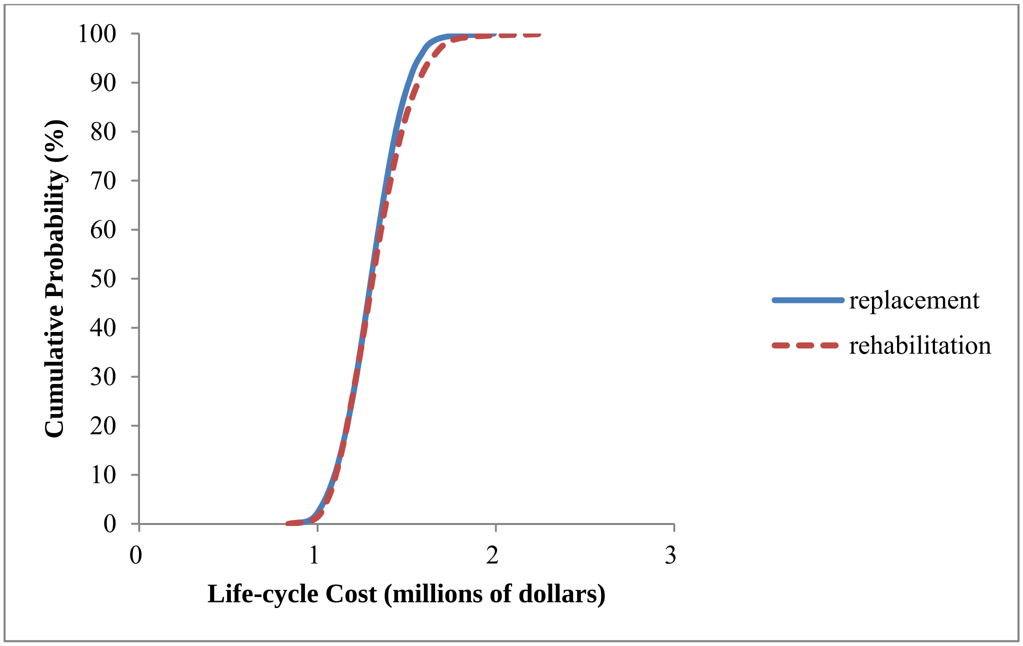


Figure E.153-Ascending cumulative probability distributions for waterway bridge with modification 2a ADT case 1, 2, 3 (Table 3.6)

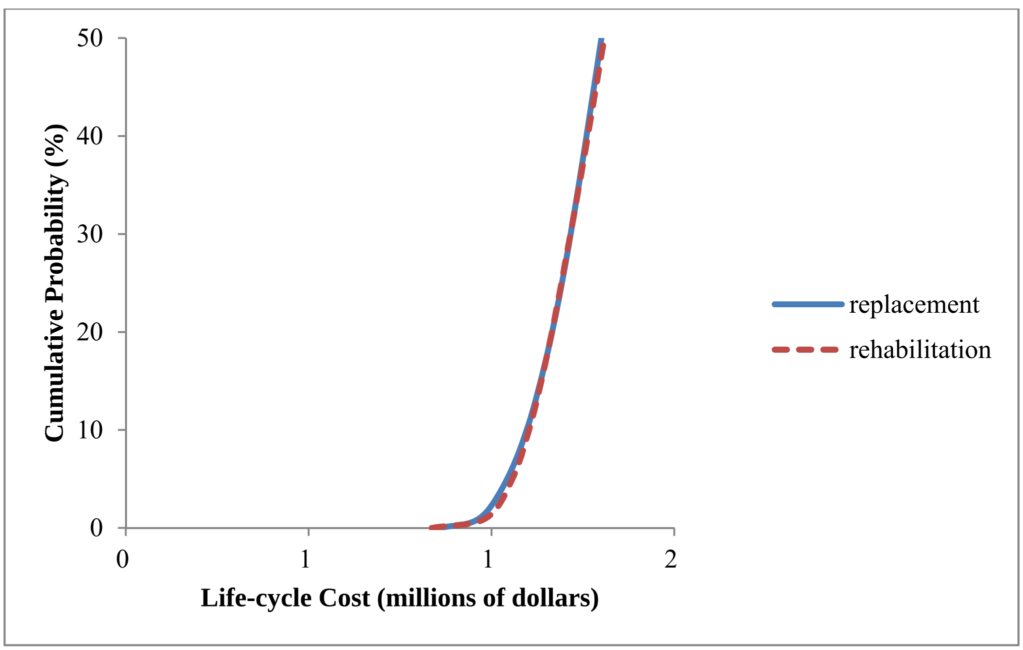


Figure E.154-Ascending cumulative probability distributions for waterway bridge with modification 2a ADT case 1, 2, 3 (Table 3.6)

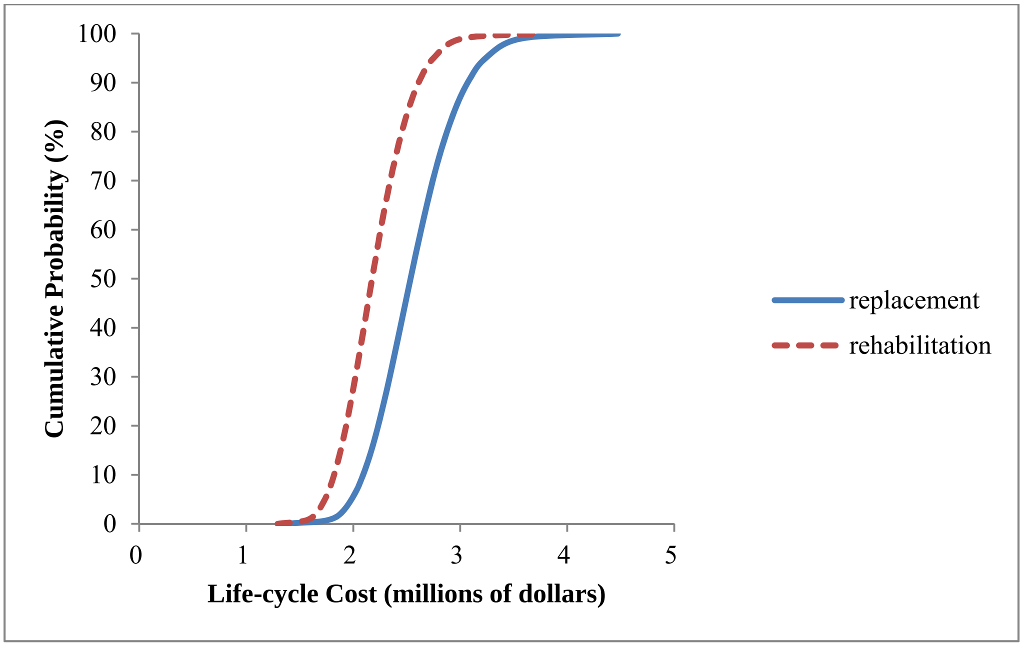


Figure E.155-Ascending cumulative probability distributions for waterway bridge with modification 1a ADT case 4, 6, 6 (Table 3.6)

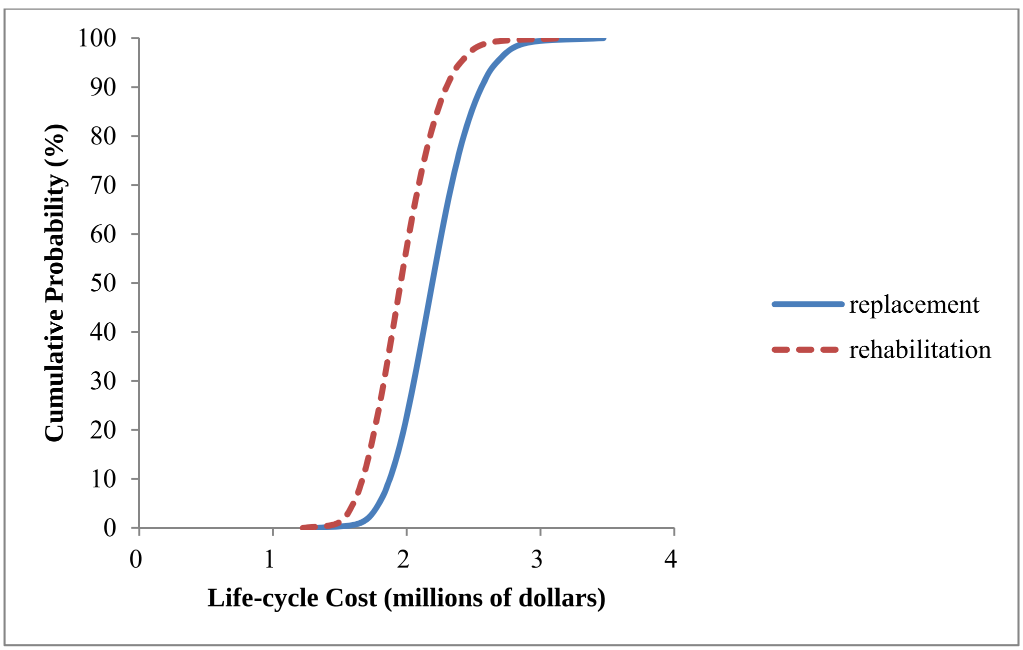


Figure E.156-Ascending cumulative probability distributions for waterway bridge with modification 2a ADT case 4, 5, 6 (Table 3.6)

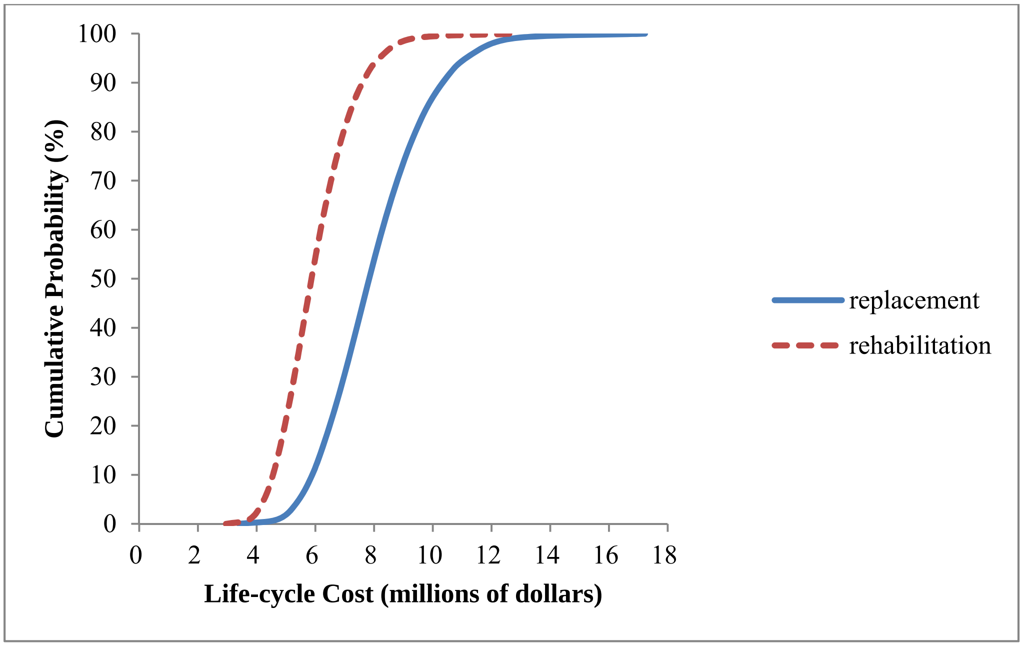


Figure E.157-Ascending cumulative probability distributions for waterway bridge with modification 1a ADT case 7, 8, 9 (Table 3.6)

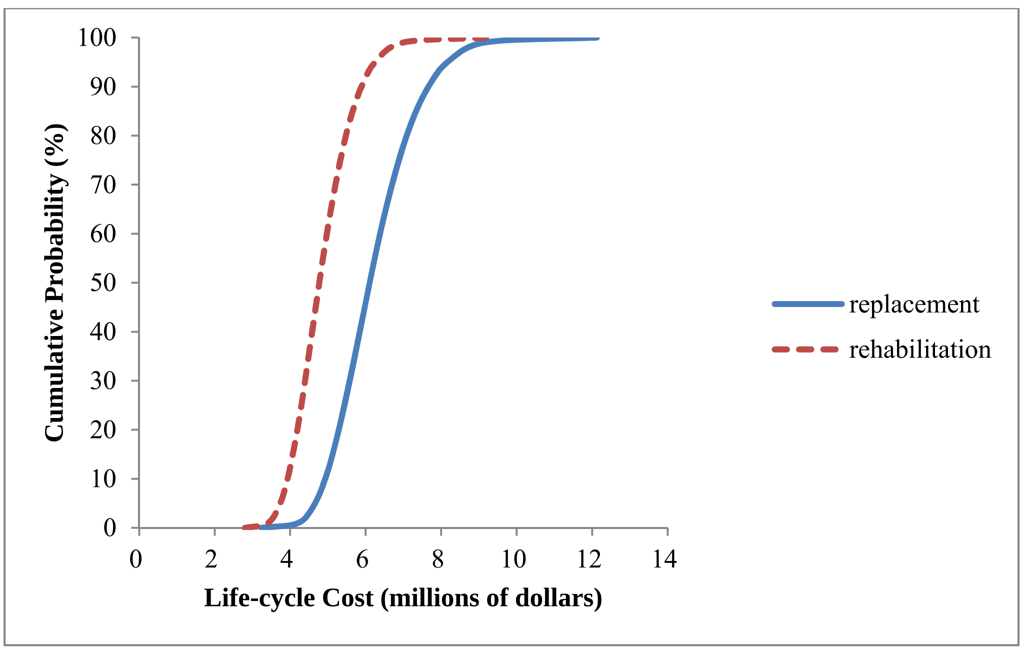


Figure E.158-Ascending cumulative probability distributions for waterway bridge with modification 2a ADT Case 7, 8, 9 (Table 3.6)

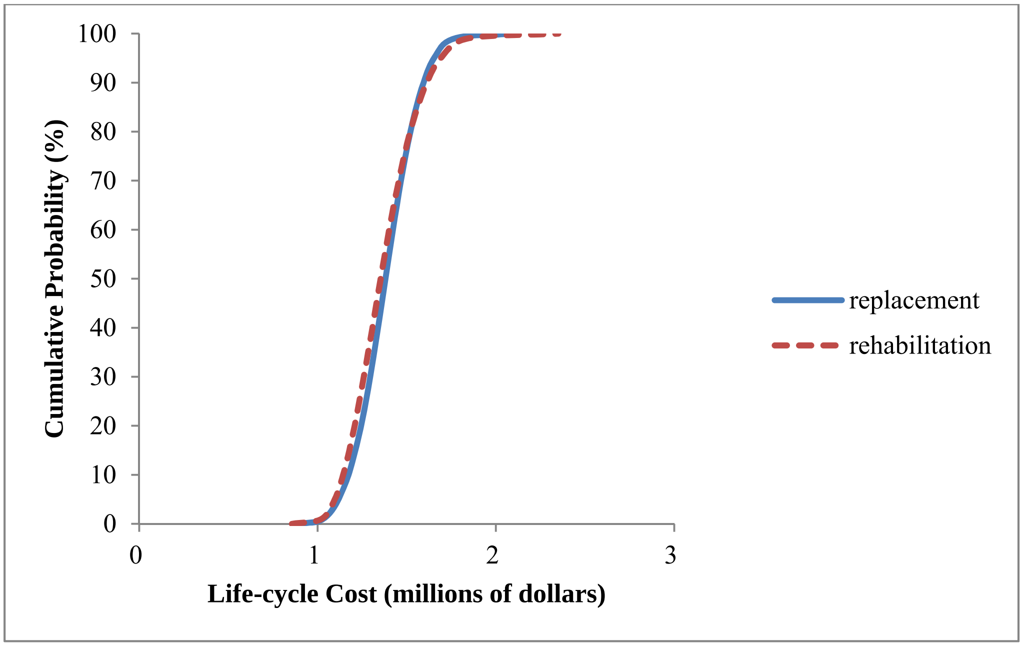


Figure E.159-Ascending cumulative probability distributions for waterway bridge with modification 1b ADT case 1, 2, 3 (Table 3.6)

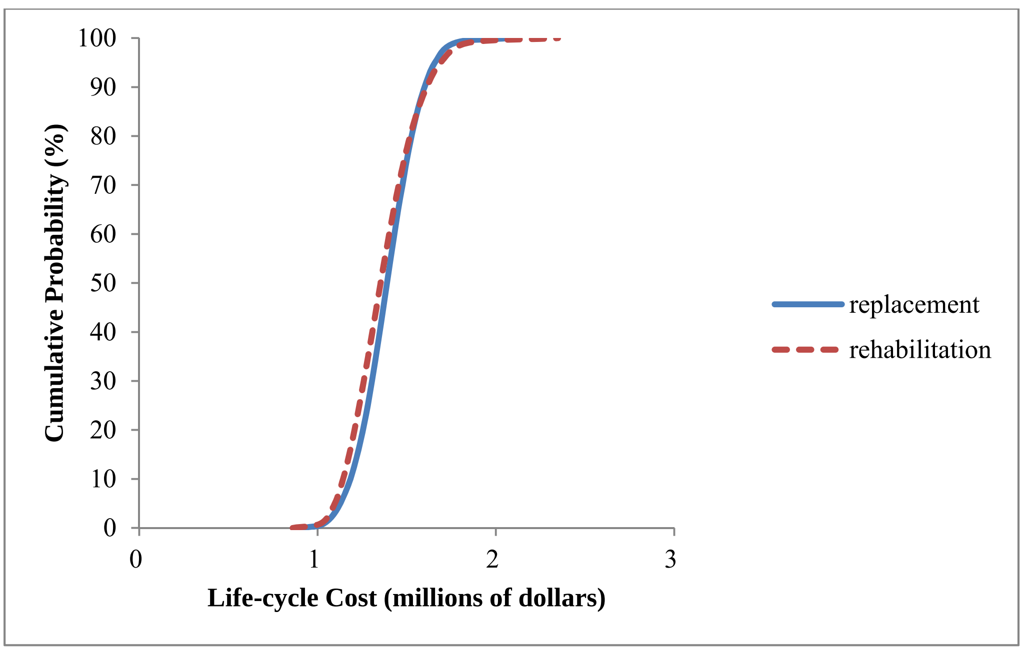


Figure E.160-Ascending cumulative probability distributions for waterway bridge with modification 2b ADT case 1, 2, 3 (Table 3.6)

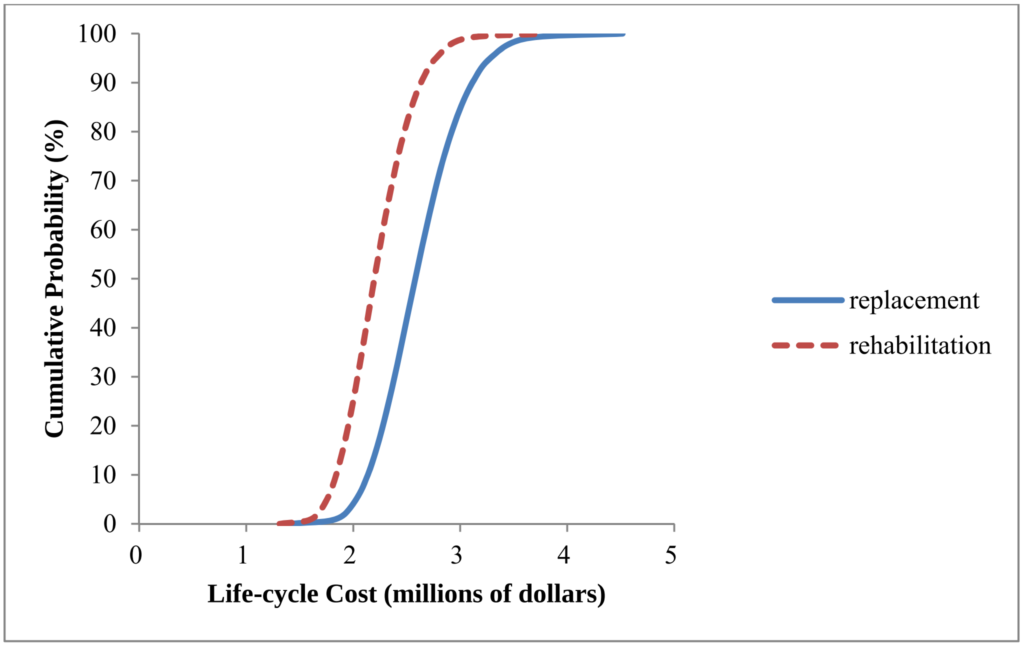


Figure E.161-Ascending cumulative probability distributions for waterway bridge with modification 1b ADT case 4, 5, 6 (Table 3.6)

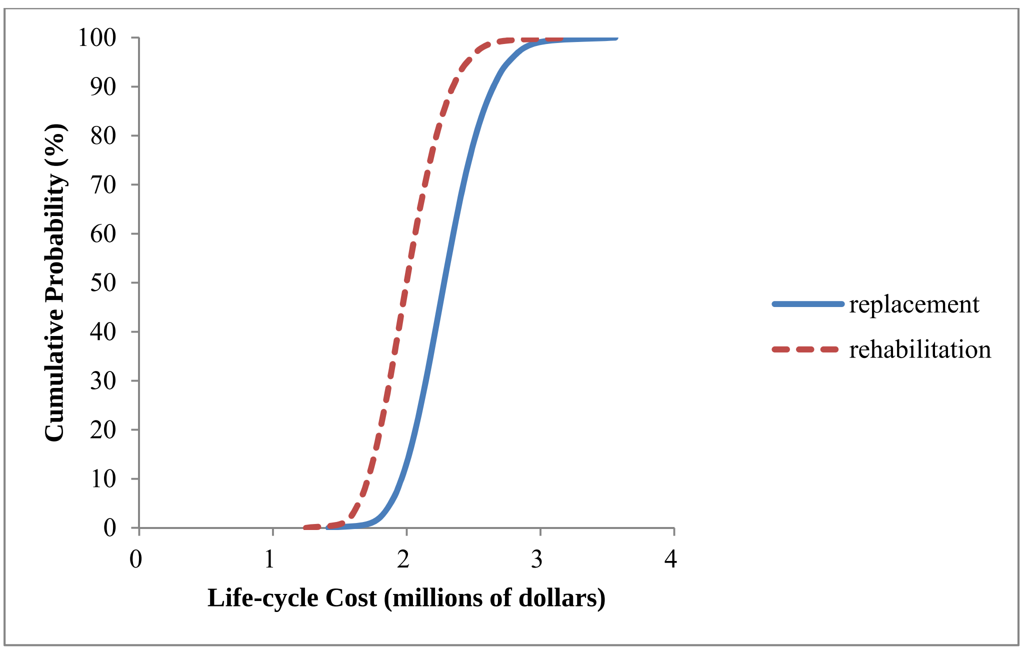


Figure E.162-Ascending cumulative probability distributions for waterway bridge with modification 2b ADT case 4, 5, 6 (Table 3.6)

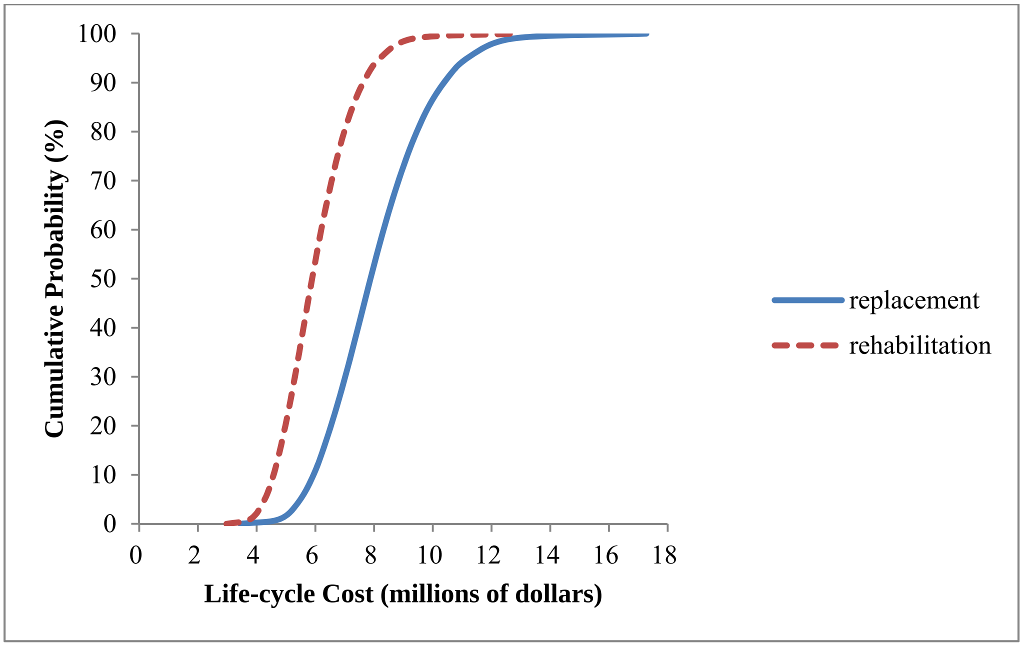


Figure E.163-Ascending cumulative probability distributions for waterway bridge with modification 1b ADT case 7, 8, 9 (Table 3.6)

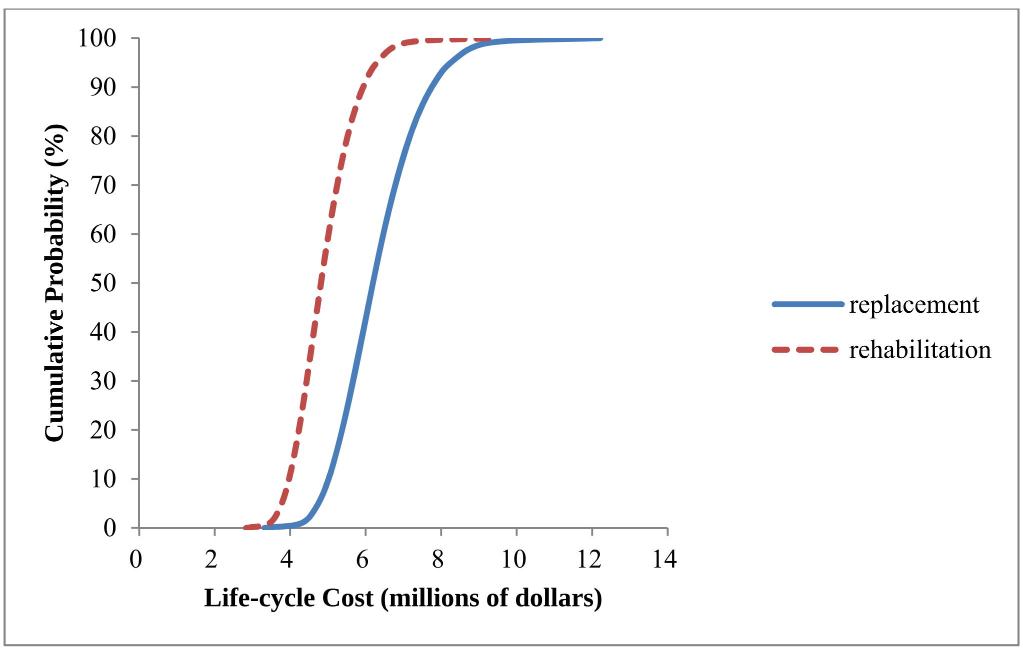


Figure E.164-ascending cumulative probability distributions for waterway bridge with modification 2b ADT case 7, 8, 9 (Table 3.6)

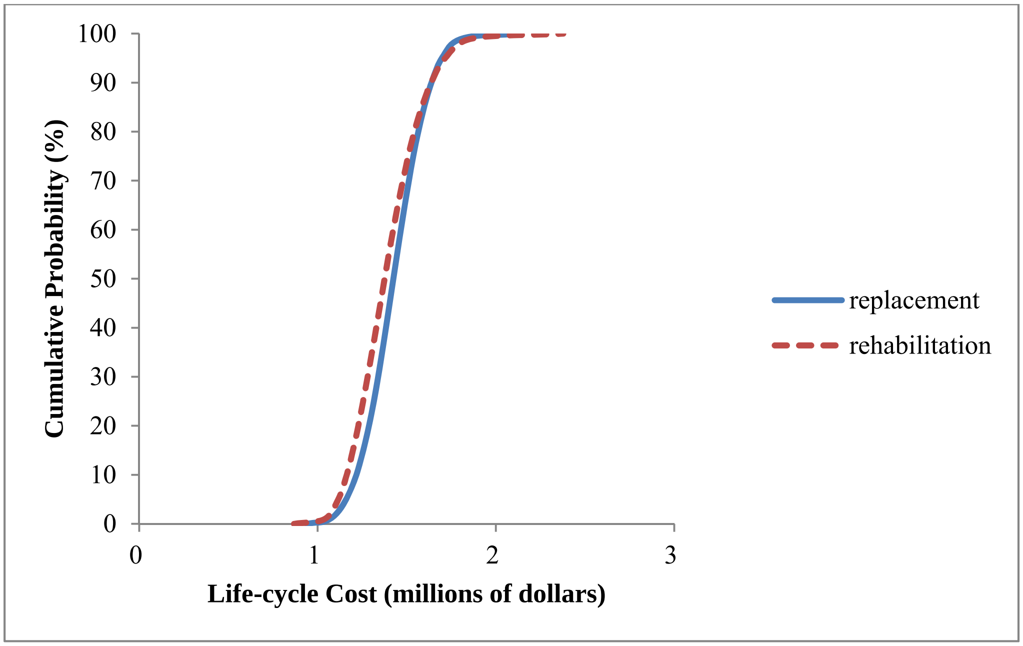


Figure E.165-ascending cumulative probability distributions for waterway bridge with modification 1c ADT Case 1, 2, 3 (Table 3.6)

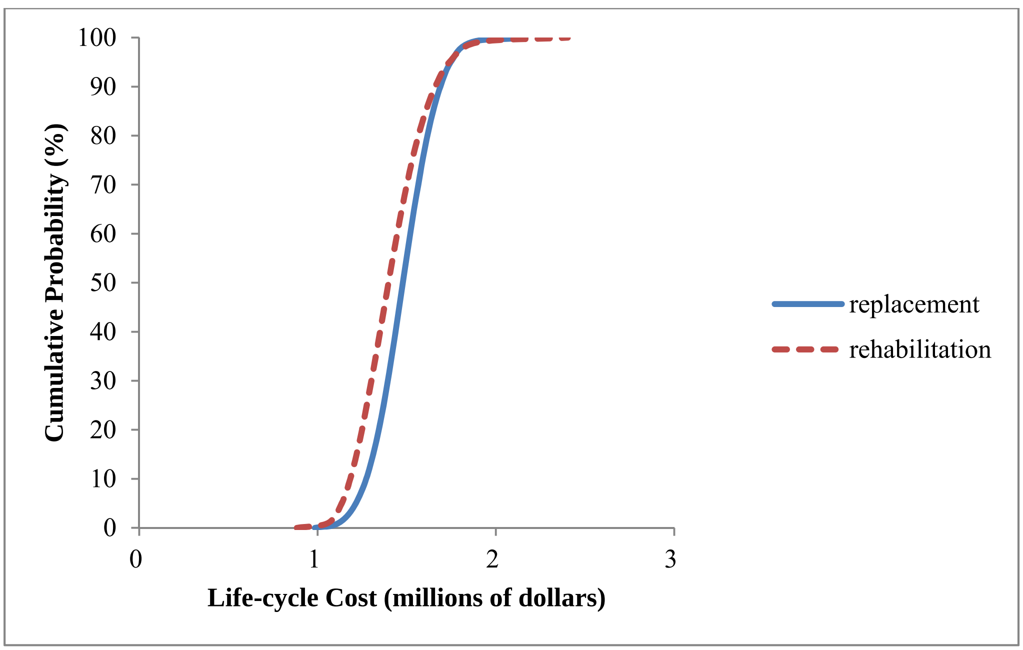


Figure E.166-Ascending cumulative probability distributions for waterway bridge with modification 2c ADT Case 1, 2, 3 (Table 3.6)

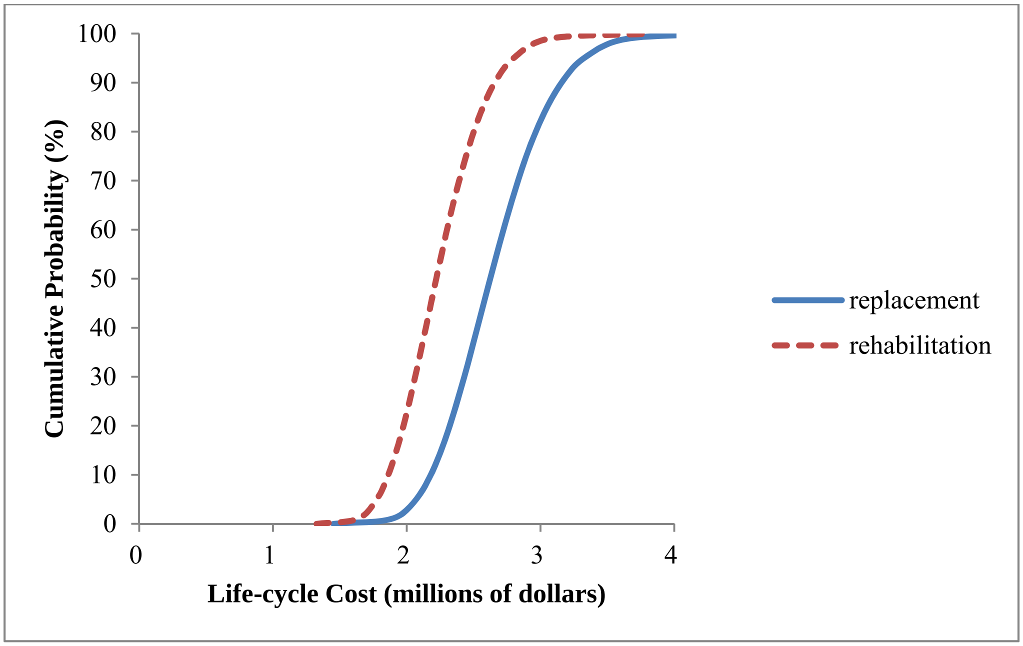


Figure E.167-Ascending cumulative probability distributions for waterway bridge with modification 1c ADT case 4, 5, 6 (Table 3.6)

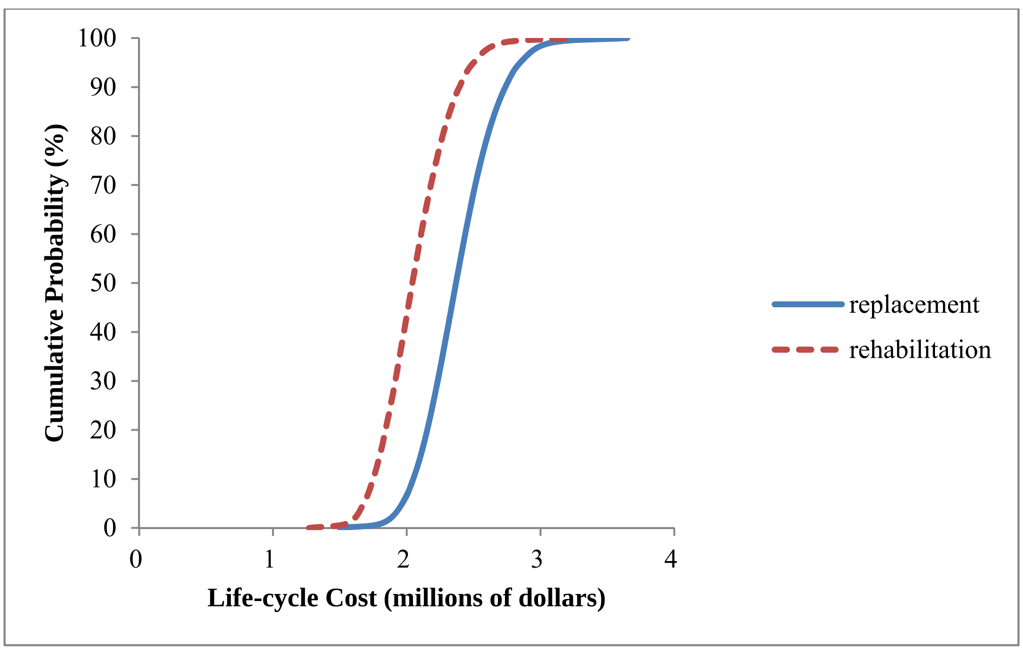


Figure E.168-Ascending cumulative probability distributions for waterway bridge with modification 2c ADT case 4, 5, 6 (Table 3.6)

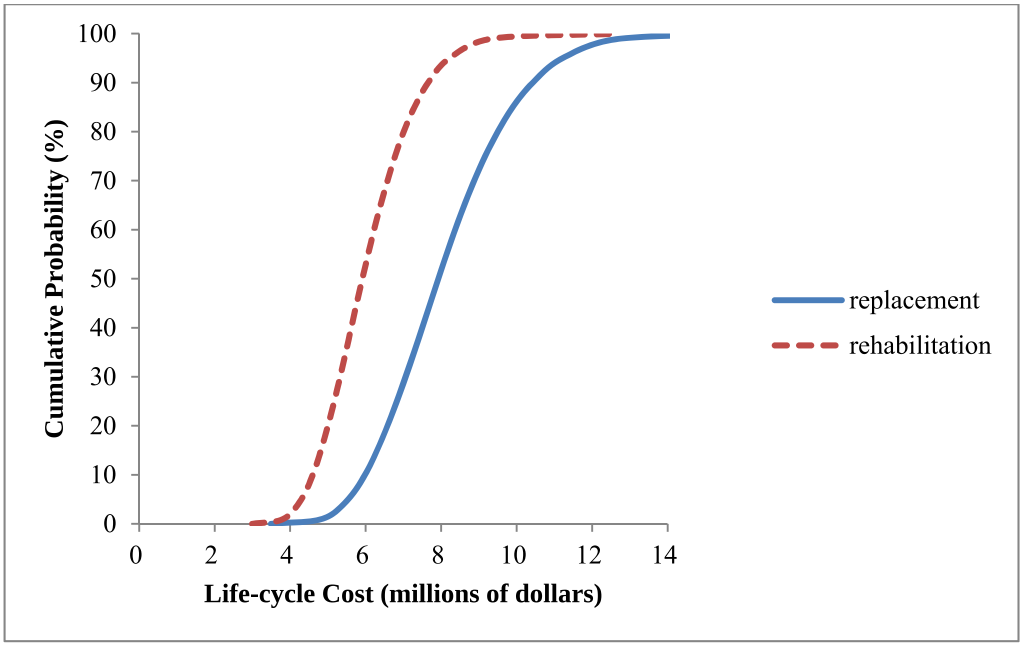


Figure E.169-Ascending cumulative probability distributions for waterway bridge with modification 1c ADT Case 7, 8, 9 (Table 3.6)

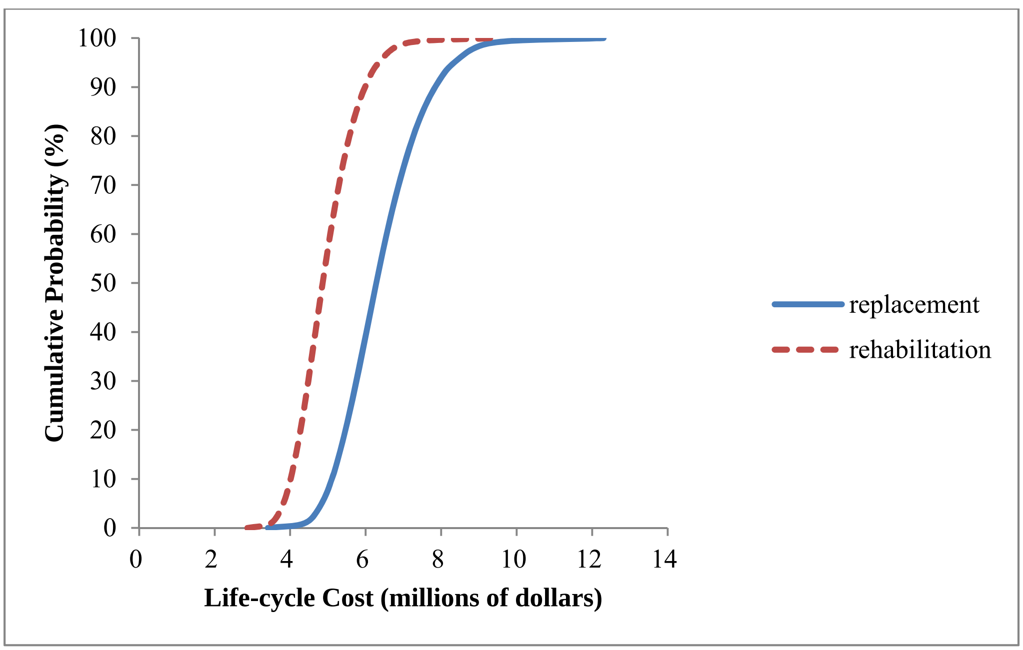


Figure E.170-Ascending cumulative probability distributions for waterway bridge with modification 2c ADT case 7, 8, 9 (Table 3.6)

APPENDIX F: SPREADSHEET INPUT

Appendix F contains a summary of the required spreadsheet input.

Analysis Period (years)	75

Discount Rates	
Short term	0.035
Long term	0.025

Agency Costs	
Preliminary Engineering (%)	10
Construction Engineering (%)	11
Maintenance of Traffic - replacement (%)	3.41
Maintenance of Traffic - rehabilitation (%)	15.12
Bridge replacement ($/SF)	107.52
Deck overlay - new bridge ($/SF)	16.54
Deck overlay - old bridge ($/SF)	16.54
Overlay approach pavement - new bridge ($/SY)	40.01
Overlay approach pavement - old bridge ($/SY)	54.83
Deck replacement ($/SF)	38.17
FRP wrap - 1 layer ($/SF)	54.39
Bridge rail retrofit with thrie beam ($/LF)	76.99
Bridge removal ($/SF)	14.13
Deck removal ($/SF)	4.87
Routine annual maintenance - new bridge ($/SF)	0.10
Routine annual maintenance - old bridge ($/SF)	0.15

Bridge Replacement	
New Bridge	
Roadway width (ft)	28
Total width (ft)	31
Length (ft)	204
Approach roadway (%)	5
Overlay approach pavement area (SY)	355

Bridge Rehabilitation	
Existing bridge	
Roadway width (ft)	25
Total width (ft)	28
Length (ft)	204
Area of applied FRP - 1 layer (SF)	5700
Overlay approach pavement area (SY)	278

Activity - Replacement Alternative	Duration (d)	Timing (yr)
Bridge replacement	240	0
Deck overlay	30	20
Deck replacement	45	40
Deck overlay	30	60

Activity - Rehabilitation Alternative	Duration (d)	Timing (yr)
Bridge rehabilitation	30	0
Bridge replacement	240	20
Deck overlay	30	40
Deck replacement	45	60

User Costs	
Length of detour (miles)	
Replacement	2.00
Rehabilitation	0.00
Average daily traffic, ADT, initial	
On bridge	100
Under bridge	5000
Truck traffic, ADTT (%)	
On bridge	5
Under bridge	12
Annual traffic growth rate (%)	
On bridge	1
Under bridge	2
Value of time, VOT ($/hr)	
Cars	16.28
Trucks	25.30
Vehicle Operating Cost, VOC ($/mile)	
Cars	0.27
Trucks	0.74
Vehicle occupancy rate (persons/vehicle)	
Cars	1.5
Trucks	1.05
User Time Delay (min)	
Bridge replacement-on bridge	10
Bridge replacement-under bridge	5
Bridge rehabilitation-on bridge	5
Bridge rehabilitation-under bridge	5
Deck overlay-on bridge	5
Deck overlay-under bridge	0
Deck replacement-on bridge	10
Deck replacement-under bridge	0
Cost per crash ($)	
Non-fatal	126,870
Fatal	9,100,000
Crash and fatality rates (per million vehicle-miles)	
Non-fatal crashes	2.65
Fatalities	0.015

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VITA

Jeffrey L. Smith

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- Miami University, Bachelor of Environmental Design, 1975
- University of Toledo, Bachelor of Science in Civil Engineering, 1979
- University of Kansas, Master of Science in Civil Engineering, 1995

Professional positions held:

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- Member of Tau Beta Pi
- Fellow of American Concrete Institute
- Licensed Professional Engineer in Ohio

Professional publications:

- Life-Cycle Cost Analysis of Reinforced Concrete T-beam Bridges Rehabilitated with CFRP, submitted to American Concrete Institute for publication in Structural Journal 2015
- Design Example: Strengthening a Reinforced Concrete T-beam Bridge with Fiber Reinforced Polymers, FHWA, 2009
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Benefit-Cost Methodology for Moses Wheeler Bridge TIGER Application

The methodology and assumptions underlying the benefit-cost analysis are described herein.

Time Horizon

All benefits and costs were based on a forecast horizon of 35 years, from 2009 through 2043. Bridge construction was assumed to be eight years in duration, beginning in 2009 and completing in 2016. User benefits were assumed to begin in January 2017, immediately after the completion of the bridge, and last through the end of the forecast horizon.

Discount Rate

Consistent with USDOT guidelines, the benefits and costs in this analysis were discounted at a rate of 7 percent.

Project Costs

The bridge was assumed to cost $299 million in 2009 dollars to design and construct. Construction would begin in 2009 and complete in 2016. The annual construction expenditures expected per year is shown in Exhibit A-1.

Exhibit A-1: Breakdown of Contract E Construction Costs by Scenario (Million 2009 Dollars)

2009	2010	2011	2012	2013	2014	2015	2016	TOTAL
$4.1	$23.1	$51.9	$68.3	$68.0	$38.5	$35.0	$10.2	**$299.1**

Source: STV Incorporated, Connecticut Department of Transportation

In the no-build scenario, the following capital expenditures would be needed to keep the bridge at a minimum level of functionality:

Exhibit A-2: Breakdown of Moses Wheeler Bridge No-Build Capital Costs

Year	Capital Cost Description	Estimated Cost (2009 $)
2010	Bridge drainage, fender system repairs	$6.5 million
2020 - 2023	Full deck & bearing replacement, steel repairs, substructure repairs, superstructure painting	$82 million
2035 - 2041	Full bridge replacement	$299 million
Total No-Build Capital Costs		**$387.5 million**

Source: STV Incorporated, Connecticut Department of Transportation

With major repairs scheduled in 2010 and again in 2020, the useful life of the bridge could be extended to 2035, but would need to be completely replaced at that time. Thus, the same annual construction costs in the build scenario from 2009 to 2016 also appear in the no-build scenario from 2035 to 2042.

The total capital costs in the build scenario are estimated to be $230 million in discounted 2009 dollars (using the 7 percent discount rate), and the capital costs in the no-build scenario are estimated to be $77 million in discounted 2009 dollars.

Operations & Maintenance Costs

In the build scenario, the annual bridge operations & maintenance (O & M) costs were estimated to be $115,000 throughout the forecast horizon (see Exhibit A-3 below). No-build operation and maintenance costs were estimated to be $670,000 from 2009 to 2020, and $190,000 from 2021 until the bridge replacement construction begins in 2035. From 2035 to 2045, no-build O & M costs were estimated to be $115,000, equivalent to the O & M costs in the build scenario. When discounted at a 7 percent rate, the total differential O & M costs between the build and no-build scenarios would carry a $4 million benefit to the state throughout the forecast period in the form of lower relative costs.

Exhibit A-3: Breakdown of Moses Wheeler Bridge Operations & Maintenance Costs

O & M Cost Description	Estimated Cost (2009 $)			
	Build Scenario	No-Build Scenario (2010 to 2020)	No-Build Scenario (2021 to 2035)	No-Build Scenario (2036 to 2045)
Drainage	40,000	40,000	40,000	40,000
Crack Sealing	20,000	40,000	20,000	20,000
Bridge Collision Repairs	5,000	10,000	10,000	5,000
Joint Repairs	-	50,000	20,000	-
Added Inspections	-	100,000	-	-
Deck Patching	-	150,000	-	-
Loose Concrete Removal	-	40,000	-	-
Substructure Patching	-	40,000	25,000	-
Minor Steel Repairs	-	100,000	25,000	-
Spot Painting	50,000	100,000	50,000	50,000
Total O & M Costs	**$ 115,000**	**$ 670,000**	**$ 190,000**	**$ 115,000**

Source: STV Incorporated, Connecticut Department of Transportation

Residual Value of Bridge – Negative Cost

The useful life of the replaced Moses Wheeler Bridge is estimated to be 75 years. At the end of the forecast horizon in 2045, the bridge will have approximately 46 years remaining before major rehabilitation and replacement would be necessary. Therefore, the bridge will carry a residual value past the forecast horizon that has been estimated as a negative cost for this analysis.

The residual value has been estimated at $16 million in discounted 2009 dollars. Underlying this estimate is the assumption that the bridge will depreciate on a straight-line basis, with the residual value of the bridge equal to the real value of its construction cost multiplied by the share of its useful life remaining at the end of the forecast period.

User Benefits

<u>Construction-Related Vehicle Travel Time Benefits</u>

The major quantifiable benefit of the bridge replacement project is the elimination of future travel time delays that would occur if the bridge was not replaced today. These delays would be caused by the future capital replacement projects needed just to maintain the Bridge at its current state of good repair rating, which would require lane closures for significant periods of time and cause major delays on I-95 for most of the day.

In particular, the current deck would need to be completely replaced in 2020 if the replacement project was not implemented. Such a replacement would require at least one lane of traffic to be closed in both directions at all times for roughly three years, which would cause severe delays on a daily basis and likely draw heavy opposition from the trucking industry and the residents of Connecticut.

In order to determine the impact of the lane closures during this deck replacement project several methodologies were used to determine the average delay time over the 24 hour period. The peak hourly demand at the bridge has been estimated at 6,600 vehicles in each direction. A lane closure would reduce the capacity to 3,300 veh./hr. in each direction. Based on manual calculations for the daily demand volume across the Moses Wheeler Bridge, the following data was determined:

1) The northbound direction of the bridge would experience a maximum queue of approximately 8,200 vehicles from 2-7 PM, the period when vehicle demand exceeds roadway capacity (total two-lane capacity = 3,330 veh/hr). Given a per vehicle spacing of 30 feet over 3 lanes, the queue length would be approximately 82,000 feet (15.5 miles).
2) The southbound direction of the bridge would experience a maximum queue of approximately 2,730 vehicles from 6:30-9 AM, the period when demand exceeds roadway capacity. Given a per vehicle spacing of 30 feet over 3 lanes, the queue length would be approximately 27,300 feet (5.2 miles).

This information was then analyzed using the Highway Capacity Manual and VISSIM simulation models to develop average delay times over the 24 hour period. The two methods revealed peak period delays ranging from 40 minutes to an hour with average hourly delays over the 24 hour period of 22 minutes in the northbound direction and 15 minutes in the southbound direction. Using weighted averages based on the volumes, an average delay time of 18.3 minutes was estimated over the 24 hour period.

This average delay per vehicle per day on the Moses Wheeler Bridge in the no-build scenario was applied to the forecasted ADT volumes from 2020 to 2022 to arrive at annual travel time savings over the forecast period. Annual ADT projections were based on a study by CTDOT in 2001 that computed historical volumes on the bridge in 1999 and projected volumes in 2025. Applying the compound annual growth rate used in the study to 1999 volumes allowed for an annual ADT forecast to be created from 2009 to 2043.

Applying the projected volumes from 2020 to 2022 to the computed per-vehicle delays during this period led to the computation of total daily vehicle travel time savings. These benefits were then converted to total daily passenger travel time savings (see Exhibit A-4) using a vehicle-occupancy rate of 1.0 for commercial vehicles, estimated to be 13 percent of total ADT, along with a passenger vehicle occupancy rate of 1.424 for the 87 percent passenger share of total ADT[1].

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[1] Source: Connecticut Department of Transportation.

Exhibit A-4: Annual Hours of Passenger Travel Time Savings in Build Scenario, 2009 Dollars

Benefit Description	2020	2021	2022	TOTAL
Passenger Trips	16,185,111	16,290,800	16,397,179	48,873,090
Commercial Trips	1,698,360	1,709,450	1,720,613	5,128,424
TOTAL	**17,883,471**	**18,000,250**	**18,117,792**	**54,001,514**

Source: Parsons Brinckerhoff

The estimated travel time savings in the build scenario were converted into dollar benefits for commercial vehicles, passenger work trips, and passenger non-work trips. Commercial vehicle travel time savings were valued at 100 percent of the hourly truck driver wages plus fringe benefits, according to USDOT guidelines. Truck driver wage data was obtained by inflating the 2008 Bureau of Labor Statistics (BLS) wage data for truck drivers in Connecticut to 2009 dollars, and using a fringe benefits factor of 33 percent of hourly wages. Total hourly 2009 commercial vehicle compensation was estimated to be $32.22.

Passenger work trips, defined by USDOT as non-commute work trips occurring for business purposes, was assumed to represent 5.6 percent of total passenger vehicle travel time savings. This estimate was taken from USDOT estimates of the share of local passenger travel comprising business trips in its 2003 publication "Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis." These trips were valued at 100 percent of hourly passenger wages plus fringe benefits, which was estimated to be $37.50. Passenger wage data was obtained by inflating the 2008 average wage for all Connecticut employees from the BLS to 2009 dollars, and using a fringe benefits factor of 33 percent of hourly wages.

Passenger non-work trips, defined as all "off-the-clock" commute or leisure trips, represent the remainder of total passenger vehicle travel time savings. These trips were valued at 50 percent of hourly passenger wages, which were estimated to be $28.20. Passenger wage data was obtained by inflating the 2008 average wage for all Connecticut employees from the BLS to 2009 dollars.

The total travel time benefits in discounted 2009 dollars are shown in selected years in Exhibit A-5. When discounted at a 7 percent annual rate, such benefits total $73 million for commercial vehicles, $41 million for passenger work trips, and $291 million for passenger non-work trips.

Exhibit A-5: Total Annual Travel Time Benefits, Discounted 2009 Dollars

Benefit Description	2020	2021	2022	TOTAL
Passenger Work Trips	$ 14,419,988	$ 13,564,626	$ 12,760,003	$ 40,744,617
Passenger Non-Work Trips	$ 102,999,911	$ 96,890,187	$ 91,142,879	$ 291,032,977
Commercial Trips	$ 25,997,026	$ 24,454,941	$ 23,004,328	$ 73,456,295
TOTAL	**$ 143,416,924**	**$ 134,909,754**	**$ 126,907,210**	**$ 405,233,889**

Source: Parsons Brinckerhoff

Accident-Related Vehicle Travel Time Benefits

Users of the bridge would also benefit from reduced delays caused by vehicle accidents, since the replaced bridge will have much wider shoulders to efficiently move damaged vehicles. As previously mentioned, the current bridge does not have adequate shoulders, which leads to major backups and travel time delays during accidents due to damaged vehicles remaining in one or more lanes. This problem will be resolved by the new design of the replacement bridge.

To estimate the benefits associated with more efficient accident management on the bridge, historical bridge vehicle accident data from 2003 to 2007 was analyzed and used to derive an annual estimate (65) of accidents. It was assumed that this historical average number of accidents would increase throughout the forecast horizon at the projected annual growth rate of vehicle traffic.

For each projected accident, it was assumed that the accident would create, on average, a 45 minute travel time delay for all vehicles during a two hour window of the day, after which the damaged vehicles would presumably be cleared from the roadway. The costs of this delay were quantified using the same approach and data described in the previous section.

The replaced bridge was assumed to reduce average travel delays from 45 minutes to 15 minutes during accidents, though the bridge is not expected to reduce the overall number of accidents in the future.

FAC 8514 Tunnel

FY25 SUC:	$2.88 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8521 Vehicle Parking, Surfaced

FY25 SUC:	$1.85 / SY
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8522 Vehicle Parking and Staging Area, Unsurfaced

FY25 SUC:	$0.32 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	RS Means Costworks Assembly Costs. 2022 Quarter 3 Release Update

CostWorks 2022 Quarter 3 - FAC 8522 Veh Parking and Staging Area, Unsurfaced

ESL 32

Size 8634

Qty	Description	Unit	Bare Mat.	Bare Labor	Bare Equip.	Total	Total Incl. O&P	Frequency	Occureances	Total for Assembly	
2.000	Utility area drain, catch basins or manholes frames and covers, inverts, single channel con	Ea.	464.00	244.00	0.00	708.00	900.00	5	6	$	5,400.00
6.000	Public storm utility drainage piping, reinforced concrete pipe (RCP), 42" diameter, 8' length	L.F.	1,308.00	186.00	219.00	1,713.00	1,980.00	5	6	$	11,880.00
864.000	Base course drainage layers, aggregate base course for roadways and large paved areas,	S.Y.	5,270.40	561.60	691.20	6,523.20	7,473.60	5	6	$	44,841.60
48.000	Geosynthetic soil stabilization, geotextile fabric, woven, 200 lb. tensile strength	S.Y.	70.08	12.48	0.00	82.56	96.48	5	6	$	578.88
864.000	Fine grading, grade subgrade for base course, roadways	S.Y.	0.00	181.44	207.36	388.80	509.76	1	32	$	16,312.32
	Totals		**$7,112.48**	**$1,185.52**	**$1,117.56**	**$9,415.56**	**$10,959.84**		Total M&R	$	79,012.80
									M&R per Year	$	2,469.15
									SUC	$	0.29

FAC 8523 Vehicle Staging Area, Surfaced

FY25 SUC:	$1.58 / SY
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8524 Sidewalk and Walkway

FY25 SUC:	$0.0187 / SY
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8525 Pedestrian Bridge

FY25 SUC:	$55.17 / SY
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	American Association of State Highway and Transportation Officials, and other industry sources, 2010

FAC 8525 Pedestrian Bridge

UM = SY

Mean Qty = 107

ESL = 35

Hourly rate taken from GSA Awarded rates for for Sr. Eng ($129) and Technician (GS-9 S5: $64)

Requirements		Unit	Qty	Unit Cost	Frequency (years)	Occurances over Lifetime	Extended Cost
	Inspection - preparation/review plans	HR	2	193.00	2	17	$6,562.00
	Inspection - travel	HR	8	193.00	2	17	$ 26,248.00
	Inspection - site work	HR	4	193.00	2	17	$ 13,124.00
	Inspection - tests	EA	2	550	2	17	$ 18,700.00
	Inspection - site work review, calculations &	HR	4	253.66	4	8	$ 8,117.12
	Paint bridge structure	SF	963	22.49	10	3	$ 64,972.17
	Replace deteriorated planks (10% required)	SF	96.0	136.34	10	3	$ 39,265.92
TOTAL							$ 176,989.21
PER UNIT (SY)							$ 47.26

Reference:

AASHTO Manual for Inspection of Bridges and Recommendations for the Inspection and Maintenance of Steadfast Vehicular Bridges and Continental

Pedestrian Steel Bridges

2 years for Bridge Inspection, 10 year cycle for painting/plant replacement from ASCE J. Perf Constr. Fac/Vol 16/Issue2/TECHNICAL PAPERS "Life Cycle Cost Based Maintenance Plan for Steel Bridge Protection Systems"

Bridge Painting and plank Replacement unit costs from RS Means "Costworks" 2021Q3 FMR

FAC 8526 Miscellaneous Paved Area

FY25 SUC:	$1.85 / SY
Source:	Set to FAC 8521, Cost Works Model

FAC 8531 Parking Garage/Building

FY25 SUC:	$0.73 / SF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8541 Traffic Control Signals

FY25 SUC:	$1,380.11 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Competitive Contract Awards

ANN ARBOR'S LED STREETLIGHT PROGRAM

SUMMARY

The City of Ann Arbor is installing LED streetlights in order to reduce lighting costs and greenhouse gas emissions. After successfully piloting an LED replacement for our downtown "globe" lights, the City received a $630,000 grant from the Ann Arbor Downtown Development Authority to fund retrofits for over 1,000 downtown lights. This initial installation will save the City over $100,000 per year, reducing annual greenhouse gas emissions by 267 tonnes CO_2e. In addition, testing will continue on LED replacements for neighborhood streetlights, with the eventual goal of replacing all of our public lighting with LEDs. Full implementation of LEDs would cut Ann Arbor's public lighting energy use in half and reduce greenhouse gas emissions by 2,200 tonnes CO_2e annually.

PROJECT HISTORY

Funding for public lighting is increasingly difficult as electric costs rise and available municipal funds get tighter. In its 2005-2006 budget, the City of Ann Arbor established a moratorium on new street lighting to help keep costs under control. City staff were tasked with finding ways to reduce public lighting costs. Like other cities, Ann Arbor had already replaced all its incandescent traffic signals with LEDs (light-emitting diodes). As with the traffic signals, LED streetlights, if the technology was sufficiently developed, could create significant energy and maintenance savings since LEDs reduce lighting energy requirements by one-half or more and last five times longer than conventional outdoor lighting technologies. In 2005, Ann Arbor committed to investigate LEDs for outdoor public lighting purposes as part of the ICLEI Great Lakes Climate Policy Project.

Initial research into past efforts with LED outdoor lighting in other municipalities like Honolulu and San Diego revealed failed efforts. These tests found that LED products had high costs and poor light output. To assess the current LED technologies, the city invited numerous LED manufacturers to provide test lights, which the City then installed at its own expense to evaluate the performance. Early lighting tests in 2006 were performed in the City Hall parking lot and showed improvement over the older LED technologies. Over the next two years, more successful technologies were demonstrated on city streets in the downtown area and in neighborhoods. Over the last two years of testing, city staff has seen a tremendous improvement in light output and color rendition from LED lighting manufacturers. While lighting distribution and uniformity remain a problem for the highly directional LEDs, we have found applications where the LED technology is ready to replace existing public lighting today.

Tests on LED replacements for our downtown pedestrian "globe" lights have been very successful. This retrofit globe from Lumecon houses LEDs on four panels that face down and out, directing the light toward the street and away from the sky. Each fixture draws 56 watts and is expected to last ten years, replacing fixtures that use 120 watts and only last two years. These globe lights are mounted on ten-foot poles. As a test, 25 of these LED globes, purchased with help from our Downtown Development Authority (DDA), were installed to light one complete block in the Ann Arbor downtown.

With five times the lifetime and less than half the energy use, the lights have a 4.4 year payback. We are now planning to retrofit all of these downtown lights over the next two years. Funding for the downtown light conversions is being provided by a $630,000 grant from the DDA. The downtown LED project will reduce annual greenhouse gas emissions by 267 tonnes CO_2e and save the city over $100,000 annually. The DDA grant will be administered through the Ann Arbor Municipal Energy Fund, which ensures that a portion of the savings from the retrofits is paid back to the fund to pay for future retrofits.

Meanwhile, Ann Arbor will continue to test possible LED replacements for the remainder of our streetlights. If the project succeeds in retrofitting all of the streetlights in Ann Arbor, the annual greenhouse gas emissions reduction is expected to be around 2,200 tonnes CO_2e annually. All of the test installations have signs requesting public input, and the response from the community has been overwhelmingly positive. There seems to be agreement that Ann Arbor's LED streetlight future will indeed be bright.

MORE INFORMATION: BENEFITS OF LEDS

The primary benefits of LEDs are their reduced energy consumption, longer lifetime, directionality and controllability. The energy savings are 50% or more and the lifetime is estimated at 5 times longer which yields the excellent payback time of 4.4 years. The "instant-on" and dimming ability of LEDs will offer additional energy savings through control strategies that can brighten and dim based on time of day, ambient light, or any other control parameters desired. Motion sensors can turn LEDs on or off instantly, allowing lighting to be used only when needed. Typical outdoor lighting (MH or HPS) has a re-strike time of a few minutes before they can turn on and therefore cannot be used with motion sensors. The City of Ann Arbor is partnering with lighting control companies to explore these new possibilities with LED lights. Finally, because LEDs emit directional light, we have more control over what we light (streets and sidewalks) and what we don't (the night sky). This makes for easier compliance with the Dark Skies Initiative, which aims to reduce light pollution and its associated wildlife impacts.

Our test globe LED fixtures use half the energy of the bulbs they replace and cobrahead fixtures use 50 to 80 percent less energy than our current cobraheads. This reduces emissions of mercury from coal power plants which leads directly to reduced CO2 emissions. Full implementation of LED streetlights could cut Ann Arbor's greenhouse gas emissions by over 2,200 tonnes CO_2-equivalent emissions.

One of the greatest advantages of LED fixtures is their lifetime, which reduces maintenance costs. At a ten-year lifetime (compared to two years for a metal halide bulb), city staff will need to change far fewer bulbs, ballasts, and igniters. In fact, maintenance savings alone are sufficient to make LED fixtures cheaper on a lifecycle basis than conventional fixtures.

MORE INFORMATION: LIFE-CYCLE COST ANALYSIS

Continue with existing bulbs (2 year life)

	Number	Cost	
Bulb replacements	5	$37	$186
Bulb labor & equip	5	$211	$1,056
Ballast (10 yr life)	1	$59	$59
Igniter (10 yr life)	1	$35	$35
Energy cost (4,380 kWh)			$325
			$1,661

10-year Maintenance saving	**$819**
10-year Energy saving	**$143**
Total	**$962**

Change to LED bulb (10 year life)

	Number	Cost	
Bulb replacements	1	$460	$460
Bulb labor & equip	1	$56	$56
Energy cost (2,100 kWh)			$182
			$698

Each LED replacement bulb saves $962 in energy and maintenance costs over its ten-year lifetime. At this savings rate, the new bulb pays for itself in 4.4 years ($423 / $96). This analysis is based on our downtown globe lights, but initial inquiries into cobrahead fixtures suggest that the results will be even better.

MORE INFORMATION: TEST INSTALLATIONS

The first test fixtures that the City received and installed in our City Hall parking lot in the summer of 2005 were unimpressive. We got the sense that LED lighting manufacturers were not quite ready to meet our public lighting needs. Over the following year, however, the test fixtures we received from manufacturers increased markedly in quality and today Ann Arbor is seriously considering moving to LEDs for public lighting.

Lumecon globes

The second test installation consists of a series of overhead streetlights (called "cobraheads" because of their shape) in a residential neighborhood. These fixtures have not been purchased yet as the block of downtown globes have, but are instead on loan from the manufacturers. Wattages vary from 50 to 80 watts for fixtures that replace 250-watt fixtures. Manufacturers of cobrahead replacements currently installed for testing include **Holophane, IntenCity, Leotek, Lumecon, and Millenia Technologies**.

Holophane cobrahead

To evaluate these fixtures, Ann Arbor is employing a four-part test process, with lights being assessed on light output, heat management (which affects lifetime), and general public input.

Light Output: The cobrahead replacements are installed on a residential street where the spacing allows for each fixture's light output to be judged independent of adjacent fixtures but where different fixtures can be easily compared. City staff is measuring light output and plans are in the works for a more involved public input process to evaluate the fixtures' aesthetics.

Heat Management: One of the most attractive characteristics of LEDs is their long lifetime, but this lifetime depends directly on the fixture's operating temperature. As a result, heat management testing is vital to identifying fixtures that achieve our goal of a ten-year life. City staff is measuring the operating temperature of fixtures to project the useful life of different test fixtures.

Energy Consumption: Each light is tested for electricity use in watts to verify energy savings.

Public Input: All the test installations have signs requesting public input, and the response from the community has been overwhelmingly positive (81 of 83 responses). The 81 positive responses emphasized the lack of light spilling out onto yards and house faces ("light trespass"). One negative response commented that the light was too harsh. The other negative comment reflects a minority opinion about the purpose of public lighting, objecting that the LED cobrahead no longer lit up their garage and yard and that the globe LEDs were creating a "dark cavern" through the downtown.

Test light public input sign

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City of La Palma
Agenda Item No. 6

MEETING DATE: May 20, 2014

TO: CITY COUNCIL

FROM: CITY MANAGER

SUBMITTED BY: Mike Belknap, Community Services Director

AGENDA TITLE: First Amendment to the Agreement with Computer Service Company (CSC) for Traffic Signal Maintenance Services

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PURPOSE:

The purpose of this report is to seek City Council approval for an amendment to the Agreement with Computer Service Company of Corona, California, for the Citywide Traffic Signal Maintenance Services, extending the term of the agreement through June 5, 2016.

BACKGROUND:

On June 5, 2011, the City entered into a three-year contract with Computer Service Company (CSC) of Corona, California for Citywide traffic signal maintenance with an optional two-year extension. CSC performs monthly signal maintenance services in addition to the extraordinary maintenance on as as-needed basis.

SUMMARY:

Computer Service Company has expressed their willingness to extend the contract for an additional two (2) year term, extending their agreement through June 5, 2016, and has requested a rate increase for the extension period. Following a cost analysis staff has determined the increase is justified and, according to the current agreement, would like to excise our option for a two (2) year extension. The table below is a comparison of the current rates and the proposed rates:

ROUTINE MAINTENANCE RATES

	Current Unit Price	Current Monthly Total	Proposed Unit Price	Proposed Monthly Total
Full Traffic Signal Maintenance per intersection (21) per month	\$53	\$1113	\$60	\$1260

Samples of Extraordinary Maintenance Costs
Labor and Equipment Rates

Labor Position / Equipment	Current Rate	Proposed Rate
Bench Technician	$72	$90
Transportation Maintainer Level 1	$65	$76
Transportation Maintainer Level 2	$55	$68
Boom Truck/Crane	$220	$240
Bucket Truck	$30	$32
Service Truck	$15	$17
Compressor	$25	$27
Arrow Board	$10	$12
Replace 8” LED Red Indication	$65	$70
Replace 8” LED Green Indication	$90	$95
Replace 12” LED Red Indication	$85	$100
Replace 12” LED Green Indication	$117	$121
Replace LED Pedestrian Head Nodule	$215	$225

The cost for routine maintenance would increase by $147 monthly for a total annual increase of $1,764. Extraordinary maintenance costs are undetermined as repairs are performed on an emergency basis. It should be noted that CSC has not requested a rate increase since the commencement of the Agreement.

Computer Service Company has been performing the City’s traffic signal maintenance since June 2006. They currently perform traffic signal maintenance for several cities in Southern California and their performance and response time has been excellent.

ALTERNATIVE:

The alternative to this Agreement Amendment would be to issue a Request for Proposals for the Citywide Traffic Signal Maintenance.

FISCAL IMPACT:

Sufficient funds for the Traffic Signal Maintenance contract are budgeted accordingly each Fiscal Year in account numbers 011-324-600 and 011-324-709.

RECOMMENDED ACTION:

It is recommended that the City Council amend the Agreement with Computer Service Company of Corona, California, for the Citywide Traffic Signal Maintenance Services, increasing the monthly routine maintenance costs and extraordinary maintenance costs, and extending the term of the agreement through June 5, 2016.

APPROVED:

Department Director	Administrative Services Director	City Manager

Attachment: 1. Proposed Agreement and Attachments

FIRST AMENDMENT
AGREEMENT FOR MAINTENANCE OF TRAFFIC SIGNALS

COMPUTER SERVICE COMPANY

THIS FIRST AMENDMENT TO THE AGREEMENT FOR MAINTENANCE SERVICES (hereinafter, the "Agreement"), entered into as of **June 5, 2014**, by and between the CITY OF LA PALMA, a municipal corporation (hereinafter, the "City"), and **Computer Service Company,** a corporation (hereinafter, the "Consultant"). The Consultants and the City are hereafter together referred to as the "Parties" and each individually as a "Party."

RECITALS

A. The parties hereto have previously entered into an Agreement for Maintenance of Traffic Signals, dated June 5, 2011, for services providing routine monthly maintenance and extraordinary maintenance of the traffic signals. A true and correct copy of this Agreement is attached hereto, marked "Exhibit B" and incorporated herein by this reference.

B. The City desires to extend the Agreement with the Contractor for a period of two (2) years through June 5, 2016 for the Maintenance of Traffic Signals.

WHEREFORE, the parties desire to amend said Agreement as follows:

1. **Period Covered by Agreement.** Said service of Maintenance of Traffic Signals shall continue through June 5, 2016.

2. **Consideration.** For services rendered, the following amount of $1260 for monthly routine maintenance costs, and fees or extraordinary maintenance shall apply as specified in "Exhibit A".

2. **Status of Agreement.** Except as noted in Section 1 above, all other terms of the Agreement dated June 5, 2011, shall remain in full force and effect.

IN WITNESS WHEREOF, this Agreement has been executed as of the date first written above.

CITY OF LA PALMA

By ______________________________

Steve Shanahan
Mayor

ATTEST:

____
Laurie A. Murray, CMC
City Clerk

COMPUTER SERVICE COMPANY

By ______________________________

____
[Title]

By ______________________________

____
[Title]

Exhibit A

COMPUTER SERVICE COMPANY
12907 E. GARVEY AVENUE, BALDWIN PARK, CA 91706
PH: (951) 738-1444 FAX: (626) 962-2521
STATE LICENSE NO. 171920

February 6, 2014

City of La Palma
Attn: Larry Baldwin
7822 Walker Street
La Palma, CA 90623-1771

RE: Extension of the Traffic Signal Maintenance Agreement

Dear Mr. Baldwin,

Pursuant to the terms of our current agreement, Computer Service Company would like to express its willingness to extend your contract for an additional two year period for traffic signal maintenance from June 6, 2014 through June 5, 2016.

At this time, we would also like to request an across the board modest rate increase that will be in effect for the remainder of the contract extension period. If you should have any questions regarding this matter, please feel free to contact our office. We look forward to another two years of service with the City of La Palma.

Very Truly Yours,

Jeff Telander

Jeff Telander
Business Development Manager
Customer Service Company

Cc Justin Cataldo, Operations Manager
Tim Roberts, Senior Estimator

EXHIBIT "B"

COMPENSATION RATES

ROUTINE MAINTENANCE RATES

Item No.	Quant.	Item of Work	Unit Price	Total
1.	21	Full Traffic Signal Maintenance each intersection per month	$ 60.00	$ 1,260.00
		Total of Item 1		$ 1,260.00
			X 12 months	$ 15,120.00

LABOR AND EQUIPMENT RATES
(for extraordinary maintenance)

Item No.	Labor Position	Straight Time Rate	Overtime Rate
1.	Bench Technician	$ 90.00 per hr.	$ 128.00 per hr.
2.	Transportation Maintenance Technician II	$ 76.00 per hr.	$ 114.00 per hr.
3.	Transportation Maintenance Technician I	$ 68.00 per hr.	$ 108.00 per hr.

Item No.	Equipment	Rate
1.	Boom Truck/Crane	$ 240.00 per hr.
2.	Bucket Truck	$ 32.00 per hr.
3.	Service Truck	$ 17.00 per hr.
4.	Compressor	$ 27.00 per hr.
5.	Arrow Board	$ 12.00 per hr.

LUMP SUM COMPENSATION RATES

Item No.	Item	Rate
1.	Detector Loop Replacement (6' Round Loop, Type E, Including Sawcut Lead-in)	$ 415.00 each
2.	Safety Light Bulb Replacement	$ 85.00 each
3.	Internally Illuminated Street Name Sign Bulb Replacement	$ 85.00 each
4.	Replace 8" LED Red Indication	$ 70.00 each
5.	Replace 8" LED Yellow Indication	$ 70.00 each
6.	Replace 8" LED Green Indication	$ 95.00 each
7.	Replace 12" LED Red Indication	$ 100.00 each
8.	Replace 12" LED Yellow Indication	$ 95.00 each
9.	Replace 12" LED Green Indication	$ 125.00 each
10.	Replace 12" LED Red Arrow Indication	$ 95.00 each
11.	Replace 12" LED Yellow Arrow Indication	$ 95.00 each
12.	Replace 12" LED Green Arrow Indication	$ 121.00 each
13.	Replace LED Pedestrian Head Module (Hand/Man)	$ 225.00 each
14.	Replace LED Pedestrian Head Module (Countdown)	$ 325.00 each

Exhibit B

AGREEMENT FOR MAINTENANCE OF TRAFFIC SIGNALS

THIS AGREEMENT, made and entered into this 5th day of June, 2011, by and between the CITY OF LA PALMA ("City"), and Computer Service Company ("Contractor").

WITNESSETH:

The parties hereto do agree as follows:

1. RECITALS: This AGREEMENT is made and entered into with respect to the following facts:

(a) That CITY, pursuant to Section 37103 of the Government Code of the State of California, desires to obtain certain services available through Contractor, specifically special engineering and maintenance skills relative to traffic signaling devices.

(b) That the principals of Contractor are well qualified to perform such services by reason of their special training and experience relating to the repair and maintenance of traffic signaling devices.

(c) That the public interest, convenience and necessity requires that City obtain such services upon the terms and conditions hereinafter set forth.

2. DEFINITIONS:

(a) "City Engineer" shall mean and refer to the City Engineer of the City of La Palma, acting personally or through his/her duly authorized agents, each agent acting only within the scope of authority delegated to him/her.

(b) "Police Chief" shall mean and refer to the Senior Management employee of the Police Department of the City of La Palma, acting personally or through his/her duly authorized agents, each agent acting only within the scope of authority delegated to him/her.

(c) The word "Contractor" shall mean and refer to Computer Service Company.

3. AUTHORITY OF THE CITY ENGINEER:

(a) The City Engineer shall decide any and all questions which may arise as to the quality or acceptability of materials furnished and work performed, and as to the manner of performance and rate of progress of the work. The City Engineer shall further decide all questions which arise as to the acceptable fulfillment of the agreement on the part of the Contractor; and all questions as to claims and compensations.

(b) The City Engineer's decision shall be final and he shall have authority to enforce and make effective such decisions and orders that the Contractor shall carry out promptly.

(c) At no time will any changes in timing or progression of the signals be made except with the approval and under the direct supervision of the City Engineer.

4. <u>SERVICES</u>:

(a) Traffic Signals: Contractor shall, during the term of this Agreement, service, maintain and overhaul, as set forth in detail below, traffic signal devices (i.e. time, semi-actuated and fully actuated traffic signals) at the locations set forth on EXHIBIT "A," attached hereto and incorporated herein by this reference, and at such other locations where such devices may from time to time be installed within the City. It is understood and agreed that all said labor, services, materials and equipment shall be furnished and said work performed and completed by the Contractor as an independent Contractor, subject to the inspection and approval of the City, the City Engineer's office, or inspectors or their representatives. When City desires to add traffic signal devices, to be served and maintained pursuant to this Agreement, it shall notify Contractor of such added signal devices at least ten (10) days in advance of the time such service shall commence. In the event any signals are installed, which are a more complicated type than those shown on Exhibit "A," these signals may be added to the maintenance contract at a price mutually satisfactory to the Contractor and the City.

The services to be performed by Contractor hereinunder shall consist of a maintenance program including, but not limited to the following:

i) The inspection, cleaning and adjustment of each controller unit, and the repair and replacement of any and all defective parts; such inspection, cleaning and adjustment shall take place as to each unit at least once per calendar month.

ii) The Contractor shall relamp on a group relamping basis. The relamping period shall be based on an 80% depletion curve, not to exceed twelve (12) months. Lamps shall be General Electric, Sylvania, Westinghouse, or City-approved equal.

iii) The replacement and/or repair of any and all defective parts of the controller mechanisms of any unit, or any part thereof, as may be necessary for the operation thereof.

iv) The cleaning, polishing, and inspection of all lenses and reflectors in each unit at the time the signal is relamped. All broken or deteriorated parts will be replaced or changed as necessary.

v) The maintenance of a patrol to insure the prompt replacement of burned out lamps and repair of controller malfunctions, and to ensure the traffic signal progression of all units according to timing relationships determined by the City Engineer.

vi) The servicing of the signal systems on an emergency basis in the event of malfunction of the controller or signal systems.

vii) Painting of Equipment. At the request of the City, the Contractor shall furnish a written estimate for the painting of the equipment. The painting of the equipment shall commence thirty (30) days after approval and be completed within sixty (60) days of commencement. Equipment that shall be painted shall include signal heads, pedestrian heads, back plates, service cabinets, pedestrian buttons, and controller cabinets.

5. ANSWERING SERVICE CALLS: The Contractor shall maintain a 24-hour emergency service so that it may be contacted at any hour of the day or night and will be required to answer different types calls, as specified below, within certain time limits. The Contractor shall supply the City Engineer and the Police Chief with a telephone number from which its radio operator may be contacted at all hours.

(a) Light out calls. Two separate signal head indications will be required for each direction of traffic at all times. When this number falls below two, the Contractor shall answer the light out call as soon as possible, not to exceed two hours, day or night. In the event a light out call is received with the report that two indications are still remaining, the Contractor shall answer the call within 24 hours. It shall be the responsibility of the Contractor to determine the number of indications in operation.

(b) Emergency calls. Except as set forth in Paragraph (a) above, if the signal is malfunctioning in any manner, the Contractor shall answer the call immediately, regardless of the fact that the controller may have been switched to flashing operation by the Police Department. The word "immediately" is construed to mean with all possible haste, and shall not exceed one hour.

(c) Equipment required. The Contractor shall be equipped with spare parts sufficient to place the signal back in operation for ordinary trouble calls. In those cases where a complex controller or component has to be repaired, the Contractor shall be required to furnish and install a substitute controller or component until the defective controller or component is repaired or replaced to its original condition as originally installed.

6. EXTRAORDINARY MAINTENANCE: Whenever during the course of this Agreement any part of the signal system is damaged by collision, Acts of God or malicious mischief, excepting damage resulting from the negligence of the Contractor, the repair of such damage will be paid for as extraordinary maintenance according to the terms set forth in EXHIBIT "A," attached hereto and incorporated herein by this reference. In addition to this, the replacement of vehicle detectors, pedestrian signal neon tubes and transformers, fluorescent street name signs, or any revision work the City may request the Contractor to perform will be paid for as extraordinary maintenance. All non-emergency extraordinary maintenance will be subject to prior approval of the Director of Public Works/City Engineer. Emergency extraordinary maintenance shall be considered as damage resulting from collision, Acts of God or malicious mischief. Under an extraordinary emergency situation, the Contractor shall use reasonable judgment as to the extent of the hazard present and perform whatever work is necessary to put the signal system back into service. If permanent repairs are not immediately possible, Contractor shall put the signal in temporary operating condition. If service cannot be reestablished, temporary four-way Stop signs (36" size minimum) and advance warning signs ("Stop Ahead") shall be placed to control the traffic. On arterial streets, a minimum of two (2) Stop signs shall be required for each direction of traffic.

7. COMPENSATION: City shall pay to Contractor the sum in accordance with the proposals in EXHIBIT "B" per month for each intersection as listed in EXHIBIT "C", for the traffic signal maintenance program set forth in Section 4 (a) of this Agreement.

Contractor shall be entitled to additional compensation for extraordinary maintenance. Billing for extraordinary maintenance shall include only the following:

(a) Labor and equipment as listed in EXHIBITS "B" and "C".

(b) Cost of materials plus 15 percent.

On a monthly basis, the Contractor and the City Engineer or his representative will meet for approximately one hour at a mutually agreed upon time and place. The Contractor shall deliver to the City Engineer or his representative at this meeting, not to be held later than the 10th of the month, a complete written record of all work that was performed on the City's traffic signal equipment during the previous month. Such record shall include the location of each separate service, the day and approximate time, and the reason for the service, whether routine, emergency, or extraordinary, and the number of hours spent.

Upon receipt of each monthly invoice and certification by the City Engineer, the City will, within thirty (30) days after receipt of such invoice, pay to the Contractor all certified sums.

8. EXTENSION OF AGREEMENT: Sixty (60) days prior to the end of the agreement period, the City Engineer will contact the Contractor and determine if Contractor desires the City to extend the Agreement. In the event the Contractor is willing to extend the agreement the City will determine if justification exists for increase or decrease in the monthly service cost per intersection and whether extraordinary maintenance charges for labor and equipment (service type) is applicable. Following this cost analysis, the City Engineer will present the cost increase and/or decrease to the City Council for approval, and ask the Council to extend the basic contract for an additional two-year period. The provisions of the balance of the Agreement will remain applicable. To the extent that they are modified, the monthly maintenance per intersection costs and EXHIBITS "B" and "C" shall be attached as applicable to this Agreement, and signed by the City and the Contractor.

9. LICENSE: The Contractor shall take out and maintain during the life of this Agreement a City Business License.

10. INSURANCE AND LIABILITY: The Contractor shall not commence work under this Agreement until it has secured all types and amounts of insurance required under this section, nor shall it allow any Subcontractor to commence work on any subcontract until all similar insurance required of the Subcontractor has been obtained. Without limiting Contractor's indemnification obligations, Contractor shall procure and maintain, at its sole cost and for the duration of this Agreement, insurance coverage as provided below, against all claims for injuries against persons or damages to property which may arise from or in connection with the performance of the work hereunder by Contractor, its agents, representatives, employees, and/or subcontractors. In the event that Contractor subcontracts any portion of the work, the contract between the Contractor and such subcontractor shall require the subcontractor to maintain the same policies of insurance that the contractor is required to maintain pursuant to this Section 10.

(a) Insurance Coverage Required. The policies and amounts of insurance required hereunder shall be as follows:

i) General Liability (including premises and operations, contractual liability, personal injury, independent contractor's liability): Three Million Dollars ($3,000,000.00) per occurrence.

ii) Automobile Liability (including owned, non-owned, leased, and hired autos): One Million Dollars ($1,000,000.00), single limit, per occurrence for bodily injury and property damage.

iii) Workers Compensation and Employer's Liability Workers Compensation Insurance (if Contractor is required to have) in an amount required by the laws of the State of California and Employer's Liability Insurance in the amount of One Million Dollars ($1,000,000.00) per occurrence for injuries incurred in providing services under this Agreement.

iv) Professional Liability (covering errors and omissions): One Million Dollars ($1,000,000.00) per claims made.

(b) General Requirements. Contractor's insurance:

i) Shall be issued by an insurance company which is an admitted carrier in the State of California and maintains a Secure Best's Ratings of "-A" or higher; unless otherwise approved by City;

ii) General Liability, Automobile Liability and Employer's Liability shall name the City, and its officers, officials, employees, agents, representatives and volunteers (collectively hereinafter "City and City Personnel") as additional insureds and contain no special limitations on the scope of protection afforded to City and City Personnel. All insurance provided hereunder shall include the appropriate endorsements.

iii) Shall be primary insurance and any insurance or self-insurance maintained by City or City Personnel shall be in excess of Contractor's insurance and shall not contribute with it;

iv) Shall be "occurrence" rather than "claims made" insurance, excluding Professional Liability;

v) Shall apply separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the insurer's liability;

vi) Shall be endorsed to state that the insurer shall waive all rights of subrogation against City and City Personnel, excluding Professional Liability;

vii) Shall be written by good and solvent insurer(s) admitted to do business in the State of California and approved in writing by City; and

viii) Shall be endorsed to state that coverage shall not be suspended, voided, cancelled, reduced in coverage or in limits, non-renewed, or materially changed for any reason, without thirty (30) days prior written notice thereof given by the insurer to City by U.S. mail, or by personal delivery, except for nonpayment of premiums, in which case ten (10) days prior notice shall be provided.

(c) Deductibles. Any deductibles or self-insured retentions must be declared to and approved by City prior to the execution of this Agreement by City.

(d) Evidence of Coverage. Contractor shall furnish City with certificates of insurance demonstrating the coverage required by this Agreement which shall be received and approved by City not less than five (5) working days before work commences.

(e) Workers Compensation Insurance. If Contractor is required to provide Workers' Compensation Insurance, Contractor shall file with City the following signed certification:

> "I am aware of, and will comply with, Divisions 4 and 5 of the California Labor Code by securing, paying for, and maintaining in full force and effect for the duration of the contract, complete Workers' Compensation Insurance, and shall furnish a Certificate of Insurance to City before execution of the Agreement."

In the event Contractor has no employees requiring Contractor to provide Workers' Compensation Insurance, Contractor shall so certify to City in writing prior to City's execution of this Agreement. City and City Personnel shall not be responsible for any claims in law or equity occasioned by failure of the Contractor to comply with this section or with the provisions of law relating to Workers' Compensation.

11. INDEMNIFICATION: Contractor shall indemnify, defend, and hold the City and City Personnel harmless from and against any and all actions, suits, claims, demands, judgments, attorney's fees, costs, damages to persons or property, losses, penalties, obligations, expenses or liabilities (herein "claims" or "liabilities") that may be asserted or claimed by any person or entity arising out of the willful or negligent acts, errors or omissions of Contractor, its employees, agents, representatives or subcontractors in the performance of any tasks or services for or on behalf of City, whether or not there is concurrent active or passive negligence on the part of City and/or City Personnel, but excluding such claims or liabilities arising from the sole active negligence or willful misconduct of the City or City Personnel. In connection therewith:

(a) Contractor shall defend any action or actions filed in connection with any such claims or liabilities, and shall pay all costs and expenses, including attorney's fees incurred in connection therewith.

(b) Contractor shall promptly pay any judgment rendered against City or any City Personnel for any such claims or liabilities.

(c) In the event City and/or any City Personnel is made a party to any action or proceeding filed or prosecuted for any such damages or other claims arising out of or in connection with the negligent performance or a failure to perform the work or activities of Contractor, Contractor shall pay to City any and all costs and expenses incurred by City or City Personnel in such action or proceeding, together with reasonable attorney's fees and expert witness fees.

12. OBSERVING LAWS AND ORDINANCES: The Contractor shall keep itself fully informed of all existing and future state and federal laws and all county and city ordinances and regulations which in any manner affect the conduct of the work, and of all such orders and decrees of bodies or tribunals having any jurisdiction or authority over same. If any discrepancy or inconsistency is discovered in the Contract Documents in relation to any such law, ordinance, regulation, order or decree, the Contractor shall forthwith report the same to the City Engineer in writing. The Contractor shall at all times observe and comply with and shall cause all its agents and employees to observe and comply with all such existing and future laws, ordinances, regulations, orders and decrees, and shall protect, indemnify and defend the City, the City Engineer, and all of their respective officers, employees, and representatives against any claim or assertion of liability, or liability arising from or based on the violation of any such law, ordinance, regulation, order or decree, whether by the Contractor or its employees.

(a) Labor Code of California. The Contractor's attention is directed to Division 2, Part 7, Chapter 1 of the Labor Code of the State of California and especially to Article 2 (Wages), and Article 3 (Working Hours), thereof.

i) In accordance with Section 1773 of the Labor Code, the City Council of the City of La Palma has found and determined the general prevailing rates of wages in the locality in which the public work is to be performed are those contained in that certain document entitled PREVAILING WAGE SCALE, copies of which are maintained at City Hall, and are available to any interested party on request. Contractor shall post a copy of said document at each job site.

ii) In accordance with Section 1773.1 of the Labor Code the Contractor shall pay travel and subsistence payments to each worker needed to execute the Work, as such travel and subsistence payments are defined in the applicable collective bargaining assurances filed with the Department of Industrial Relations.

iii) The Contractor is aware of and will comply with the provisions of Labor Code Section 1776, including the keeping of payroll records and furnishing certified copies thereof in accordance with said section. The Contractor shall submit certified payrolls to the City Engineer, including certified payrolls for all Subcontractors, at any tier, performing work on the site, regardless of the dollar amount or type of subcontract, on a weekly basis. If by the 15th of the month, the Contractor has not submitted satisfactory payrolls for all work performed during the monthly period ending on or before the 1st of that month, the City will retain an amount equal to ten (10%) percent of the estimated value of the work performed during the month from the next monthly estimate. Retention for failure to submit satisfactory payrolls shall be additional to all other retention provided for in the Contract.

iv) Pursuant to Labor Code Section 1810 it is stipulated hereby that eight (8) hours labor constitutes a legal day's work hereunder.

v) Pursuant to Labor Code Section 1813, it is stipulated hereby that the Contractor shall, as a penalty to the City, forfeit $25 for each worker employed in the execution of this Contract by the Contractor or by any subcontractor hereunder for each calendar day during which such worker is required or permitted to work more than eight (8) hours in any one calendar day and forty (40) hours in any one (1) calendar week in violation of the provisions of Article 3 (commencing with Section 1810), Chapter 1, Part 7, Division 2 of the Labor Code.

vi) The Contractor is aware of and will comply with the provisions of Labor Code Sections 1777.5 and 1777.6 with respect to the employment of apprentices. Pursuant to Section 1777.5 it is hereby stipulated that the Contractor will be responsible for obtaining compliance therewith on the part of any and all subcontractors employed by him or her in connection with this Contract.

vii) Pursuant to Labor Code Section 1775, it is hereby stipulated that the Contractor shall, as a penalty to City, forfeit not more than $50 for each calendar day, or portion thereof, for each worker paid less than the prevailing rates as determined by the Director of the Department of Industrial Relations for the work or craft in which the worker is employed for the Work under the contract by Contractor or by any subcontractor under the Contractor.

13. ASSIGNMENT: The Contractor shall not assign this Agreement or any portion hereof, without first obtaining the written consent of City. If such assignment is made or attempted by Contractor, City, at its sole option, may terminate this Agreement upon the giving of a 24-hour written notice to Contractor of such termination.

14. TERM OF CONTRACT: This Agreement shall be in full force and effect for a period of three years through June 5, 2014 . However, either, party, at its discretion, shall have the right to terminate this Agreement at anytime by giving sixty (60) days advance written notice.

15. PERFORMANCE: If the Contractor should neglect to prosecute the work properly, or fail to perform any provisions of this Agreement, the City, after five (5) days written notice to the Contractor, may, without prejudice to any other remedy it may have, make good such deficiencies and may deduct the cost thereof from the payment then or thereafter due the Contractor, provided, however, that the Director of Public Works/City Engineer shall approve such action and certify the amount thereof to be charged to the Contractor.

16. NOT AN AGENT OF CITY: It is expressly understood and agreed that the Contractor herein named in the furnishing of all labor, services, materials and equipment, and performing the work as provided in this contract, is acting as an independent contractor and not as an agent, servant or employee of the City.

17. WARRANTIES: Except for the manufacturer's factory warranty, the Contractor disclaims all warranties with respect to materials supplied hereunder, and further disclaims any and all liability for failure to perform or delay in performance hereunder where the same is due in whole or in part to any cause beyond Contractor's reasonable control, such as, but not limited to, fire, flood, earthquake, lightning strike, or other labor difficulty.

18. ENTIRE AGREEMENT; CONSTRUCTION; AMENDMENT: This Agreement full, complete and final agreement between the parties relating to the subject matter hereof, and no prior oral or written agreement or understanding shall have any force or effect. This Agreement shall be construed in accordance with the laws of the State of California. This Agreement may not be modified or amended except by a written instrument signed by authorized representatives of the City and Contractor.

not be modified or amended except by a written instrument signed by authorized representatives of the City and Contractor.

IN WITNESS WHEREOF, the City Council of the City of La Palma caused the Agreement to be subscribed by its Mayor and City Clerk and said Contractor has executed or caused this Agreement to be executed by its duly authorized officer(s).

CITY OF LA PALMA

Dated: May 17, 2011

Ralph D. Rodriguez
Mayor

ATTEST:

Dated: May 17, 2011

Laurie A. Murray, CMC
City Clerk

CONTRACTOR

By: ______________________

Name Vincent P. Mauch

Title CFO for Computer Service Co

By: ______________________
Gayle C. Kappelman

Name Gayle C. Kappelman

Title Secretary for Computer Service Co

APPROVED AS TO FORM:

City Attorney

EXHIBIT "A"

SCOPE OF SERVICES

SCOPE OF SERVICES:

1. General

During the term of this Agreement, the Contractor shall furnish all tools, equipment, apparatus, facilities, labor, services and material to perform all work necessary to maintain in good and workmanlike manner the traffic signal facilities and City owned street lighting, in accordance with this defined scope of work.

The Contractor shall be equipped with spare parts sufficient to return a defective traffic signal to operation following ordinary trouble calls. Since the primary traffic signal controllers/equipment used in the City of La Palma is manufactured by Econolite Products, the Contactor shall have on hand at least two spare Econolite ASC/2-2000 controllers and one ASC/2M-1000 Master for use in the City of La Palma. In addition, other spare equipment shall include bus interface units (BIU's), power supply units, and malfunction management units (MMU's).

The Contractor shall provide a Maintenance Transportation Technician with a minimum certification from the International Municipal Signal Association (IMSA) Level II Technician. Transportation Maintainers, Levels 1 and 2, may also be used to perform the scope of work as allowed by the Department of Industrial Relations. The City reserves the right at all times to concur with the Contractor's assignment of personnel to the City. If necessary, the Contractor shall replace any personnel assigned to the City whose performance is considered unacceptable by the City, or the standards established per this scope of services.

2. Specifications

All signal work shall be performed in accordance with the current Standard Plans and Section 86 of the Standard Specifications for the State of California, Department of Transportation, and the current City of La Palma Standard Plans. All work performed or equipment/parts supplied by the Contractor shall be subject to the inspection and approval of the City. Failure to pass inspection on any maintenance, repair, or service item will result in non-payment for that item until such time as the Contractor can upgrade the item to an acceptable condition.

3. Additions to System

The Contractor shall maintain, at the same unit price, additional traffic signals as they are added to the list of locations to be maintained. In the event notification is made at other than the beginning of the month, payment for that month shall be prorated from the day the Contractor is notified.

4. Maintenance Records

The Contractor shall maintain a record of all service calls and work performed upon the traffic signal facilities listing dates, hour of day, and description of the work performed. A copy of this record shall be maintained at all times within the traffic signal controller cabinet at each traffic signal location.

A summary log sheet giving a brief description of all routine and extraordinary maintenance activities shall be attached to each associated monthly invoice. Invoices will not be paid until the summary has been received.

5. Notification

The Contractor shall notify one of the City's designated representatives by telephone within twenty-four hours or the next business day regarding alterations to the operation of any traffic signal or the installation/removal of any substitute controller or component.

6. Types of Traffic Signal Equipment

The bid prices for both the routine and extraordinary maintenance shall apply to the types of traffic signal controllers, accessories, and systems as may exist in the City now or that may be installed during the life of the contract.

7. Public Convenience and Safety

The Contractor shall so conduct his operation as to cause the least possible obstruction and inconvenience to the public.

The Contractor shall furnish, erect, and maintain such fences, barriers, lights, warning devices, and signs in compliance with the current Work Area Traffic Control Handbook (WATCH), or as may deemed necessary by the Director of Public Works or his designated representative to give adequate warning to the public at all times.

8. Routine Maintenance

A. Traffic Signals

The Contractor shall provide a continuing, comprehensive, routine maintenance program designed to eliminate or reduce the incidents of malfunctions, operations complaints, and extend the useful life of the traffic signal equipment at the locations noted on Exhibit "C".

The services to be performed on the traffic signals/flashing beacons by the Contractor shall consist of a preventative maintenance program, including but not limited to the following:

- To inspect, clean, and adjust each controller unit and controller cabinet and make a routine inspection once per calendar month. All controller settings shall be checked using the cabinet timing sheets to ensure that all settings are correct. Any discrepancies shall be reported to the designated City representative. The Contractor agrees to maintain a record in each controller cabinet showing the date and time checked. Controllers which are replaced for repair must be reported to the City within 24 hours of the replacement.

- The replacement or repair of any and all defective parts of the traffic signal system which may cause a signal malfunction or failure, as the occasion arises per routine maintenance, such as the signal controller, flashers, vehicle detectors, etc.

- The Contractor shall replace the air filter elements in all traffic signal cabinets every six months. The replacement date shall be noted on the maintenance log kept in the cabinet.

B. Safety Lighting/Internally Illuminated Street Name Signs

The routine maintenance bid price for traffic signals shall include one night-time inspection each calendar month to check the safety lighting and internally illuminated street name signs (IISNS) at each signalized intersection noted on Exhibit "C". The price for this monthly night-time inspection shall be included as part of the routine maintenance of the intersection. Replacements of burned-out lamps shall be at the rates noted on Exhibit "B" compensation rates. All other repairs to the safety lighting and IISNS shall be billed under extraordinary maintenance.

C. Conflict Monitors/MMU's

The Contractor shall test the conflict monitors or MMU's using the MT-180 conflict monitor tester or other approved tester on an annual basis. The Contractor shall supply a report for each test conducted. The testing of conflict monitors shall be included in the lump sum bid for routine maintenance of the intersection. Any conflict monitor that does not pass the required test shall be repaired or replaced and billed as extraordinary maintenance.

E. Traffic Signal Master/Interconnect

The Contractor shall provide trained technicians/personnel qualified in the field testing of an Econolite ASC/2M-1000 traffic signal master and the related closed-loop traffic signal interconnect system. Technicians assigned to the installation or repair of the City's traffic signal interconnect system shall have training or be directly supervised by a technician with experience in the installation and handling of twisted pair hardwire interconnect cable. The repair or replacement of traffic signal interconnect system shall be billed as extraordinary maintenance.

F. Payment for Routine Maintenance

The Contractor shall submit monthly billings for routine maintenance at the lump sum price per traffic signal location and for the monthly saftey light survey. Said compensations shall include all labor, materials, equipment, overhead and profits for routine services in the price bid per intersection or location as detailed in the scope of services and no extra compensation will be allowed.

9. Emergency Service

The Contractor shall maintain a 24-hour emergency service for contact at any hour of the day or night and will be required to answer different types of calls, as specified below, within certain time limits.

A. Light Out Calls

Two separate indications, one of which must be the mast arm indication, will be required for each direction of traffic at all times. When this number falls below two, or the mast arm indication is out, the Contractor shall answer the light out call as soon as possible, not to exceed two hours, day or night. If a light out call is received with the report that two indications are remaining, one of which must be the mast arm indication, the Contractor shall answer the call within 24 hours. Light out calls for safety lighting will be answered within 24 hours.

B. Emergency Calls

Whenever a traffic signal is malfunctioning in any manner, the Contractor shall answer the call immediately, regardless of the fact that the controller may have been switched to flashing operation by the Police Department. The word "immediately" is construed to mean "with all possible haste", and shall not exceed one hour under normal circumstances.

The Contractor shall be equipped with spare parts sufficient to place the traffic signal back in ordinary operation. In those cases where a complex component has to be repaired, the Contractor shall be required to furnish and install a substitute component until the defective component is repaired. In the case of a controller, the substitute controller must be capable of operating with the City's Econolite closed loop traffic signal interconnect system, if the existing controller had that same capability.

The Contractor shall make the required repairs to restore or maintain the traffic signal in good working condition. The Contractor shall supply the Director of Public Works and the Police Department with a telephone number from which his radio operator may be contacted at all hours.

10. Extraordinary Maintenance

Extraordinary maintenance shall be defined as:

- Repair/services of damages resulting from collisions which have caused dislocation of poles or equipment, vandalism, street rehab/construction related projects, or natural or civil disasters.

- Additional extraordinary maintenance will include modifications to traffic signal equipment such as, but not limited to, upgrades of controller cabinets and controller components, LED signal indication replacements, LED pedestrian indication replacements, painting of traffic signal cabinets and signal heads, installation of new signal indications, lenses or framework, installation of signal loop detectors, installation of traffic signal interconnect cable or components or replacement of obsolete equipment.

- The Contractor may be required to assist in the final inspection of new installation of traffic signals, traffic signal interconnect, loop detectors or other traffic related type projects.

A. Notifications

The Contractor shall report to the Director of Public Works or his authorized representative the said conditions and provide satisfactory evidence that replacement is necessary per terms of extraordinary work. The Contractor shall provide cost estimates, including labor, equipment, and all incidentals to perform said work. No work shall proceed without the Director of Public Works or his authorized representative's authorization except in emergencies where injury or property damage may result without prompt response.

B. Payment for Extraordinary Maintenance

Upon the receipt of an itemized invoice within thirty days of completion of the work, the City shall compensate the Contractor for such repairs required beyond the scope of routine maintenance as follows:

Materials

The City shall pay the Contractor for materials used in extraordinary maintenance the Contractor's cost from the supplier plus the percentage mark-up, which shall in no case be greater than 15%. All materials and parts shall be new or have the approval of the Director of Public Works or his designated representative if otherwise. The City has the right to inspect the Contractor's records to verify any material costs used in extraordinary maintenance.

Direct Labor

The Contractor shall present with his monthly invoice a record of hours spent in extraordinary maintenance of traffic signals and appurtenances per intersection or location. The City shall pay the Contractor for such hours of extraordinary maintenance at the hourly rates specified in Exhibit “B”. Said hourly rates shall be the total cost to the City. The rates shall include all compensation for wages, profit, overhead, and any fringe benefits.

Equipment

The City shall pay the Contractor for equipment used in extraordinary maintenance on a per hour basis as specified in Exhibit “B” and per the appropriate required equipment to complete the work.

The Contractor’s listing of per-hour equipment rates shall constitute total rates to be paid by the City when specified equipment is used. No additional payment of any kind shall be paid for equipment except as specified on Exhibit “B” for per hour rates.

Any other equipment that may be needed to be rented in order to perform the extraordinary maintenance that is not listed shall be billed at the local rental rate plus the percentage mark-up, which in no case shall be greater than 15%. Documentation of the rented equipment with the applicable rental rates must be submitted with any invoices.

No additional compensation shall be paid for transporting the equipment to or from the job site.

EXHIBIT "B"

COMPENSATION RATES

ROUTINE MAINTENANCE RATES

Item No.	Quant.	Item of Work	Unit Price	Total
1.	21	Full Traffic Signal Maintenance each intersection per month	$ 53.00	$ 1,113.00
		Total of Item 1		$ 1,113.00
		X 12 months		$ 13,356.00

LABOR AND EQUIPMENT RATES
(for extraordinary maintenance)

Item No.	Labor Position	Straight Time Rate	Overtime Rate
1.	Maintenance Transportation Technician	$ 72- per hr.	$ 108- per hr.
2.	Transportation Maintainer Level 2	$ 65- per hr.	$ 97.50 per hr.
3.	Transportation Maintainer Level 1	$ 55- per hr.	$ 82.50 per hr.

Holiday and Double Time Rates will Apply

Item No.	Equipment	Rate
1.	Boom Truck/Crane w/operator	$ 220- per hr. 4 hr. Min.
2.	Bucket Truck	$ 30- per hr.
3.	Service Truck	$ 15- per hr.
4.	Compressor	$ 25- per hr.
5.	Arrow Board	$ 10- per hr.

LUMP SUM COMPENSATION RATES

Item No.	Item	Rate
1.	Detector Loop Replacement (6' Round Loop, Type E, Including Sawcut Lead-In)	$ 390 — each
2.	Safety Light Bulb Replacement	$ 80 — each
3.	Internally Illuminated Street Name Sign Bulb Replacement	$ 80 — each
4.	Replace 8" LED Red Indication	$ 65 — each
5.	Replace 8" LED Yellow Indication	$ 65 — each
6.	Replace 8" LED Green Indication	$ 90 — each
7.	Replace 12" LED Red Indication	$ 85 — each
8.	Replace 12" LED Yellow Indication	$ 85 — each
9.	Replace 12" LED Green Indication	$ 136.30 each
10.	Replace 12" LED Red Arrow Indication	$ 80 — each
11.	Replace 12" LED Yellow Arrow Indication	$ 80 — each
12.	Replace 12" LED Green Arrow Indication	$ 117 — each
13.	Replace LED Pedestrian Head Module	$ 215 — each
14.	Replace LED Pedestrian Count Down Type Head Module	$ 315 Each

EXHIBIT "C"

LOCATION OF TRAFFIC SIGNALS TO BE MAINTAINED

1. La Palma & Denni
2. La Palma & Redford
3. La Palma & Bravo
4. Moody & Crescent
5. Moody & La Luna
6. Moody & Windsong
7. Moody & La Palma
8. Moody & Sharon
9. Moody & Houston
10. Walker & JFK
11. Walker & La Luna
12. Walker & La Palma
13. Walker & LP Hospital
14. Walker & Civic Center
15. Walker & ROW
16. Walker & Marview
17. Walker & Houston
18. Walker & Orangethorpe
19. Walker & 183rd
20. Orangethorpe & Centerpointe
21. Valley View & Centerpointe

The previous SUC of $2940.62 was based upon competitive contracts awarded by cities during 2001 through 2007 for city wide maintenance.

Since that time the Energy Independence and Security Act of 2007 has impacted the manufacture of light bulbs by requiring energy efficiency, phasing out traditional incandescent bulbs and ushering in LEDs for many uses, including traffic signals. This switch and the increased reliability of signal mechanisms have resulted in significant decreases in the cost of operating and maintaining traffic signals. For example, cost reductions in maintenance of 75% and 61% have been reported by the cities of Portland, Oregon and Ann Arbor, Michigan.

A competitive award for signal maintenance of 21 intersections utilizing LED based signals for the City of La Palma CA was for $60/month/intersection ($720/yr/intersection). (2014)

A competitive award for signal maintenance by the Morris County (NJ) Cooperative Pricing Council was for $440 per year per intersection. (July 2016)

A competitive award by Glendale, CA to Siemens was for $89.14/mo/intersection ($1069.70/yr/intersection). (2013)

This table lists the annual cost per intersection, provides an area adjustment and inflation adjustment, and averages the three competitive prices:

Entity	Year Awarded	Award Price	Area Cost Factor	Inflation Adjustment	FY18v19 Price
La Palma CA	2014	$ 720.00	1.20	1.0708	$ 925.19
Morris County NJ	2016	$ 440.00	1.30	1.0257	$ 586.72
Glendale CA	2013	$ 1,070.00	1.20	1.0947	$ 1,405.64
	Average Cost per Intersection				**$ 972.51**

glendale
california

CITY OF GLENDALE, CALIFORNIA
REPORT TO THE:

Joint ☐ City Council ☒ Housing Authority ☐ Successor Agency ☐ Oversight Board ☐

June 4, 2013

AGENDA ITEM

Report: Maintenance of Traffic Signals and Other Traffic-Related Electrical Devices

1) Motion authorizing the City Manager, or his designee, to execute an agreement with Siemens Industry, Inc. for the maintenance services of traffic signals and other traffic-related electrical devices.

COUNCIL ACTION

Public Hearing ☐ Ordinance ☐ Consent Calendar ☒ Action Item ☐ Report Only ☐

Approved for ________ calendar

ADMINISTRATIVE ACTION

Signature

Submitted by:
Stephen M. Zurn, Director of Public Works

Prepared by:
Wayne C. Ko, P.E., Principal Traffic Engineer

Approved by:
Scott Ochoa, City Manager

Reviewed by:
Roubik Golanian, P.E., Deputy Director of Public Works/City Engineer

Yasmin K. Beers, Assistant City Manager

Michael J. Garcia, City Attorney

5 B /

RECOMMENDATION

Staff respectfully recommends City Council's approval of the attached motion authorizing the City Manager, or his designee, to execute a five-year agreement with Siemens Industry, Inc. to provide maintenance services for the City's traffic signals and other traffic-related electrical devices.

BACKGROUND/ANALYSIS

In Glendale, traffic signals are maintained by a private contractor because staff believes it is more economical than for the City to employ its own signal maintenance crew. Since July of 2008, Siemens Industry Inc. (formerly Republic ITS) has been maintaining the City's traffic signals and other traffic-related electrical devices. These devices currently consist of 232 traffic signals, 15 hard-wired flashing beacon systems, 23 solar-powered wireless flashing beacon systems, 13 in-roadway warning light (IRWL) systems, and other miscellaneous electrical devices.

The current contract with Siemens will expire on June 30, 2013. In March 2013, staff issued a request for proposals (RFP) for the maintenance of traffic signals and other traffic-related electrical devices. Proposals were received from three contractors: Siemens Industry Inc., Wescorp, and Aegis ITS. An evaluation committee consisting of Glendale's Public Works Engineering Division staff and a representative from the City of Pasadena reviewed all the proposals and conducted an interview with each contractor on April 17, 2013. The contractors were evaluated based on the following criteria:

1. Overall understanding of the project and quality of the proposal;
2. Firm's qualifications and similar project experience;
3. Key project personnel's qualifications, experiences and time commitment; and
4. Information obtained from references.

Siemens Industry was ranked number one by the evaluation committee. A summary of the ranking of the three contractors is listed below.

Contractor	Average Points(100 max)	Ranking
Siemens Industry, Inc.	92	1
Aegis ITS	86	2
Wescorp	75	3

Siemens was ranked the highest for its high quality maintenance program, key personnel to be assigned to Glendale, financial stability of the firm, and availability of additional resources to be assigned to Glendale in case of emergencies. Siemens has the largest team of traffic signal maintenance technicians in the nation and maintains traffic signals in over 200 communities in California. Due to the presence of Siemens personnel in many other cities in Los Angeles County, such as Alhambra, South Pasadena, San Marino and Acadia, it has the unique ability to promptly deploy extra crew members to handle emergency situations. In addition, Siemens is a licensed electrical construction contractor and is fully capable of performing various signal repairs and modification works based on pre-determined unit prices. Over the past 5 years, the City's experience with the services of Siemens has been very positive.

Due to price competition, staff was successful in negotiating a contract with Siemens that is comparable in cost with the other contractors. A summary of the cost proposals from the three contractors is listed in Exhibit 1. Even though Siemens' fees for monthly preventive maintenance is higher than the costs proposed by the other two contractors, Siemens' fees for labor and services are substantially lower. Thus Siemens' fee for extraordinary maintenance services are much lower than those proposed by Aegis ITS and Wescorp.

Because of the reasons stated above and to reduce staff's effort in conducting another contractor selection process in the near future, staff respectfully recommends City Council to approve a five-year service contract with Siemens Industry, Inc. for the maintenance of traffic signals and other traffic-related electrical devices. The City retains the right to exercise the option of terminating the contract at any time upon giving a ten-day prior written notice should any problems arise.

FISCAL IMPACT

The estimated costs of the maintenance program for fiscal years 2013-14 to 2017-18 are shown in the table below and are grouped into three categories.

1. Routine preventive maintenance: Costs are calculated based on unit prices provided by Siemens multiplied by the number of traffic signals and other traffic-related electrical devices currently in the City. These costs could increase slightly as new devices are added in the future.
2. Extraordinary maintenance services: Costs are for repairing malfunctioned or damaged traffic equipment, responses to emergency knockdowns, markings for underground facilities, and miscellaneous services. These costs are estimated based on historical maintenance records and the average frequency of occurrence for various types of malfunctions and damages in the past.
3. Installation and modification of traffic-related electrical devices: When requested by the City, Siemens will perform traffic signal modifications and installations of new traffic-related electrical devices for small scale projects such as installing yellow flashing beacons or adding protected left-turn phasings for traffic signals.

	Year 1 FY 13-14	Year 2 FY 14-15	Year 3 FY 15-16	Year 4 FY 16-17	Year 5 FY 17-18	Total
Estimated Routine Preventive Maintenance	$233,856	$238,533	$243,304	$248,170	$253,133	$1,216,996
Estimated Extraordinary Maintenance Services	$410,000	$418,200	$426,564	$435,095	$443,797	$2,133,656
Installation & Modification of Devices	$147,000	$149,940	$152,939	$155,998	$159,118	$764,994
Total Costs	**$790,856**	**$806,673**	**$822,807**	**$839,263**	**$856,048**	**$4,115,647**

The increase in costs for each one-year period were estimated based on the assumption of a 2% annual increase in the Consumer Price Index of Los Angeles County, as published by the U.S. Department of Labor.

Funding for this maintenance program will be covered under the General Funds in Account No. 43110-101-553 (Traffic Signals Contractual Services).

Funding will be requested through the annual budgetary process for the respective fiscal years. Grant funding is not associated with this maintenance services agreement. There is no revenue offsets associated with this agenda item. In addition, there are no additional staffing costs or personnel associated with this item.

ALTERNATIVES

Alternative 1: Award a service contract to Siemens Industry, Inc. for the maintenance of traffic signals and other traffic related electrical devices as recommended by staff.

Alternative 2: Create City of Glendale's own traffic signal maintenance crew. This alternative involves extensive initial capital investment including purchasing new service vehicles, tools, signal equipment, and spare parts as well as hiring new staff. In addition, a warehouse for storage and laboratory for testing equipment will be required.

Alternative 3: Contract with other public agencies such as the City of Burbank or County of Los Angeles to maintain Glendale's traffic signals and other traffic-related electrical devices. Glendale's traffic signals were previously maintained by the City of Burbank from 2000 to 2008. However, the costs were much higher and the service frequency was lower. In addition, the City has little control over other public agencies' staffing arrangement and personnel issues.

Alternative 4: The City Council may consider any other alternatives not proposed by staff.

CAMPAIGN DISCLOSURE

In accordance with the City Campaign Finance Ordinance No. 5744, the following are the names and business addresses of the members of the board of directors, the chairperson, CEO, COO, CFO, Subcontractors and any person or entity with more than 10% interest in the company proposed for contract in this Agenda Item Report:

Full Name	Title	Business Address	City	State	Zip
N/A	Chairperson	N/A	N/A	N/A	N/A
Daryl D. Dulaney	CEO/President	3333 Old Milton Parkway	Alpharetta	Georgia	30005
Helmuth Ludwig (Executive Vice President)	Chief Operating Officer	3333 Old Milton Parkway	Alpharetta	Georgia	30005
Axel Meier	Chief Financial Officer	3333 Old Milton Parkway	Alpharetta	Georgia	30005
Daniel Hislip (Secretary)	Board of Directors	3333 Old Milton Parkway	Alpharetta	Georgia	30005

EXHIBIT

Exhibit 1 – Cost Comparison

EXHIBIT 1
COST COMPARISON

Routine Preventive Maintenance	Siemens	Aegis	Wescorp
Traffic signal per location per month	$84.00	$66.80	$73.73
Hardwire flashing beacon per loc. per mo.	$42.00	$33.00	$44.69
Wireless flashing beacon per loc. per mo.	$29.50	$33.00	$44.69
In-roadway warning lights per loc. per mo.	$63.00	$38.00	$50.27

Labor Fee (Extraordinary Maintenance)	Siemens	Aegis	Wescorp
Electrician - Regular time per hour	$77	$118	$120
Electrician - Overtime per hour	$115	$178	$180
Electrician - Double time per hour	NA	$240	NA

Service Fee (Extraordinary Maintenance)	Siemens	Aegis	Wescorp
USA Markings - each	$125	$200	$100
Loop Detectors (20 or more) each	$325	$315	$350
12" LED green ball (100 or more) each	$55	$116	$141
12" LED red ball (100 or more) each	$57	$89	$132
12" LED yellow ball (100 or more) each	$59	$102	$140
Bucket truck per hour	$30	$28	$25

MOTION

Moved by Council Member______________________, seconded by Council Member____________________, that the City Manager, or his designee, is authorized to execute a maintenance services agreement with Siemens Industry, Inc. to provide maintenance services of the City's traffic signals and other traffic-related electrical devices for a period of five (5) years from July 1, 2013 to June 30, 2018.

Vote as follows:

Ayes:

Noes:

Abstain:

Absent:

MOTION ADOPTED BY THE GLENDALE CITY COUNCIL AT ITS REGULAR MEETING HELD ON __________________ 2013

APPROVED AS TO FORM
Michael J. Garcia
City Attorney
DATE 5/29/13

MORRIS COUNTY COOPERATIVE PRICING COUNCIL

A SHARED SERVICES SUCCESS STORY SINCE 1974

NOTIFICATION OF AWARD

CONTRACT #37: TRAFFIC SIGNAL MAINTENANCE & REPAIRS

Contract Period: Two Years: July 1, 2016 - June 30, 2018

Vendor: Jen Electric, Inc.

Address: 631 Morris Avenue, Springfield, New Jersey 07081

Contact Person: Jennifer Daidone **Title:** President

Tel #: 973-467-4901 **Fax #:** 973-467-4902 **E-Mail:** jen@jenelectricinc.com

Response Time: 2 hours or less for non-emergency calls

CAT. I: MAINTENANCE/REPAIRS OF TRAFFIC SIGNALS	Unit Price
1. Preventive Maintenance Contract (Annual Cost Per Intersection); Includes all items listed in “Attachment I Checklist” – found in the bid specifications (**without the testing of “LED” Modules):**	$425.00
a. Preventive Maintenance Contract (Annual Cost Per Intersection); Includes all items listed in “Attachment I Checklist” – found in the bid specifications (**to include the testing of “LED” Modules):**	$440.00
b. The testing of “LED modules along (**not to be included in the Preventive Maintenance Contract**). Cost per traffic signal head consisting of (1) red, (1) yellow and (1) green LED.	$10.00
2. Repairs (hourly cost per man hour, Monday through Friday, first 8 hours of normal workday):	$185.00/hour
3. Repairs (hourly cost per man hour, overtime, after first 8 hours, Monday through Friday and Saturdays):	$195.00/hour
4. Repairs (hourly cost per man hour, Sundays and Holidays):	$195.00/hour
5. Percentage markup above wholesale cost of parts used for repairs:	25%

CAT. II: EQUIPMENT COSTS	Unit Price
1. Use of 28 foot - 32 foot reach bucket truck (hourly rate):	$40.00/hour
2. Use of 40 foot - 50 foot reach bucket truck (hourly rate) for knockdowns only:	$30.00/hour
3. Rental cost of temporary traffic controllers (weekly):	$1.00/week

BID PACKAGE

Morris County Cooperative Pricing Council (6MOCCP)
502 Millbrook Avenue, Randolph, NJ 07869-3799
Tel: (973) 989.7059 • Fax: (973) 989.7076
Web Site: www.mccpc.org

CONTENTS

Morris County Cooperative Pricing Council

Contracts for Goods & Services (Non-Construction)

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NOTICE TO BIDDERS
MORRIS COUNTY COOPERATIVE PRICING COUNCIL (6MOCCP)

NOTICE IS HEREBY GIVEN that separate sealed bids will be received by the Purchasing Agent, Township of Randolph, on behalf of the Morris County Cooperative Pricing Council (MCCPC), in the Municipal Courtroom, 502 Millbrook Avenue, Randolph, New Jersey, on **Wednesday, April 6, 2016, at 11:00 a.m.** (prevailing time) and at that time will be publicly opened and read for:

SPRING CONTRACTS:

#10:	Lumber, Insulation, Hardware, Paint & Paint Supplies
#13-A:	Fire Equipment Services
#20-B:	Sporting Goods
#25:	Janitorial Supplies
#29:	Pest Control Services (Buildings)
#30:	Office Paper Supplies
#34:	Tree Spraying
#35:	Light Bulbs
#37:	Traffic Signal Maintenance & Repairs
#40:	Personal Protection Items & Equipment for Emergency Personnel
#42:	Landscaping Materials & Supplies
#44:	Welding Supplies
#47:	Water Meters/Data Recorders/Radio Frequency Meter Interface Units
#48:	Equipment Parts for Turf Care
#50:	Fire Department Uniforms (Purchase)
#51:	Deer Carcass Removal & Disposal

Technical bid specifications ONLY are available for review on the MCCPC website (www.mccpc.org). If after a review of the technical bid specifications bidders are interested in the entire bid package, it may be picked up for no cost from the Township Manager's Office, 502 Millbrook Avenue, Randolph, NJ 07869 after leaving necessary contact information OR by sending an email to jlambert@randolphnj.org with all of the following REQUIRED information: (1) Contract #(s), (2) Company Name, (3) Complete Company Address, (4) Company Phone #, (5) Company Fax #, (6) Contact Person Name, (7) email address. Upon receipt of ALL required information, the full bid package will be emailed. Only those bidders picking up packages or contacting the MCCPC directly and providing the necessary information will be provided with any addenda that are issued in accordance with N.J.S.A. 40A:11-23c. Failure to acknowledge receipt of any addenda that may be issued may result in the rejection of the bid.

Bids shall be submitted in a sealed envelope bearing the name and address of the bidder and plainly marked to indicate the subject of the bid and addressed to the Purchasing Agent, Township Manager's Office, Municipal Building, 502 Millbrook Avenue, Randolph, NJ 07869-

3799. **<u>Any envelope that is received that is not properly marked causing it to be opened prior to the bid will be invalidated</u>**. Bids may be received before the hour designated in this office if they are mailed or hand-delivered in person. The Township of Randolph will not be responsible for any bid that is sent by mail or other form of carrier which is lost or which arrives after the bid deadline date and time.

All bids must be submitted on the Bid Proposal Form and must conform to the specifications, terms and conditions for a fair and open contract, all of which are contained therein.

Bidders must review the bid specifications for any applicable bonding requirements. Where required, bids must be accompanied by a certified check, bid bond or cashier's check payable to the Township of Randolph in the amount specified in the bid documents. Bids for contracts that require a Performance Bond must also contain a Consent of Surety.

Bidders must have any and all required approvals, qualifications, certifications, and/or licenses necessary to perform the services or provide the products as contained in the bid specifications.

Bidders are required to comply with the requirements of N.J.S.A. 10:5-31 et. seq., and N.J.A.C. 17:27. Other requirements as well as these described above are fully detailed in the bid document.

The Morris County Cooperative Pricing Council reserves the right to reject any or all bids, or any part thereof, waive informalities herein, and to award the bid in the best interest of its members.

Jenny Lambert
MCCPC Coordinator
Township of Randolph

MORRIS COUNTY COOPERATIVE PRICING COUNCIL
A SHARED SERVICES SUCCESS STORY SINCE 1974

INVITATION TO BID

Date: February 23, 2016

NOTICE is hereby given that separate sealed bids will be received by the Purchasing Agent, Township of Randolph, on behalf of the Morris County Cooperative Pricing Council (MCCPC), in the Municipal Courtroom, 502 Millbrook Avenue, Randolph, New Jersey, on **Wednesday, April 6, 2016, at 11:00 a.m.** (prevailing time) and at that time will be publicly opened and read for:

Contract #37
Traffic Signal Maintenance and Repairs

Technical bid specifications ONLY are available for review on the MCCPC website (www.mccpc.org). If after review of the technical bid specifications bidders are interested in the entire bid package, it may be picked up for no cost from the Township Manager's Office, 502 Millbrook Avenue, Randolph, NJ 07869 after leaving necessary contact information OR by sending an email to jlambert@randolphnj.org with all of the following REQUIRED information: (1) Contract Number(s); (2) Company Name; (3) Complete Company Address; (4) Company Phone Number; (5) Company Fax Number; (6) Contact Person Name; (7) Email Address. Upon receipt of ALL required information, the full bid package will be emailed. Only those bidders picking up bid packages or contacting the MCCPC directly and providing the necessary information will be provided with any addenda that are issued in accordance with N.J.S.A. 40A:11-23c. Failure to acknowledge receipt of any addenda that may be issued may result in the rejection of the bid.

Bids shall be submitted in a sealed envelope bearing the name and address of the bidder and plainly marked to indicate the subject of the bid, and addressed to the Purchasing Agent, Township Manager's Office, Municipal Building, 502 Millbrook Avenue, Randolph, New Jersey 07869-3799. **Any envelope that is received that is not properly marked causing it to be opened prior to the bid will be invalidated.** Bids may be received before the hour designated in this office if they are mailed or hand delivered in person. The Township of Randolph will not be responsible for any bid that is sent by mail or other form of carrier which is lost or which arrives after the bid date and time specified above.

All bids must be submitted on the Bid Proposal Form and must conform to the specifications, terms and conditions for a fair and open contract, all of which are contained therein.

Bidders must review the bid specifications for any applicable bonding requirements. Where required, bids must be accompanied by a certified check, bid bond or cashier's check payable to the Township of Randolph in the amount specified in the bid documents. Bids for contracts that require a Performance Bond must also contain a Consent of Surety.

INVITATION TO BID

Bidders must have any and all required approvals, qualifications, certifications, and/or licenses necessary to perform the services or provide the products as contained in the bid specifications.

Bidders are required to comply with the requirements of N.J.S.A. 10:5-31 et seq. and N.J.A.C. 17:27. Other requirements as well as these described above are fully detailed in the bid documents.

The Morris County Cooperative Pricing Council reserves the right to reject any or all bids, or any part thereof, waive informalities therein, and to award the bid in the best interest of its members.

By Order of the Township Council,

Jenny Lambert
MCCPC Coordinator
Township of Randolph

MORRIS COUNTY COOPERATIVE PRICING COUNCIL
A SHARED SERVICES SUCCESS STORY SINCE 1974

BID SPECIFICATIONS

CONTRACT #37: TRAFFIC SIGNAL MAINTENANCE & REPAIRS

Contract Period – One Year: July 1, 2016 - June 30, 2017
Contract Period – Two Years: July 1, 2016 - June 30, 2018

THE FOLLOWING ARE MINIMUM SPECIFICATIONS WHICH MUST BE MET OR EXCEEDED.

All quantities may be more or less than estimated. No minimum order requirements are allowed.

Prices are to remain firm for the term of the contract with no exceptions.

It is the intent of the Morris County Cooperative Pricing Council (MCCPC) to seek bids for the repair of traffic signals located within the agencies of the MCCPC. Requests for locations to be serviced are noted in the specifications.

The contract will be based on time and materials. The successful bidder shall be available **twenty-four (24) hours a day, seven (7) days a week, including holidays**, and shall be responsible to acquire all necessary materials. Repairs shall be on an as needed basis as notified by the Chief of Police or his designated representative of the member municipalities.

The **annual Preventative Maintenance** and certification shall be performed as directed by the individual member of the MCCPC. Work to be performed in accordance with the Preventative Maintenance checklist is shown in **Attachment I**.

LED Modules: The determination as to whether or not to include the testing of existing LED Modules as part of the preventative maintenance contract will be made by the individual members. The individual members shall also have the option of having the contractor test the existing LED modules without performing any preventative maintenance.

For annual Preventative Maintenance, the contractor shall bid a flat rate on a **per intersection** basis and shall include all costs for labor, equipment, vehicles and material to complete checklist in **Attachment I**.

A currently licensed New Jersey Professional Engineer who may also be a certified Professional Traffic Operations Engineer shall certify (sign & seal) the Annual Preventative Maintenance & Inspection Report including: conflict monitor test results, controller timings, pedestrian clearance and yellow and red clearance intervals.

Aside from the contract, the individual member of the MCCPC will provide minor maintenance on its own to the traffic signals, including but not limited to the replacement of bulbs and other minor repairs.

After award of contract, any questions concerning the traffic signals or requests for an inspection of the signals may be directed to the Chief of Police of the member municipality who is requiring the service.

Duration of Contract
The contract will be for a period of one (1) year or two (2) years. Bidders are not required to bid on the two-year contract. The MCCPC has the right to cancel this contract at any time by giving thirty (30) days written notice to the contractor. In the event of such cancellation, the contractor shall be entitled to receive payment for services, work performed and materials, and equipment furnished under the terms of the contract prior to the

effective date of cancellation, but shall not be entitled to receive any damages on account of such cancellation or any further payment whatsoever. One reason for such a cancellation may be the takeover of the maintenance and repair of these traffic signals by the county or state.

Professional Qualifications
To qualify as a bidder for this contract, the contractor shall meet the following conditions:

A. At least one principal of the firm or corporation shall have a minimum of two (2) years of formal education in electrical engineering, electronics or a related field.

B. The firm or corporation shall have a minimum of five (5) years full time experience in the maintenance of traffic control signals or devices.

C. The contractor shall be a licensed electrical contractor in the State of New Jersey with the capability of doing commercial and industrial wiring.

D. The contractor shall be required to employ and maintain full time at least one IMSA Level II traffic signal electrician and one IMSA Level I traffic signal technician with a minimum of two years of verifiable experience, in servicing signal and/or control equipment, in order that diagnosis of system failures may be made quickly and accurately. **Personnel and contractor qualifications must be submitted with bid proposal**.

E. The contractor shall promptly respond to service calls on a twenty-four (24) hour basis.

Maintenance and Protection of Traffic
The contractor will be required to maintain traffic in all directions at all times during the fulfilling of the contract. He shall erect and maintain suitable barricades, signs, and warning lights in accordance with the “Manual on Uniform Traffic Control Devices for Streets and Highways”, latest edition, at all work sites where any danger to motorists or pedestrians may occur. Transverse openings shall be secured at the end of the workday to permit traffic.

Roadway Excavation, Curb and Sidewalk
Where the service of the roadway, the curb or sidewalk is to be disturbed, the contractor shall obtain a road opening permit from the member agency or the county in which the member is located. He shall remove all broken material; replacement shall be in kind and in strict conformance with the requirements of the county for county roads and of the municipality for municipal roads. The contractor shall also comply with all applicable laws and statutes of the New Jersey One Call System.

<u>REPAIR OF TRAFFIC SIGNALS</u>

Damaged Equipment
The contractor shall respond to emergency calls within **TWO (2) HOURS** of the time that the contractor’s communications center receives the call. He shall proceed without delay or the intervention of other acts to the location of the damaged or inoperative equipment and shall affect emergency temporary repairs.

If the emergency repairs at a signalized intersection require that the controller be disconnected, the contractor shall place “STOP” signs on such approaches to the intersection as the engineer shall designate as a temporary means of traffic regulation. If power is available, the contractor shall also install a flasher, operating as the engineer shall designate. The member shall furnish the contractor a sufficient number of signs. The contractor shall notify the police department charged with traffic safety at the intersection of any disconnected controller, and shall keep them informed of his progress should repairs require more than 24 hours.

The contractor shall, after making emergency temporary repairs, proceed at his earliest possible convenience, to restore the signal to its original operating condition. No written authorization is required for this work. However, the Chief of Police or the Engineer may authorize additional work, intended to change or upgrade the operation of the signal, to proceed concurrently with the repairs, should such arrangement be in the best interests of the member.

Extra Work
Whenever any major equipment in the system is damaged or deteriorated so as to require extensive repairs to, or complete replacement of such equipment, or whenever the Chief of Police or the Engineer deems it necessary to make alterations to existing equipment, they shall authorize the contractor to make such repairs, replacement or alteration.

The scope of extra work is as follows:

A. Repair and/or replacement of major equipment including controllers, detectors, posts, heads, cabinets and foundations.

B. Repair and/or replacement of conduit, ground wiring, or signal cable beyond this post.

C. Relocation of any major component of the system.

D. Installation of new signals and devices.

E. Any other non-emergency work that the engineer may designate.

F. Major deficiencies found during annual Preventative Maintenance.

Authorization of extra work shall be given by the Chief of Police or the Engineer in writing. Claims for extra work which have not been authorized in such a manner shall be rejected. Any extra work resulting from the negligence of the contractor or his agents shall be done by the contractor at no cost to the member.

Methods and Workmanship
The contractor shall at all times maintain a force of qualified workmen sufficient to perform the work required and described herein. The workforce shall be sufficient to perform routine repairs in a timely fashion and to respond promptly to emergency calls at any time. The workforce shall include qualified persons experienced in the electrical and mechanical fields associated with the specialized equipment.

Records
The contractor shall maintain comprehensive records of his services. These shall include invoices, bills of lading, receipts, payroll records and other documents relating to or verifying his bills. He shall also maintain a file showing all types of service he has performed on each signal. He shall keep a careful inventory of all material and equipment in his possession in order to advise the member of the best method of repairing these signals. Records shall also be kept concerning the date, time and the name of the inspector for the monthly inspections.

Copies of all records including monthly and annual re-inspections, etc. should be sent to the member municipality (police department – Traffic Safety Bureau) for their files.

Communications
The contractor shall have or establish a twenty-four (24) hour-a-day telephone answering service or recorder to insure compliance with the response times specified above.

Transportation
The contractor shall provide his own transportation from his place of employment to the job sites. He shall have access at all times to a ladder or bucket truck capable of reaching the appropriate height while supporting a load of 350 lbs.

Tools
The contractor shall furnish all tools and instruments necessary to test and repair the equipment covered in this bid.

1. Conflict Monitor Tester ATSI Model #PCMT 2600 or equivalent with the most current software revision, and cable harnesses for 3, 6, 12, and 16 channel conflict monitor and malfunction management units.

2. Automated Loop System Analyzer ASTI Model #ALSA-1250/HILT9000 or equivalent.

3. Calibrated Spectra Candela III Traffic Signal Light Tester, Model #ST-TSL-2000 or equivalent, six channels, for testing LED signal modules, including arrows.

Note: All specialty testing equipment shall be calibrated annually, or as required by the respective manufacturer for the duration of this contract. Copies of calibration and testing of equipment shall be produced by the contractor if requested by any member agency.

Method of Payment
On or about the first day of each month, or as required, the contractor shall submit invoices to the Chief of Police for all work performed during the preceding month. The invoice shall be accompanied by itemized statements showing in detail the labor, material and equipment used for each job, and specifying the unit and total cost for each. Invoices must reflect detailed list of parts used and list price of each part before discount/ markup.

Materials
All traffic lights presently consist of components and materials that are in conformance with New Jersey Department of Transportation specifications and standards. Any materials used as replacement parts shall also conform to New Jersey Department of Transportation standards and specifications.

Hourly Rate and Materials
Bidders shall indicate an hourly charge as well as a percentage mark-up above wholesale on all parts necessary for all repairs described herein. Bidder shall also indicate the monthly and annual costs for inspections. There will be no charge for “travel time” to job sites.

Equipment Costs
Bidders shall indicate an hourly cost for equipment such as a reach bucket truck and a weekly rental cost for temporary traffic controllers.

Warranties
All equipment installed shall be subject to equipment manufacturer warranties.

Award of Contract :
The MCCPC will award one contract to one vendor to service all of the agencies in the 8 counties served by the MCCPC. The award will be made to the lowest responsive, responsible bidder based on the lowest aggregate total of all Maintenance/Repairs of Traffic Signals costs and equipment costs (percentage markup above wholesale cost of parts used for repairs will not factor into the award of the contract).

An award will be made at the discretion of the Morris County Cooperative Pricing Council for a one- or two-year contract. Bidders are not required to bid on both years.

See attached list of locations of traffic signals of MCCPC members.

BONDING REQUIREMENTS

Bid Guarantee: Each bid must be accompanied by (i) an acceptable certified check or cashier’s check payable to the Township of Randolph or (ii) a bid bond issued by a surety authorized to transact business in New Jersey and acceptable to the Township of Randolph in the amount of **$500.00**. A properly dated and executed Power of Attorney in full force and effect must accompany the bid bond. Failure to submit said bid guarantee shall be cause for rejection of the bid.

Consent of Surety: Each bid must also be accompanied by a Consent of Surety issued by a surety authorized to transact business in New Jersey and acceptable to the Township of Randolph. The Consent of Surety shall serve as a guarantee that the surety company will provide the appropriate performance bond within ten (10) business days of the date of Notification of Award letter. A properly dated and executed Power of Attorney in full force and effect must accompany the Consent of Surety. Failure to submit the Consent of Surety or Power of Attorney shall be cause for rejection of the bid.

Performance Bond: Within ten (10) business days of the date of Notification of Award letter, the successful bidder shall furnish a performance bond in the amount of **$5,000.00**.

The performance bond shall be in the form of either (i) an acceptable certified check or cashier's check payable to the Township or (ii) a performance bond issued by a surety authorized to transact business in New Jersey and acceptable to the Township of Randolph. The bonds shall be issued by a surety company licensed to transact business in New Jersey, and pursuant to New Jersey law, holding sufficient financial resources to issue said bonds. The performance bond shall bear a date on or subsequent to the date of the contract. Each signature of an attorney-in-fact shall be accompanied by a properly dated, executed and certified Power of Attorney in full force and effect. Said bonds shall assure fulfillment of the contract and all of its provisions, including any additions, deductions, or other modifications, or full reimbursement to the Township for all expenses incurred in making good any default. A current statement of financial condition must also be provided with each bond to certify that the total amount of the bonds required will be within the maximum amount specified for that company pursuant to N.J.S.A. 17:18-9. In addition, each surety must provide a Surety Disclosure Statement in proper form pursuant to N.J.S.A. 2A:44-143. The performance bond shall contain a Waiver of Notice being required of alterations, additions, deductions, extension of time, or other modifications of the contract as ordered. Failure to deliver the performance bond with the executed contract shall be cause for declaring the contract null and void.

Note: If a certified or cashier's check is submitted at the time of bid for the Bid Bond, the Bid Bond form is not required. If the bidder is planning on submitting a certified or cashier's check for its Performance Bond, it MUST be submitted with its bid proposal. In that instance the Consent of Surety would not be required. If the bidder is NOT planning on submitting a certified check or cashier's check for its Performance Bond with its bid proposal, the Consent of Surety will be required with the bid proposal. If the bidder is planning on providing a certified or cashier's check as their Bid Bond and Performance Bond with their bid proposal, they MUST provide two separate checks.

If the bidder submits a certified /cashier's check for its Performance Bond with its bid proposal, the Performance Bond form would not need to be filled out after award of contract.

ATTACHMENT 1

ANNUAL INSPECTION CHECKLIST FOR PREVENTATIVE MAINTENANCE CONTRACT

The following preventative maintenance items will be performed on an annual basis for each intersection.

Vehicular & Pedestrian Signal Heads

1. Clean and inspect all visors & lenses.
2. Inspect traffic signal housing for cracks or damage.
3. Check terminal block connections.
4. Check gaskets and mounting hardware; re-tighten as necessary.
5. Check head alignment relative to lanes they serve.
6. Check safety chains.
7. Re-lamp all incandescent bulbs.

Pedestrian Pushbuttons

1. Check for tightness.
2. Verify operation.

3. Check accompanying sign; repair or replace as necessary.

Signal Poles and Arms

1. Check anchorage and all connection hardware.
2. Check tightness of all mounting and connection hardware.
3. Re-tighten bolt covers.

Span Wire Signal Installations

1. Check condition of strain vises, if applicable.
2. Visually inspect each upper and lower tether span wire for damage or deterioration.
3. Visually inspect each upper and lower tether span wire for excess sag. Inspect all connecting span wire hardware; tighten as necessary.
4. Inspect guy anchors for proper attachment and/or damage.
5. Visually inspect pole condition for cracks and/or checks (wood poles); note any deficiencies.

Conduit System and Junction Boxes

1. Check grounding bushings on rigid metallic conduit.
2. Inspect junction box covers for cracks or misalignment.
3. Check proper seating of junction and splice box covers.
4. Check grounding; secure all straps and rod connections.

Vehicle Detection – Loops

1. Verify operation of areas of detection.
2. Visually inspect all visual loops: photograph and document damaged areas of detection.
3. Check loop detector splices.
4. Check and retune detector amplifiers as needed to obtain proper operation. Perform testing at the cabinet using ASTI Model #ALSA-1250 or HILT-9000 tester or equivalent; record test results.

Vehicle Detection – Microwave

1. Verify position of detector for area(s) of detection; re-position if necessary.
2. Remove any branches or obstructions from field of view.
3. Check and re-tighten all mounting hardware.
4. Check wiring connections.
5. Verify operation of the central unit at the cabinet.

Vehicle Detection – Cameras

1. Verify operation of areas of detection.
2. Check video camera positioning.
3. Check video camera mounting hardware.
4. Verify operation of video processor at cabinet.

Traffic Signal Cable

1. Check all splices in each traffic signal transformer base; re-splice as necessary to provide a waterproof connection. **STANDARD WIRENUT WITH TAPE SPLICES ARE NOT ACCEPTABLE**.
2. Visually check the condition of the traffic signal cable for dry rot, nicks, cuts or other damage to the outer jacket insulation.
3. Check all overhead cables and connections

Overhead Street Name Signs

1. Clean sign faces.
2. Check mounting hardware; tighten as necessary.

Uninterruptible Power Source (Battery Back-Up), if Installed

1. Verify automatic transfer switch operation.
2. Verify incoming line voltage.
3. Verify DC output to batteries.

4. Verify AC output to inverter.
5. Check electrical connections.
6. Test system via simulated power outage at cabinet.

Controller and Meter Cabinets

1. Vacuum cabinet interior.
2. Change cabinet filter.
3. Check operation of fan and thermostat.
4. Check and tighten all terminal connections including line filter, surrestor and mercury switch.
5. Verify operation of detector panel relays.
6. Check police functions.
7. Lubricate and adjust hinges and locks.
8. Check cabinet door gaskets for tight seal.
9. Check and tighten neutral and grounding bus.
10. Check conditioning of incoming line voltage.
11. Test circuit breakers.
12. Check GFCI receptacle on power distribution panel.
13. Seal all conduits.

Controller Assembly

1. Check all conflict monitors by actual conflict. The contractor shall utilize an ATSI Model #PCMT 2600 conflict monitor tester or equivalent to certify proper operation of the conflict monitor (to be performed only by an IMSA Level II or higher signal electrician). Provide documentation of all tests performed that include the make, model and serial unit of each unit tested.

2. Run internal diagnostics on the controller, if unit capable.

3. Verify input timing versus approved timing.

4. Note and record controller timing and parameters. Check Yellow, all-Red and Pedestrian Clearances and compare to required duration per chapter 4D of the current MUTCD.

5. Verify vehicle and pedestrian calls on detector panel.

6. Check pre-emption function for firehouses.

7. Check programming and operation of time clocks (school zone flashers only).

8. Verify correct date, time and DST function for controller (intersections only).

9. Verify existing cycles, splits and offsets for coordinated signals, if programmed.

10. Verify existing day and week plans, if programmed.

LED Testing for Existing Vehicular Signal Modules (If and Where directed)

1. Inspect LED modules for cracks or other visible signs of damage.

2. Test all existing LED signal full ball and arrow modules for luminous intensity and photometric brightness using handheld Spectra Candela III Traffic Signal. Light Tester or equivalent.

3. Note and record results of field testing.

4. Compare field readings with ITE Specification, Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement.

A report signed and sealed by an Engineer meeting the qualifications at the beginning of this section shall be submitted to the member agency containing an itemized list of all work and materials performed, conflict monitor test results, controller timing printouts, results of red and yellow intervals, results of pedestrian clearance intervals. Report shall also include a list of deficiencies found (if any), which indicates any signals, signs and pavement markings that are missing or do not conform to the currently approved drawings and/or design standards.

The price quoted per location in the proposal shall include all labor, equipment, vehicles and material necessary to complete the above maintenance items. In addition, the price quoted shall include all expendable items such as bulbs, cabinet filters, fans, thermostats, miscellaneous connectors, grounding lugs and duct seal.

Various Locations of Traffic Signals of MCCPC Members

This list of MCCPC members specifying locations of traffic signals does not exclude the remaining or new members from utilizing the services once the contract has been awarded.

BELLEVILLE (ESSEX COUNTY)
1. Joralemon Street and Passaic Avenue
2. Joralemon Street and Main Street
3. Chestnut Street and Passaic Avenue

BOONTON (TOWN OF) (MORRIS COUNTY)
1. Boonton Avenue and Main Street
2. Division Street and Main Street
3. Myrtle Avenue and Wootton Street
4. Vreeland Avenue and Myrtle Avenue
5. Boonton Avenue and Wootton Street

BUTLER (MORRIS COUNTY)
1. Decker Road and Hamburg Turnpike

CHATHAM BOROUGH (MORRIS COUNTY)
1. Watchung Avenue and River Road
2. Watchung Avenue and Hillside Avenue
3. Watchung Avenue and Fairmount Avenue
4. Watchung Avenue and Washington Avenue
5. Watchung Avenue and Lafayette Avenue
6. Washington Avenue and Chatham Street

CHESTER BOROUGH (MORRIS COUNTY)
1. Oakdale Road
2. Route 513
3. Route 510

CLIFTON (PASSAIC COUNTY)
1. Van Houten and Valley
2. Allwood and Hepburn
3. Allwood and Market
4. Allwood and Passaic
5. Bloomfield and Brighton
6. Bloomfield and Styretowne
7. Broad and Fenner
8. Broad and Van Houten
9. Clifton and Colfax
10. Clifton and Getty
11. Clifton and Lakeview
12. Clifton and Lexington
13. Clifton and Main
14. Clifton and Paulison
15. Clifton and Randolph
16. Clifton and Third

17. Grove and School 16
18. Lakeview and Merselis
19. Lakeview and Piaget
20. Lexington and Ackerman
21. Lexington and Center
22. Lexington and Piaget
23. Main and Clifton Shopping Center
24. Main and Bridewell
25. Main and Harding
26. Main and Madison
27. Main and Piaget
28. Main and Union
29. Main and Washington
30. Parker and Lake
31. Paulison and Highland
32. Piaget and Third
33. Randolph and Lake
34. Valley and Fenner
35. Van Houten and Grove
36. Van Houten and Huron
37. Van Houten and Scales Plaza
38. Van Houten and Mt. Prospect
39. Kingsland and Washington
40. Main and Delawanna
41. River and Kingsland
42. Allwood and Styretowne
43. Kingsland and Target Drive
44. Valley and Rock Hill
45. Piaget and Getty
46. Allwood and Book
47. Broad Street at Stop & Shop
48. Hazel/Kuller/Rollins

DENVILLE (MORRIS COUNTY)
1. Diamond Spring Road and Pocono Road
2. North Shore and Franklin Road

DOVER (MORRIS COUNTY)
1. Morris Street and E. Blackwell Street
2. Sussex Street and E. Blackwell Street
3. Warren Street and W. Blackwell Street
4. Bassett Highway and Warren Street
5. Prospect Street and W. Blackwell Street
6. W. Clinton Street and Warren Street
7. Sussex Street and W. Clinton Street
8. Morris Street and E. Clinton Street
9. Bergen Street and E. Blackwell Street
10. Richads Avenue and Bergen Street
11. E. Blackwell Street and S. Salem Street

FLORHAM PARK (MORRIS COUNTY)
1. Park Avenue and Driveway at 200 Park Avenue
2. Park Avenue and Campus Drive

3. Park Avenue and Florham Road – Rockefeller Connector Road
4. Park Avenue and Punchbowl Road – Ward Place
5. Park Avenue and Danforth Road – Rockefeller South Driveway
6. Columbia Turnpike and Mack-Cali Driveway/Jughandle
7. Columbia Turnpike and Park Street
8. Columbia Turnpike and James Street – Florham Village Driveway
9. Columbia Turnpike and Ridgedale Avenue
10. Columbia Turnpike and Hanover Road
11. Columbia Turnpike and Crescent Road
12. Columbia Turnpike and Fernwood Road – Primrose Driveway
13. Columbia Turnpike and Vreeland Road – Beacon Hill Road
14. Hanover Road and Vreeland Road
15. Ridgedale Avenue and James Street
16. Ridgedale Avenue and Brooklake Road/Park Street
17. Ridgedale Avenue and Briarwood Road – Borough Access Road
18. Ridgedale Avenue and Greenwood Avenue
19. Brooklake Road and East Madison Avenue (flasher)

HANOVER TOWNSHIP (MORRIS COUNTY)
1. Troy Hills Road and Highland Avenue
2. Whippany Road and Eden Lane
3. Whippany Road and Fairchild Place
4. Whippany Road and Woodfield Drive/Adams Drive
5. Whippany Road and Park Avenue
6. Hanover Avenue and Horse Hill Road
7. Columbia Road and Park Avenue
8. Ridgedale Avenue and Malapardis Road
9. Ridgedale Avenue and Elm Place/Mountain Avenue
10. Ridgedale Avenue and Cedar Knolls Road
11. Ridgedale Avenue and Horse Hill Road
12. Ridgedale Avenue and East Frederick Place
13. Park Avenue and Ford Hill Road
14. South Jefferson Road and Cedar Knolls Road
15. South Jefferson Road and Eden Lane
16. Troy Hills Road and Bee Meadow Parkway
17. Troy Hills Road and Baird Place (pedestrian blinker)
18. Reynolds Avenue and Bee Meadow Parkway (blinker)
19. North Jefferson Road and Parsippany Road
20. Mt. Pleasant Avenue and Parsippany Road
21. Hanover Avenue (Morris County Library Access Driveway)

HARDING TOWNSHIP (MORRIS COUNTY)
1. Blue Mill Road and Village Road

JEFFERSON TOWNSHIP (MORRIS COUNTY)
1. Berkshire Valley Road, Ridge & Chamberlain Road
2. Schoolhouse Road and Ridge Road (blinker)

MADISON BOROUGH (MORRIS COUNTY)
1. Kings Road and Green Avenue
2. Kings Road and Prospect Street
3. Kings Road and Samson Avenue

4. Kings Road and Green Village Road
5. Woodland Road and Green Village Road
6. Woodland Road and Green Avenue
7. Woodland Road and Noe (flasher)
8. Brittin Street and Greenwood (flasher)
9. Fairview Avenue and Central (flasher)
10. Fairview Avenue and Greenwood (flasher)
11. School Zone Flashers (7)
12. Radar Sign Flashers (2)

MENDHAM BOROUGH (MORRIS COUNTY)

1. Main Street (2 signals)

MONTVILLE TOWNSHIP (MORRIS COUNTY)

1. Fire House and White Hall Road
2. Fire House and Route 202
3. Park and Route 202
4. Changebridge and Route 202
5. Changebridge, Horseneck Road and River Road
6. Horseneck and Hook Mountain Road
7. Pine Brook and White Hall Road (flashing traffic signal)
8. Changebridge, Eckhardt Circle and Cambray Road
9. Woodmont Road and Changebridge
10. Bloomfield Avenue and Changebridge Road
11. Hook Mountain and Bloomfield Avenue
12. 123 Changebridge Road/Lazar Middle School (flashing traffic signal)
13. 46 Pine Brook Road/Cedar Hill School (flashing traffic signal)
14. 29 Woodmont Road/Woodmont School (flashing traffic signal)

MORRIS TOWNSHIP (MORRIS COUNTY)

1. Columbia Road at Honeywell Service Driveway
2. Columbia Road and Normandy Heights Road (Honeywell Main Driveway)
3. Columbia Road and Normandy Parkway
4. West Hanover Avenue and Burnham Road
5. West Hanover Avenue and Jane Way
6. West Hanover Avenue and Ketch Road
7. East Hanover Avenue and Ridgedale Avenue
8. James Street and Harter Road
9. Mill Road and Burnham Road (flasher)
10. Punchbowl Road and Old Turnpike Road (flasher)
11. Ridgedale Avenue and John Street
12. Sussex Avenue and Gaston Road
13. Sussex Avenue and Kahdena Road
14. Sussex Avenue and Raynor Road
15. Whippany Road and Lindsley Drive

MT. OLIVE TOWNSHIP (MORRIS COUNTY)

1. International (by Extended Stay Hotel)
2. International and Continental
3. International South (by Sam's Club)
4. International South by McDonalds

PARSIPPANY (MORRIS COUNTY

1. Allentown Road and Kingston Road (flasher)
2. Baldwin Road and Vail Road
3. Baldwin Road at Baldwin Oaks Senior Complex (pedestrian signal)
4. Beverwyck Road and Reynolds Avenue
5. Cherry Hill Road and Interpace Parkway/Grecian
6. Cherry Hill Road and Interpace Parkway/Grecian Street
7. Cherry Hill Road and Old Cherry Hill Road
8. Dryden Way and Campus Drive
9. Dryden Way and Sylvan Way
10. Greystone Ped. Sign/North Cottage Street (pedestrian cross walk)
11. Halsey Road and Ludlow Road (flasher)
12. Interpace Parkway and Upper Pond Road
13. Jefferson Road and East Halsey Road
14. Knoll Road and Greenbank/Lake Shore Drive (flasher)
15. Knoll Road and North Beverwyck Road (flasher)
16. Littleton Road and Campus/Gatehall
17. Littleton Road and Halsey Road
18. Littleton Road and Park Road/Crestview
19. Littleton Road and Parsippany Road (traffic preemption light)
20. Littleton Road and Rita Drive/Beachwood Road
21. Littleton Road and Sylvan Way
22. New Road and Edwards Road/I-280 EB Ramp
23. North Beverwyck Road and Hiawatha Boulevard
24. North Beverwyck Road and I-80 EB Ramp
25. North Beverwyck Road and Lakeshore Drive
26. North Beverwyck Road and Vail Road
27. Parsippany Boulevard and Driveway for Brookside
28. Parsippany Boulevard and Waterview Boulevard/I-287 SB Ramp
29. Parsippany Boulevard/Fanny Road/Intervale Road
30. Parsippany Road and Allentown Road
31. Parsippany Road and East Halsey
32. Parsippany Road and Eastman Road
33. Parsippany Road and Freneau (Ambulance Building) (flasher)
34. Parsippany Road and I-287 NB Ramp
35. Parsippany Road and I-287 SB Ramp
36. Parsippany Road and Lanidex Plaza
37. Parsippany Road and North Jefferson Road
38. Route 10 and Littleton Road (Route 202)
39. Route 10 and Powder Mill Road
40. Route 10 and Yacenda Drive
41. Route 46 and Baldwin Road
42. Route 46 and Beverwyck Road
43. Route 46 and Cherry Hill Road
44. Route 46 and Fox Hill Road
45. Route 46 and Lackawanna Place
46. Route 46 and New Road
47. Route 46 and Parsippany Boulevard (Route 202)
48. Route 46 and Smith Road/Littleton Road
49. Route 46 and Vail Road
50. Route 46 and Waterview Boulevard
51. Route 53 and Park Road
52. Smith Road and I-80 EB Ramp
53. Smith Road and Jefferson Road
54. Smith Road and Woodhollow Road/Tara Hotel

55. South Beverwyck Road and Reynolds Avenue
56. Sylvan Way and Tiffany Drive
57. Vail Road and Knoll Road (flasher)
58. West Hanover Avenue and Freedom Way (Police & Fire Academy)
59. West Hanover Avenue and Koch/Ketch
60. West Hanover Avenue and Shongum Road

RANDOLPH TOWNSHIP (MORRIS COUNTY)
1. Dover Chester Road and Pleasant Hill Road
2. Dover Chester Road and Sussex Turnpike
3. Dover Chester Road and Morris Turnpike
4. Millbrook Avenue and Quaker Church Road
5. South Morris Street and Franklin Road
6. Quaker Church Road and Center Grove Road
7. Millbrook Avenue near Freedom Park (flasher)
8. Sussex Turnpike and Church Road (flasher)

READINGTON TOWNSHIP (HUNTERDON COUNTY)
1. County Road 523 and Dreahook
2. County Road 523 and Halls Mill

ROCKAWAY TOWNSHIP (MORRIS COUNTY)
1. Sanders Road and Green Pond Road
2. Independence Way and Mt. Hope Avenue

ROXBURY (MORRIS COUNTY)
1. Hillside Avenue and Righter Road, Succasunna
2. Hillside Avenue and Main Street, Succasunna
3. Eyland Avenue and Righter Road, Succasunna
4. Commerce Avenue and Righter Road, Succasunna

SUSSEX COUNTY (SUSSEX COUNTY)
1. Spring Street and Madison, Newton
2. CR517 and CR606, Andover
3. CR616 and CR669, Andover
4. CR616 and CR623, Andover
5. CR519 and CR626, Hampton
6. CR519 and Plotts Road, Newton
7. CR519 and CR622, Newton
8. CR607 and Brooklyn Mountain Road, Hopatcong
9. CR519 and Town Center Road, Sparta
10. CR620 and Main Street, Sparta
11. CR519 and CR616, Sparta
12. CR565/CR628/CR639 in Wantage
13. CR517/CR620/Station Road, Sparta
14. CR515 and Shopping Center, Vernon
15. CR616 and CR621, Newton
16. CR616 and Diller Avenue, Newton
17. CR607 and CR602, Hopatcong
18. CR607 and Sharp Avenue, Hopatcong
19. CR607 and Bell Avenue, Hopatcong

20. CR607 and CR609, Hopatcong

WAYNE TOWNSHIP (PASSAIC COUNTY)

1. Paterson Hamburg Turnpike and Ratzer Road
2. Paterson Hamburg Turnpike and College Road
3. Paterson Hamburg Turnpike and Duncan Lane
4. Paterson Hamburg Turnpike and Hinchman Avenue
5. Paterson Hamburg Turnpike and Valley Road
6. Paterson Hamburg Turnpike and Church Lane
7. Paterson Hamburg Turnpike and Berdan Avenue
8. Paterson Hamburg Turnpike and Alps Road
9. Berdan Avenue at Wayne Hills High School
10. Paterson Hamburg Turnpike and Squad Place
11. Paterson Hamburg Turnpike and Geoffery Way
12. Paterson Hamburg Turnpike and Colfax Road
13. Paterson Hamburg Turnpike and Black Oak Ridge Road
14. Paterson Hamburg Turnpike and Terhune Drive
15. French Hill Road and Valley Road
16. Valley Road and MacDonald Drive
17. Valley Road and Nellis Drive – Runnymead Road
18. Valley Road and Preakness Avenue
19. Valley Road and Ratzer Road
20. Valley Road and Berdan Avenue
21. Paterson Hamburg Turnpike and Jackson Avenue
22. Jackson Avenue and Squad Place
23. Alps Road and Ratzer Road
24. Alps Road and French Hill Road
25. Alps Road and Tall Oaks Drive – Nellis Drive
26. French Hill Road and Parish Drive – Matthew Drive
27. Berdan Avenue and Geoffrey Way
28. Willowbrook Boulevard – North Leg
29. Willowbrook Boulevard – Mall Service Road
30. Black Oak Ridge Road and Pompton Plains Cross Road
31. Black Oak Ridge Road and Jackson Avenue
32. Riverview Drive and Edison Drive – Corporate Drive
33. Mountain View Boulevard and Sherman Street
34. Berdan Avenue and Brittany Drive – Preakness Access
35. Wayne Towne Center – North Leg
36. Mountain View Boulevard and Parish Drive – Legion Place
37. Valley Road and Barbour Pond Drive
38. Riverview Drive and Totowa Road
39. West Belt / NJ Transit Access Road
40. Ratzer Road and Pike Drive/Stanford Place
41. Dawes Highway and Paterson-Hamburg Turnpike
42. Paterson-Hamburg Turnpike and Jackson Avenue

ENERGY EFFICIENCY SUCCESS STORY

LED Traffic Signals = Energy Savings

for the City of Portland, Oregon

In 2001, the City of Portland replaced nearly all its red and green incandescent traffic signal lights with new signal lights featuring highly efficient light-emitting diodes (LEDs).

The right timing and carefully arranged financing resulted in a successful energy-efficiency project, with annual energy and maintenance savings totalling $400,000 and net payback in less than three years.

A Project Whose Time Had Come

In 1995, when the City of Portland first looked at the LED option, green LEDs were not available and red LEDs were quite expensive. In 2001, they found that prices had dropped dramatically.

> *"When we investigated last year, I thought the sales rep was pulling my leg. The new LED prices were less than half of what they had been…The cost of technology had come down while power prices were going up and utilities were offering aggressive rebates for energy efficiency.*
>
> *It was—and still is—an ideal time to act."*
>
> *—Curt Nichols, Senior Energy Manager for the City of Portland.*

Portland seized the opportunity and met the project's budgeting and timing challenges. By the end of the year, 6,900 red and 6,400 green incandescent signal lamps had been replaced with LED lamps, and the savings had begun.

The City
Portland, Oregon

The Project
Retrofit traffic signals with LED lamps

The Utilities
PGE and Pacific Power

The Cost
$2.2 Million (total)
$900,000 (net)

The Challenge
Fund the project with no capital budget

The Achievement
In three months more than 13,300 signals retrofitted to LED

The Benefits
Annual Energy Savings of $335,000

Annual Maintenance Savings of $45,000

Net Return on Investment:
37% (energy only)
44% (total)

"It's a good thing when City Government can help protect the environment and save taxpayer money at the same time. These LED lamps are clearly superior to traditional incandescent lights in terms of energy efficiency, and that translates directly into reduced impacts on wildlife habitat and global warming emissions. With $335,000 in annual utility bill savings, this investment will pay back multiple benefits for the City for years to come."

— Dan Saltzman
Portland City Commissioner

Paul Zebell, signal operations specialist, holds an incandescent bulb and an LED replacement module.

A Challenge and a Solution

Three factors brought a sense of urgency to the LED project:

- The energy crisis facing the Western states.
- Significant electric rate increases in October 2001.
- Special incentives that two local electric utilities, PGE and Pacific Power, were offering for energy efficiency projects completed before 2002.

Leasing + Incentives + Tax Credit Benefits = Major Savings for the City

Even at the new lower LED prices, retrofitting Portland's traffic signals would cost about $2.2 million. The City didn't have capital allocated for a project of that size. A leasing arrangement provided the solution.

First, leasing spread the capital costs out to more closely match the energy and maintenance savings of the retrofit.

Second, the terms of the lease allowed the City to use contract labor to complete the project before the end of 2001, and thus claim rebates from PGE and Pacific Power totalling $715,000.

Third, the lease option also allowed the City to benefit from Oregon's Business Energy Tax Credit (BETC). Although the City doesn't pay income taxes, it can still benefit from tax credits through an arrangement where the tax credit taken by the leasing company can be shared with the other party. The BETC tax credit—worth 35 percent of an energy project's total cost—made the lease option even more attractive. In Portland's LED project, the leasing company gets a 35 percent tax credit taken over time, reducing the cost of the City's lease by about 22 percent, saving the City nearly $500,000.

"The LEDs have reduced transportation maintenance costs by $45,000 a year in off-hour call out costs and replacement bulbs. LED modules have a life of six years or more while the current bulbs have only a two-year life. In addition, we've been able to save 1,400 hours of valuable staff time per year previously used for group relamping and apply that time to other maintenance needs."

— Bill Kloos
Portland Signals and Streetlighting Manager

Note:
Since the completion of this project, the State of Oregon has revised its administrative rules to allow the sharing of tax credits without a lease arrangement. Today, any equipment supplier or installation contractor can provide a tax credit "pass-through" equal to 27 percent of the project's cost.

A City-hired contractor installs one of more than 13,000 LED lamps during the fall of 2001.

Portland's LED retrofit

- 6,900 red and 6,400 green signal lamps (a mix of 12″ balls, 8″ balls, and turn arrows in both colors.)
- 140 flashing amber beacons
- several light rail transit signals

. . .and its benefits

Energy use and savings

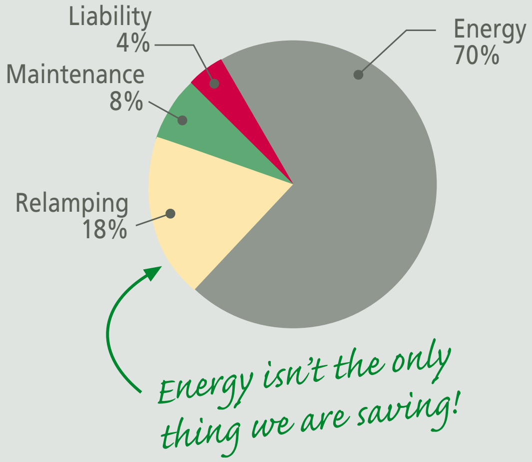
	BEFORE	AFTER
Kilowatt hours per year	**6.1 million**	**1.2 million**
Electric cost per year	**$420,000**	**$85,000**
Energy savings per year		**$335,000**

Maintenance savings

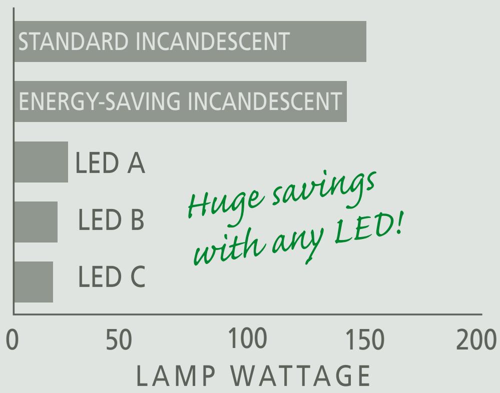
	BEFORE	AFTER
Average lamp life	**~2 years**	**~6 years**
Maintenance costs per year	**$60,000**	**$15,000**
Savings		**$45,000**

LED Project Figures

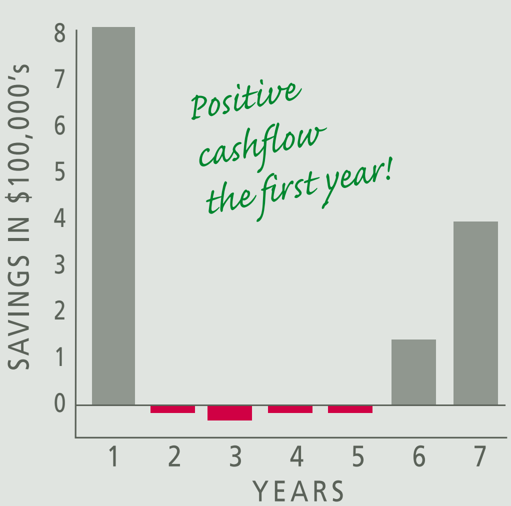
Savings



Energy Usage Comparison



Net Cashflow



NORTHWEST
ENERGY
EFFICIENCY
ALLIANCE
www.nwalliance.org

The Northwest Energy Efficiency Alliance is a non-profit group of electric utilities, state governments, public interest groups and industry representatives committed to bringing affordable, energy-efficient products and services to the marketplace.

Funding for this success story was provided by the Alliance. This is a part of their efforts to support local government use of efficient products and services in Idaho, Montana, Oregon and Washington.

You can learn more about LED traffic signals by visiting the following web sites:

The Environmental Protection Agency (EPA) site listing ENERGY STAR® rated traffic signals,

http://yosemite1.epa.gov/estar/consumers.nsf/content/traffic_signals.htm

The Consortium for Energy Efficiency (CEE) site on energy-efficient traffic signals,
http://www.cee1.org/gov/led/led-main.php3

You can learn more about BETC from the Oregon Office of Energy web site: http://www.energy.state.or.us/bus/tax/taxcdt.htm

Or, call Curt Nichols at 503.823.7418
E-mail curt@ci.portland.or.us.

Additional Resources

Association of Idaho Cities
http://www.idahocities.org

Association of Washington Cities
http://www.awcnet.org

League of Oregon Cities
http://www.orcities.org

Montana League of Cities and Towns
http://www.mlct.org

City of Portland – Energy Division
Office of Sustainable Development
721 NW 9th Ave, Suite 350
Portland, OR 97209
http://www.sustainableportland.org/

FAC 8601 Railroad Track

FY25 SUC:	$13,605.92 / MI
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Mulple Commercial Sources: US Department of Transportation, University of Illinois, Short Line Regional Rail Association

FAC 8601 Railroad Track

Source	Year Cited	Per Mile	ENR-based Inflation to 2014 October	Inflated Price/Mile
U.S. Department of Transportation, *Benefit & Cost Analysis, Sulphur Junction, TX*	2014	$ 5,000.00	1	$ 5,000.00
Benefit-Cost Analysis of Heavy Haul Railway Track Upgrade for Safety & Efficiency , Rail Transportation & Engineering Center, University of Illinois, Liu, Saat & Barkan	2008	$ 10,252.00	1.19532	$ 12,254.42
Facts & Figures , Short Line and Regional Railroad Association, 2012	2012	$ 5,000.00	1.064172	$ 5,320.86
Average of Sources				$ 7,525.09

FAC 8611 Railroad Bridge

FY25 SUC:	$241.96 / LF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Army, Air Force, Department of Transportation-Federal Railway Administration, General Accounting Office, Federal Highway Administration, 2010

FAC 8611 Railroad Bridge

UM = LF

Mean Qty = 208

ESL = 46

Requirements		Unit	Qty	Unit Cost	Frequency (years)	Occurances over Lifetime	Extended Cost
	Inspection - by contract including underwater	EA	1	$12,556.12	1	46	$ 577,581.67
	Scour/Paint bridge structure	LF	208	$6,628.00	25	1	$ 1,378,624.00
	Replace deteriorated RR ties (10% required) installed	EA	21.0	$142.00	5	9	$26,838.00
TOTAL							$ 1,983,043.67
PER UNIT (LF)							$ 207.26

Reference:

Bridge Inspections by Contract: average per-bridge cost cited by CTDOT and Bids to Flint MI

GAO Report: RAILROAD BRIDGES AND TUNNELS Federal Role in Providing Safety Oversight and Freight Infrastructure Investment Could Be Better Targeted Proceedings of the 2010 Joint Rail Conference JRC2010 April 27-29, 2010, Urbana, IL, USA Army TM 5-600 - Bridge Inspection Maintenance and Repair

FAC 8612 Miscellaneous Railroad Facility

FY25 SUC:	$4,244.19 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Commercial Sources

FAC 8612 Miscellaneous Railroad Facility (Scales)

In V11.2 there are 18 records; 2 catcodes Army 86130 Railroad Scales and Navy 86041 Railroad Scalehouse UM = EA
Mean Qty = 1 EA (V11.2)
Median Qty = 1 EA (V11.2)
Hourly rate taken from SAIC GSA PES Price Schedule, Aug 10, 2010 Technician Grade
Operator rate taken at WS-10 Step 3, Arlington VA, July 2010 ($29.62) plus 32.85% fringe (A-76)

Requirements		Unit	Qty	Reference FAC	Unit Cost	Frequency (years)	Extended Cost
	Inspection by authorized distributor; 2/year	HR	2		81.73	2	$ 3 26.92
	Inspection - travel	HR	8		81.73	2	$ 1,307.68
	Scale Operator PM - inspect deck/remove debris	HR	4		39.35	12	$ 3 14.80
	Scale Operator PM - inspect approach for damage	EA	1		39.35	12	$ 78.70
	Scale Operator PM - inspect rails for clearance	HR	1		39.35	12	$ 78.70
	Scale Operator PM - inspect load cells for plumb	SF	2		39.35	12	$ 1 57.40
	Scale Operator PM - inspect load cell connections - adjust as necessary	SF	4		39.35	12	$ 3 14.80
TOTAL							$ 2,579.00
PER UNIT (SY)							$ 2,579.00

Reference: Avery Weigh-Tronix Railweight Users Manual

FAC 8711 Storm Drainage

FY25 SUC:	$0.0426 / LF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8711 Storm Drainage

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $0.0426
UM: LF
Expected Service Life: 34
Model Size: 14551

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	12.00 S.F.	$488.21	$594.60	2.2667	2	2	$1,189.21	$1,189.21
Clean floor drain w/o bucket	4	2.00 Ea.	$247.26	$309.67	8.5000	8	8	$2,477.39	$2,477.39
General maintenance & repair distribution: gutters, pipe	1	0.28 M.L.F.	$89.23	$111.76	34.0000	34	34	$3,799.69	$3,799.69
Replace pipe or gutter distribution	20	105.00 L.F.	$6,027.58	$7,318.66	1.7000	1	1	$7,318.66	$7,318.66
Raise MH or catch basin frame and cover	10	4.00 Ea.	$1,720.51	$2,096.94	3.4000	3	3	$6,290.81	$6,290.81
			$8,572.79	$10,431.63				MR Subtotal:	$21,075.76
								MR Per Year:	$619.88
								PM Total:	$0.00
								Subtotal:	$619.88
								Total Per Unit:	$0.0426

FAC 8711 Storm Drainage

Release:	2024 Qtr 3		FY25 SUC:	$0.0426
Zip Code Prefix:	222		UM:	LF
Type:	PM		Expected Service Life:	34
			Model Size:	14551

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
						$0.00	$0.00	$0.00

FAC 8712 Retaining Structure

FY25 SUC:	$0.88 / LF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Multiple Commercial Sources; R.S. Means Facilities Maintenance and Repair 2010

FAC 8712 V13 Sustainment Unit Cost

Background:

"Because retaining walls are generally not subject to dynamic (changing) loads like bridges are, their expected life is limited more by longevity of their construction material. This is the reason we no longer use wood for walls. Steel binwalls will have an expected life of 40 years, while concrete retaining walls may last well over 100 years if properly constructed and not subject to vehicular damage. Walls fabricated with steel wire gabion baskets may have an expected service life of 30 years."

PORTLAND OFFICE OF TRANSPORTATION, STRUCTURES MANAGEMENT PLAN Capital Oversight Committee, June 2001

"Follow these simple maintenance steps to ensure a lifetime of performance from your ALLAN BLOCK wall:

- Make a thorough annual inspection of the wall.
- Correct any settling or grading problems around the wall.
- Maintain the landscape surfaces around the wall.
- Take notice of any wall movement - settling, bulging or rotation, • and then take proper corrective measures.
- Control any random weed growth as necessary.
- Avoid use of salts as deicers around the wall."

Allan Block Corporation, 5300 Edina Industrial Blvd., #100, Edina, MN • 952-835-5309 • 952-835-0013 – Fax, Tech Sheet #797.

"As far as maintenance activities went, most of it was related to drainage reestablishment, vegetation removal, and minor masonry work (2/3 of the inventory was stone masonry walls). Very little structure maintenance was captured for concrete walls, MSE walls, or bin walls, which made up a smaller portion of the database. Concrete walls were about 15% of the database and either in good shape or needed entire replacement. MSE walls were very limited in use and relatively new and well-functioning. Metal bin walls really aren't that serviceable, and most needed replacement or retrofit with soil nailing.

Not knowing the volume of walls to be included, I can tell you what we had cost-wise re inspections. Generally, inspections required two people to conduct wall measurements, assessment of conditions and develop a brief work order. Accomplished teams can do 10-20 walls/day, depending on wall size and the depth and breadth of your inventory/assessment procedure. Travel, labor, lodging, etc. is predicated on this inventory/assessment work rate.

Settlement correction takes on a lot of definition – is it grade re-establishment at the top of the wall or foundation treatment? Options should ideally be expensed as time and materials – though you'll see we were required to work within a unit cost realm. Vegetation removal/control is largely labor-based, possibly with some equipment rental if not already capital equipment (chippers, haul trucks). The parks bill equipment hours to projects, so we had some base equipment rates in our estimates. Hourly rates were assumed for two-man crews (I recall a $55/hr labor figure).

Seems pretty straightforward. I will say this – development of the inspection/assessment plan is where the big effort is. Actually collecting the data and developing the contracting is just grinding the process. We spent two years developing the program around the evolving NPS needs. There are a lot of details to be sure! -Matt

”

Matthew.DEMARCO@dot.gov U.S. Department of Transportation, Federal Highway Administration. Matthew J. DeMarco leads the Geotechnical Team for FHWA's Central Federal Lands Highway Division

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U/M: LF
Mean 722 LF, Median 125 LF
Cost Source: R.S. Means Facilities Maintenance and Repair 2010

Cost Elements

Drainage Re-establishment:

- Crew A-18 (Laborer & Farm tractor with attachment)
- Contractor cost: $631.28 per day
- EPS Standard 11-120 RT 018 0.28530/SY of dirt leveled and graded by hand ○ Assume 9 CF per 100 LF (drainage openings every 25 ft, 4 openings in 100 LF) ○ Approximately 2 CF of material blocking opening or channel
- {0.28530 hr/sy} x {1/3 sy/100 lf} x $631.28/day x {1 day/8 hours} = $0.0750/LF

Vegetation Removal:

- Crew A-18 (Laborer & Farm tractor with attachment)
- Contractor cost: $631.28 per day
- EPS Standard 11-190 RT 056 0.10188 hrs/100 LF ○ Plus set-up time per job 0.05519 hrs ○ Plus debris removal 1.12492 hr/cy (assume .33 cy = 9 cf) ○ Total time = 0.52829 hr/100 LF = .0052829 hr/LF
- 0.0052829 hr/lf x $631.28/8 per hr = $0.4168/LF

Visual Inspection:

- $58.30/Hr (Skilled Worker Foreman) x 6 hr / (10 Walls/Day x 722 LF x) = $0.047/LF

Total:

- $0.5388/LF
- Arlington VA Adjustment = 99.6
- $0.5388 x .996 = $0.5367 / LF

FAC 8713 Grounds Drainage Dams

FY25 SUC:	$3,387.21 / EA
Source:	Set to FAC 8811 with UM Conversion (100 : 1)

FAC 8714 Levees and Dikes for Grounds Drainage

FY25 SUC:	$11.12 / LF
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	RS Means/USACE (2006)

FAC 8714 SUC FY16v18 Levees and Dikes for Ground Drainage
UM: LF

Average Size: 1092
ESL 39

Maintenance Type	Maintenance Activity	Frequecy	Duration (Hours) or total Qty (MFS)	Crew	Labor Rate (+ Fringe and Overhead)	Equipment	Equipment rate	Material	Material Quantity (Cu yds)	Material Cost / Unit	Cost / Occurance	Occurances in ESL	Cost Over Lifetime
Preventative Maintenance	Maintenance Inspection, Debris Removal, and Mechanical Component Testing	0.5	4	1 x WG9(5) 1 x WG7(5)	$ 66.64	1 x Pickup Truck	$ 13.65	0	0	0	$ 321.16	78	$ 25,050.61
Maintenance / Repair	Repair Embankment and side slopes	1	24	1 x WG11(5) 2 x WG9(5) 2 x WG7(5)	$ 175.80	1 x Truck, Dump 1 x Flatbed, 2 Axil, 25T 1 xExcavator, 3/4 cu yd	$ 75.45	Engineered Soil, Riprap, Machine Placed	16	$ 54.50	$ 6,901.88	39	$ 269,173.51
Maintenance / Repair	Mowing	1	16.95			Tracktor w/brushog	$ 47.50	0	0	0	$ 805.13	39	$ 31,399.88
										Sum of Costs over Lifetime			$ 325,623.99
										Cost per Year			$ 8,349.33
										Cost per UM			**$ 7.65**

References

Equipment Costs: RS Means Facilities Construction Cost Data, 30th Ed
Labor Costs 2015 Salary Tables from OPM.gov with Circular No. A-76 Revised
Material Costs RS Means "Costworks" with Facility Maintenance and Repair Costbook, 2015Q3
USACE: Upper Mississippi River Restoration Environmental Management Program Design Handbook, Chapter 7 River Training Structures, 201
DoD Real Property Categorization System (RPCS); 2015
DoD Real Property Assets Database, 2014

FAC 8715 Storm Water Ponds

FY25 SUC:	$0.0038 / GA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	New model for FY16; Based on data from USACE-ERDC, EPA, and NAVFAC EV.

Report 28 October, 2015

Prepared by R&K Solutions

Subject

Reevaluation of Sustainment Unit Cost for FAC 8715, Storm Water Ponds

Background

In the spring of 2015, the Navy lead for the Facilities Sustainment Model, Commander Jay Bieszke of OPNAV N464 and the Marine lead for FSM, Mr. Roger Welborn, recommended a reevaluation of the Sustainment Unit Cost for FAC 8715. From the beginning of FSM, this type of asset was modeled as not requiring maintenance, and therefore the SUC was determined to be $0.00. Informed by their Environmental office at NAVFAC, the Navy believed there are maintenance activities being conducted at these facilities, and that the model should be reevaluated, and recalculated.

Findings

The USACE research center for hydrology, ERDC's Coastal and Hydraulics Laboratory (Mr. James Leech, and Mr. Shaun Stanton) report that there are maintenance activities for storm water ponds, and that USACE distributes program funds to installations to maintain their storm water ponds. The Environmental Protection Agency has Best Management Practices (BMP) for inspection and maintenance of storm water ponds. Required maintenance tasks for storm water ponds will be the product of analyzing these EPA BMPs, storm water pond design recommendations from EPA's Stormwater Management Resource Center, USACE/ERDC/CHL information, and maintenance tasks provided by NAVFAC's Environmental Directorate.

Expected Service Life

As the EPA Best Management Practice lists removal of accumulated sediment from the main cell of the SWP on a 20 year interval, 20 years will be the expected service life of this facility type. Restoring the main catch basin of a storm water pond to its original depth meets the definition of restoration; and therefor is not a sustainment task.

Inputs

Analyzing service and independent sources, the following tasks are assessed as required for the typical facility over the life of a storm water pond:

- Maintenance Inspection, Debris Removal, and Mechanical Component Testing
- Repair Embankment and side slopes
- Maintenance Mowing
- Removing accumulated sediment from forebays
- Remove and replace control valve

Summary

With labor, material, and equipment costs for these activities, the SUC is $2,577.45

FAC 8715 SUC FY16v18 - Storm Water Ponds													
UM: MG													
Average Size:	0.891												
ESL	20												
Maintenance Type	**Maintenance Activity**	**Frequecy**	**Duration (Hours) or total Qty (MFS)**	**Crew**	**Labor Rate (+ Fringe and Overhead)**	**Equipment**	**Equipment rate**	**Material**	**Material Quantity**	**Material Cost / Unit**	**Cost / Occurance**	**Occurances in ESL**	**Cost Over Lifetime**
Preventative Maintenance	Maintenance Inspection, Debris Removal, and Mechanical Component Testing	0.5	1.75	1 x WG9(5) 1 x WG7(5)	$ 66.64	1 x Pickup Truck	$ 13.65	0	0	0	$ 140.51	40	$ 5,620.33
Maintenance / Repair	Repair Embankment and side slopes	1	2.5	1 x WG9(5) 2 x WG7(5)	$ 96.61	1 x Truck, Dump 1 x Flatbed, 2 Axil, 25T 1 x Backhoe/loader	$ 54.75	Engineered Soil	8	$ 24.50	$ 574.40	20	$ 11,488.05
Maintenance / Repair	Mowing	0.5	9.928			Tractor w/brushog	$ 47.50	0	0	0	$ 471.58	40	$ 18,863.20
Maintenance / Repair	Removing accumulated sediment from forebays	5	4.5	1 x WG9(5) 2 x WG7(5)	$ 96.61	1 x Truck, Dump 1 x Flatbed, 2 Axil, 25T 1 x Backhoe/loader	$ 54.75	0	0	0	$ 681.12	4	$ 2,724.50
Maintenance / Repair	Remove and replace control valve	10	2.5	1 x WG9(5) 1 x WG7(5)	$ 66.64	1 x Pickup Truck	$ 13.65	Valve, Gate	1	$ 3,416.30	$ 3,617.03	2	$ 7,234.05
										Sum of Costs over Lifetime			$ 45,930.13
											Cost per Year		$ 2,296.51
References											Cost per UM		$ 2,577.45
Equipment Costs:	RS Means Facilities Construction Cost Data, 30th Ed												

Average Size: 0.723
ESL 20

Labor Costs	2015 Salary Tables from OPM.gov with Circular No. A-76 Revised
Material Costs	RS Meams "Costworks" with Facility Maintenance and Repair Costbook, 2015Q3

FAC 8715 SUC FY1v19 - Storm Water Ponds
UM: MG

Maintenance Type	Maintenance Activity	Frequecy	Duration (Hours) or total Qty (MFS)	Crew	Labor Rate (+ Fringe and Overhead)	Equipment	Equipment rate	Material	Material Quantity	Material Cost / Unit	Cost / Occurance	Occurances in ESL	Cost Over Lifetime
Preventative Maintenance	Maintenance Inspection, Debris Removal, and Mechanical Component Testing	0.5	1.75	1 x WG9(5) 1 x WG7(5)	$ 67.31	1 x Pickup Truck	$ 14.00	0	0	0	$ 1 42.29	40	$ 5,691.53
Maintenance / Repair	Repair Embankment and side slopes	1	2.5	1 x WG9(5) 2 x WG7(5)	$ 97.58	1 x Truck, Dump 1 x Flatbed, 2 Axil, 25T 1 x Backhoe/loader	$ 56.16	Engineered Soil	8	$ 24.50	$ 580.34	20	$ 11,606.71
Maintenance / Repair	Mowing	0.5	4.928			Tracktor w/brushog	$ 48.72	0	0	0	$ 2 40.10	40	$ 9,603.83
Maintenance / Repair	Removing accumulated sediment from forebays	5	4.5	1 x WG9(5) 2 x WG7(5)	$ 97.58	1 x Truck, Dump 1 x Flatbed, 2 Axil, 25T 1 x Backhoe/loader	$ 56.16	0	0	0	$ 691.80	4	$ 2,767.22
Maintenance / Repair	Remove and replace control valve	10	2.5	1 x WG9(5) 1 x WG7(5)	$ 67.31	1 x Pickup Truck	$ 14.00	Valve, Gate	1	$ 3,774.30	$ 3,977.57	2	$ 7,955.14
Maintenance / Repair	Removing accumulated sediment from main cell	20	8.5	1 x WG9(5) 2 x WG7(5)	$ 97.58	1 x Truck, Dump 1 x Flatbed, 2 Axil, 25T 1 x Backhoe/loader	$ 56.16	0	0	0	$ 1,306.74	1	$ 1,306.74

Sum of Costs over Lifetime $ 38,931.18

Cost per Year $ 1,946.56

<u>References</u>

Cost per UM $ 2,692.34

Equipment Costs: RS Means Facilities Construction Cost Data, 30th Ed

Labor Costs 2016 Salary Tables from OPM.gov with Circular No. A-76 Revised

Material Costs RS Means "Costworks" with Facility Maintenance and Repair Costbook, 2016Q3

FAC 8716 Storm Water Filtration

FY25 SUC:	$1.94 / SY
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8717 Storm Water Treatment Structure

FY25 SUC:	$4.02 / GM
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8721 Boundary Fence and Wall

FY25 SUC:	$1.77 / LF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8721 Boundary Fence and Wall

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $1.77
UM: LF
Expected Service Life: 26
Model Size: 2497

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor chain link fence repairs, per 10 LF	1	12.00 Ea.	$356.32	$439.46	26.0000	26	26	$11,425.91	$11,425.91
Replace bent 1-5/8" top rail, per 20 LF	2	6.00 Ea.	$736.74	$871.82	13.0000	13	13	$11,333.64	$11,333.64
Replace broken barbed wire arm	2	24.00 Ea.	$1,595.25	$1,983.43	13.0000	13	13	$25,784.58	$25,784.58
Replace barbed wire, 3 strands, per 100 LF	5	3.00 Ea.	$1,526.25	$1,838.18	5.2000	5	5	$9,190.89	$9,190.89
Replace 6' x 18' cantilever slide gate	5	1.00 Opng.	$3,645.59	$4,165.72	5.2000	5	5	$20,828.60	$20,828.60
Replace 2" line post	20	9.00 Ea.	$6,302.92	$7,447.64	1.3000	1	1	$7,447.64	$7,447.64
Replace 3" corner post	10	4.00 Ea.	$4,119.71	$4,846.57	2.6000	2	2	$9,693.13	$9,693.13
			$18,282.78	$21,592.82				MR Subtotal:	$95,704.39
								MR Per Year:	$3,680.94
								PM Total:	$732.70
								Subtotal:	$4,413.64
								Total Per Unit:	$1.77

FAC 8721 Boundary Fence and Wall

		FY25 SUC:	$1.77
Release:	2024 Qtr 3	UM:	LF
Zip Code Prefix:	222	Expected Service Life:	26
Type:	PM	Model Size:	2497

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Manual slide gate, annualized	2	3.03	$23.02	$164.82	$0.0000	187.84	239.59	292.49
Electric slide gate, annualized	1	4.77	$18.77	$260.47	$0.0000	279.24	359.26	440.21
						$467.08	$598.85	$732.70

FAC 8722 Security Fence

FY25 SUC:	$5.18 / LF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8811 Dam

FY25 SUC:	$338,721.07 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	CostWorks Model

CostWorks 2018 Quarter 3 - FAC 8811 - Dam								
ESL =	39							
Mean Size	1	Each						
Qty	**Description**	**Freq**	**Crew**	**Total**	**Total Incl. O&P**	**Occurances in Life**		**Total for Life**
3,467.000	Geosynthetic soil stabilization, geotextile fabric, non-woven, 120 lb. tensile str	30	2 Clab	4,992.48	5,859.23	1	$	4,992.48
600.000	Rip-rap and rock lining, random, broken stone, 50 lb. average, dumped	30	B11A	23,454.00	26,100.00	1	$	23,454.00
2,311.000	Compaction, 4 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	30	B10G	3,489.61	4,321.57	1	$	3,489.61
41.600	Mowing, mowing brush, heavy density, tractor with rotary mower	1	B84	3,619.20	4,867.20	39	$	141,148.80
68.000	Public storm utility drainage piping, reinforced concrete pipe (RCP), 36" diamet	30	B13	7,609.20	9,316.00	1	$	7,609.20
41.600	Seeding athletic fields, seeding slope mix, 6 lb. per M.S.F., tractor spreader	1	B66	1,243.84	1,497.60	39	$	48,509.76
60.000	Drain, trench, polyester polymer for cement concrete encasement, 4" internal w	10	Q1	8,406.00	9,480.00	3	$	25,218.00
1.000	Utility area drain, catch basins or manholes frames and grates, cast iron, 24" s	30	B6	548.50	660.00	1	$	548.50
	Totals			**$53,362.83**	**$62,101.60**		**$**	**254,970.35**

FAC 8812 Lock

FY25 SUC:	$1,979,053.68 / EA
Source:	Set to FAC 2131: CNIC-NAVSEA estimate; UM conversion factor = 46867 SF

FAC 8813 Navigation Revetments

FY25 SUC:	$0.88 / LF
Source:	Set to FAC 8712; multiple commercial sources

FAC 8814 Training Dikes/Wing Dams/Pile Dikes

FY25 SUC:	$11.12 / LF
Source:	Set to FAC 8714; R.S. Means, USACE

FAC 8821 Flood Control Structures

FY25 SUC:	$5,205.23 / EA
Source:	Set to FAC 8714: R.S. Means, USACE; UM conversion factor = 468 LF

FAC 8822 Flood Control Levee/Floodwall

FY25 SUC:	\$11.12 / LF
Source:	Set to FAC 8714; R.S. Means, USACE Data

FAC 8831 Fish Facilities

FY25 SUC:	$2,613.74 / EA
Source:	Set to FAC 8714: R.S. Means, USACE; UM conversion factor = 235 LF

FAC 8840 Monitoring Well

FY25 SUC:	$40.41 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8910 Utility Building

FY25 SUC:	$7.39 / SF
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8910 Utility Building

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: MR

FY25 SUC: $7.39
UM: SF
Expected Service Life: 55
Model Size: 1374

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	25.00 S.F.	$1,017.11	$1,238.76	3.6667	3	3	$3,716.28	$3,716.28
Repair concrete stairs	30	12.00 S.F.	$382.53	$442.73	1.8333	1	1	$442.73	$442.73
Replace metal hand rail	30	8.00 L.F.	$493.07	$573.31	1.8333	1	1	$573.31	$573.31
Replace steel decking	30	16.00 S.F.	$96.06	$111.63	1.8333	1	1	$111.63	$111.63
Point and refinish painted concrete block wall, 1st floor	25	14.00 C.S.F.	$7,675.15	$9,432.76	2.2000	2	2	$18,865.53	$18,865.53
Replace glass - 1st floor (1% of glass) - alum. window fixed	1	6.00 S.F.	$81.91	$96.18	55.0000	55	55	$5,289.63	$5,289.63
Repair 2'-0" x 3'-0" aluminum window - 1st floor	20	2.00 Ea.	$323.00	$384.91	2.7500	2	2	$769.82	$769.82
Replace 2'-0" x 3'-0" aluminum window - 1st floor	50	2.00 Ea.	$1,643.53	$1,920.23	1.1000	1	1	$1,920.23	$1,920.23
Repair steel, painted, door	14	4.00 Ea.	$3,110.24	$3,683.07	3.9286	3	3	$11,049.22	$11,049.22
Refinish 3'-0" x 7'-0" steel, painted, door	4	1.00 Ea.	$47.99	$58.75	13.7500	13	13	$763.78	$763.78
Replace 3'-0" x 7'-0" steel, painted, door	45	1.00 Ea.	$735.86	$856.57	1.2222	1	1	$856.57	$856.57
Repair 12' x 12' steel roll-up door	10	1.00 Ea.	$902.17	$1,063.12	5.5000	5	5	$5,315.61	$5,315.61
Replace 12' x 12' steel roll-up door	35	1.00 Ea.	$3,608.67	$4,252.49	1.5714	1	1	$4,252.49	$4,252.49
Total EPDM roof replacement	25	1.50 Sq.	$1,230.15	$1,447.71	2.2000	2	2	$2,895.42	$2,895.42
Repair 8" concrete block wall - (2% of walls) painted	25	2.10 C.S.F.	$2,553.47	$3,067.10	2.2000	2	2	$6,134.20	$6,134.20
Replace 8" concrete block wall painted	75	2.10 C.S.F.	$2,711.25	$3,262.97	0.7333	0	0	$0.00	$0.00
Repair steel painted interior door	14	1.00 Ea.	$296.85	$346.32	3.9286	3	3	$1,038.97	$1,038.97
Refinish 3'-0" x 7'-0" steel painted interior door	4	1.00 Ea.	$60.20	$74.02	13.7500	13	13	$962.32	$962.32
Replace 3'-0" x 7'-0" steel painted interior door	60	1.00 Ea.	$1,409.52	$1,632.80	0.9167	0	0	$0.00	$0.00
Repair solid core wood door, interior	11	3.00 Ea.	$890.55	$1,038.97	5.0000	5	5	$5,194.83	$5,194.83
Refinish 3'-0" x 7'-0" solid core wood door, interior	4	3.00 Ea.	$164.04	$199.57	13.7500	13	12	$2,594.36	$2,394.79
Replace 3'-0" x 7'-0" solid core wood door, interior	40	3.00 Ea.	$1,931.33	$2,226.90	1.3750	1	1	$2,226.90	$2,226.90
Refinish concrete floor finished	25	4.93 C.S.F.	$2,260.47	$2,715.81	2.2000	2	2	$5,431.62	$5,431.62
Replace flush valve diaphragm tankless water closet	10	1.00 Ea.	$27.59	$34.28	5.5000	5	5	$171.38	$171.38
Rebuild flush valve tankless water closet	20	1.00 Ea.	$193.27	$232.95	2.7500	2	2	$465.91	$465.91
Unplug clogged line tankless water closet	5	1.00 Ea.	$229.78	$287.79	11.0000	11	11	$3,165.67	$3,165.67
Replace tankless flush valve	25	1.00 Ea.	$272.66	$320.03	2.2000	2	2	$640.06	$640.06
Replace wax ring gasket for tankless water closet	5	1.00 Ea.	$149.75	$187.38	11.0000	11	11	$2,061.20	$2,061.20
Replace flush valve diaphragm for a urinal	7	1.00 Ea.	$27.59	$34.28	7.8571	7	7	$239.93	$239.93
Rebuild flush valve for a urinal	20	2.00 Ea.	$386.54	$465.91	2.7500	2	2	$931.82	$931.82
Unplug line urinal	5	2.00 Ea.	$305.81	$383.01	11.0000	11	11	$4,213.07	$4,213.07
Replace washer in spud connection lavatory, vitreous china	7	2.00 Ea.	$34.79	$42.47	7.8571	7	7	$297.27	$297.27
Replace washer in faucet lavatory, vitreous china	2	2.00 Ea.	$27.20	$33.93	27.5000	27	27	$915.99	$915.99
Replace faucets lavatory, vitreous china	10	2.00 Ea.	$397.25	$477.57	5.5000	5	5	$2,387.83	$2,387.83
Clean out strainer and P trap lavatory, vitreous china	2	2.00 Ea.	$74.18	$92.90	27.5000	27	27	$2,508.35	$2,508.35
Replace faucet washer sink, service/utility	2	2.00 Ea.	$27.01	$33.69	27.5000	27	27	$909.67	$909.67
Clean trap	3	2.00 Ea.	$18.04	$22.59	18.3333	18	18	$406.58	$406.58
Replace faucets sink, service/utility	10	2.00 Ea.	$397.25	$477.57	5.5000	5	5	$2,387.83	$2,387.83
Unstop sink	2	1.00 Ea.	$44.15	$55.30	27.5000	27	27	$1,493.07	$1,493.07
Replace sink, P.E.C.I. service/utility	35	1.00 Ea.	$1,659.02	$1,940.60	1.5714	1	1	$1,940.60	$1,940.60
Unclog floor drain, PVC	20	2.00 Ea.	$100.77	$126.21	2.7500	2	2	$252.42	$252.42
Unclog 4" - 12" diameter PVC main drain per L.F.	10	1.00 L.F.	$4.00	$5.01	5.5000	5	5	$25.05	$25.05
General maintenance & repair drain: roof, scupper, area	1	2.00 Ea.	$78.44	$98.24	55.0000	55	55	$5,403.02	$5,403.02
Replace drain: roof, scupper, area	40	2.00 Ea.	$2,192.71	$2,530.43	1.3750	1	1	$2,530.43	$2,530.43
Maintenance and repair explosionproof industrial heater	2	2.00 Ea.	$440.91	$515.28	27.5000	27	27	$13,912.64	$13,912.64
Rebuild 4" diameter reduced pressure backflow preventer	10	1.00 Ea.	$1,010.59	$1,174.64	5.5000	5	5	$5,873.21	$5,873.21
Inspect sprinkler system	1	1.00 Ea.	$36.26	$45.41	55.0000	55	55	$2,497.55	$2,497.55
Replace sprinkler head	20	12.00 Ea.	$1,100.29	$1,355.97	2.7500	2	2	$2,711.93	$2,711.93
Replace fuse	25	9.00 Ea.	$5,469.39	$6,266.08	2.2000	2	2	$12,532.16	$12,532.16
Maintenance and inspection switchgear, indoor, less than 600 V	3	1.00 Ea.	$43.82	$54.97	18.3333	18	18	$989.41	$989.41
Replace switchgear, 225 A	30	1.00 Ea.	$480.76	$603.11	1.8333	1	1	$603.11	$603.11
Repair switchboard meter	10	1.00 Ea.	$1,321.89	$1,553.91	5.5000	5	5	$7,769.55	$7,769.55
Maintenance and repair secondary transformer, dry	10	1.00 Ea.	$295.51	$351.26	5.5000	5	5	$1,756.32	$1,756.32
Maintenance and inspection secondary transformer, dry	0.5	2.00 Ea.	$174.05	$218.34	110.0000	110	110	$24,017.63	$24,017.63
Maintenance and inspection lighting panel, indoor	3	1.00 Ea.	$43.82	$54.97	18.3333	18	18	$989.41	$989.41
Replace EMT conduit, 1" diameter	50	0.20 M.L.F.	$2,311.85	$2,786.43	1.1000	1	1	$2,786.43	$2,786.43
Maintenance and repair breaker, molded case, 480 V, 1 pole	20	4.00 Ea.	$309.15	$387.82	2.7500	2	2	$775.65	$775.65
Replace circuit breaker molded case, 480 V, 1 pole circuit breaker	50	4.00 Ea.	$3,609.81	$4,170.56	1.1000	1	1	$4,170.56	$4,170.56
Repair failed breaker, molded case, 600 V, 3 pole	10	1.00 Ea.	$404.44	$481.30	5.5000	5	5	$2,406.52	$2,406.52
Replace circuit breaker molded case, 600 V, 3 pole circuit breaker	50	1.00 Ea.	$5,172.22	$5,924.40	1.1000	1	1	$5,924.40	$5,924.40
Maintenance and repair safety switch general, 2 pole	8	3.00 Ea.	$131.45	$164.90	6.8750	6	6	$989.41	$989.41
Replace safety switch, 240 V, 2 pole	25	3.00 Ea.	$1,469.85	$1,776.62	2.2000	2	2	$3,553.23	$3,553.23
Maintenance and repair receptacles and plugs	20	32.00 Ea.	$1,464.29	$1,829.61	2.7500	2	2	$3,659.22	$3,659.22
Replace receptacle/plug receptacles and plugs	20	32.00 Ea.	$2,583.78	$3,178.27	2.7500	2	2	$6,356.55	$6,356.55
Repair 4-pin receptacle cover	10	12.00 Ea.	$761.20	$940.92	5.5000	5	5	$4,704.58	$4,704.58
Replace 4-pin receptacle	20	12.00 Ea.	$1,919.28	$2,281.68	2.7500	2	2	$4,563.37	$4,563.37
Replace wiring devices, switches	15	15.00 Ea.	$1,043.02	$1,298.76	3.6667	3	3	$3,896.28	$3,896.28
Replace fluorescent light fixture ballast, 80 W	10	12.00 Ea.	$1,307.18	$1,611.93	5.5000	5	5	$8,059.64	$8,059.64
Replace lamps (2 lamps), 4', 34 W energy saver	10	12.00 Ea.	$325.82	$408.55	5.5000	5	5	$2,042.77	$2,042.77
Replace metal halide ballast, 175 W	10	6.00 Ea.	$1,029.37	$1,232.98	5.5000	5	5	$6,164.92	$6,164.92
Replace metal halide fixture lamp, 175 W	5	6.00 Ea.	$365.03	$443.54	11.0000	11	11	$4,878.95	$4,878.95
Repair smoke detector	10	5.00 Ea.	$303.83	$376.03	5.5000	5	4	$1,880.13	$1,504.10
Check operation smoke detector	1	5.00 Ea.	$87.33	$109.55	55.0000	55	55	$6,025.40	$6,025.40
Replace smoke detector	15	5.00 Ea.	$1,687.11	$2,007.54	3.6667	3	3	$6,022.61	$6,022.61
Repair heat detector	10	4.00 Ea.	$265.02	$325.77	5.5000	5	5	$1,628.85	$1,628.85
Check operation heat detector	1	4.00 Ea.	$69.86	$87.64	55.0000	55	55	$4,820.32	$4,820.32
Check and repair manual pull station	10	4.00 Ea.	$379.95	$467.63	5.5000	5	4	$2,338.13	$1,870.51
Replace manual pull station	15	4.00 Ea.	$920.30	$1,106.02	3.6667	3	3	$3,318.05	$3,318.05
Minor repairs to fire alarm control panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection fire alarm control panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Minor repairs to annunciation panel	5	1.00 Ea.	$160.28	$195.43	11.0000	11	11	$2,149.68	$2,149.68
Maintenance and inspection annunciation panel	0.5	1.00 Ea.	$46.25	$58.02	110.0000	110	110	$6,382.31	$6,382.31
Maintenance and repair electrical service ground	25	0.10 M.L.F.	$9.55	$11.93	2.2000	2	2	$23.87	$23.87
Replace electrical service ground	50	0.10 M.L.F.	$483.93	$588.64	1.1000	1	1	$588.64	$588.64
Replace lamp emergency lighting fixture	2	3.00 Ea.	$171.95	$207.54	27.5000	27	27	$5,603.49	$5,603.49
Replace lamp with exit light L.E.D. retrofit kits	15	4.00 Ea.	$412.07	$474.66	3.6667	3	3	$1,423.98	$1,423.98
Maintenance and repair voice/data outlet	10	4.00 Ea.	$222.77	$278.46	5.5000	5	5	$1,392.30	$1,392.30
Replace voice/data outlet	20	4.00 Ea.	$113.27	$137.94	2.7500	2	2	$275.89	$275.89
Maintenance and inspection patch panel	0.5	2.00 Ea.	$185.00	$232.08	110.0000	110	110	$25,529.23	$25,529.23
Replace patch panel	15	1.00 Ea.	$947.18	$1,138.31	3.6667	3	3	$3,414.92	$3,414.92
Remove and replace hydraulic dock leveler lift cylinder	15	2.00 Ea.	$16,605.83	$18,912.06	3.6667	3	3	$56,736.19	$56,736.19
			$98,175.96	$116,089.73				MR Subtotal:	$389,380.76
								MR Per Year:	$7,079.65
								PM Total:	$3,077.34
								Subtotal:	$10,156.99
								Total Per Unit:	$7.39

FAC 8910 Utility Building

Release:	2024 Qtr 3	FY25 SUC:	$7.39
Zip Code Prefix:	222	UM:	SF
Type:	PM	Expected Service Life:	55
		Model Size:	1374

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Door, emergency egress, swinging, annualized	2	0.52	$31.64	$23.47	$0.0000	55.11	65.32	77.10
Door, overhead, electric, roll up, to 24' high x 25' wide, annualized	1	4.07	$82.62	$184.02	$0.0000	266.64	330.10	397.70
Urinals, annualized	1	0.23	$6.84	$12.27	$0.0000	19.11	23.47	28.18
Toilet (vacuum breaker type), annualized	2	0.35	$18.37	$19.12	$0.0000	37.49	45.06	53.55
Lavatories, annualized	2	0.70	$15.44	$43.99	$0.0000	59.43	74.17	89.68
Unit heater, gas radiant, annualized	2	2.02	$3.46	$108.29	$0.0000	111.75	144.58	177.58
Backflow prevention device, up to 4", annually	1	0.33	$14.56	$21.15	$0.0000	35.71	43.51	52.04
Extinguishing system, wet pipe, annualized	1	11.34	$54.71	$714.87	$0.0000	769.58	989.51	1,212.18
Switchboard, annualized	1	0.70	$4.75	$50.30	$0.0000	55.05	70.61	86.41
Circuit breaker, high voltage air, annualized	2	0.94	$33.03	$66.73	$0.0000	99.77	123.09	148.06
Transformer, oil pad mounted, annualized	1	1.08	$0.95	$77.19	$0.0000	78.14	101.39	124.69
Panelboard, 225 A and above, annualized	1	0.44	$25.95	$31.37	$0.0000	57.32	69.33	82.63
Light, emergency, hardwired system, annualized	2	0.50	$18.16	$31.57	$0.0000	49.74	61.03	73.22
Hydraulic lift, loading dock, annually	1	0.82	$31.31	$31.15	$0.0000	62.46	74.93	88.97
Hoist / winch, chain / cable, electric, annually	1	1.65	$226.24	$64.09	$0.0000	290.33	332.18	385.35
						$2,047.63	$2,548.28	$3,077.34

FAC 8921 Installation Gas Production Plant

FY25 SUC:	$28,426.13 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8922 Installation Gas Storage

FY25 SUC:	$1,775.89 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Composite of four Cat Codes, 2010

FAC 8922 SUC FY16v18 Installation Gas Storage
UM: EA
Design Size: 1
ESL: 30

Composite of FACs

FAC Component	Component UM	QTY/LF	Reference FAC	Unit Cost (FY16)	Component Cost
Open storage shed	SF	400	4422	1.30	520.00
Storage tank for gases	GA	350	1244	2.00	700.00
					$ 1,220.00

References
DoD Real Property Categorization System (RPCS) FY2015
FY 2014 Real Property Assets Database
RS Means "Costworks" FMR 2015Q3

FAC 8923 Vehicle Scales

FY25 SUC:	$7,418.29 / EA
Source:	Inflated from previous FY using ENR labor and material cost indices to measure actual inflation
Original Source:	Multiple Industry Studies

What every truck scale owner should know about scale maintenance

Do not be fooled by service companies selling scale maintenance agreements that lack focus on calibration. Calibration is the most important component of any periodic maintenance program.

Companies purchase scales because product entering or exiting company facilities are determined to have value based on weight. Without assured scale accuracy, through regular calibration, a company can lose thousands, if not hundreds of thousands of dollars annually, due to inaccurate weights.

Depending on the requirements and type of weighing device, annual maintenance costs for a truck scale run anywhere from $1,000 to $3,000. When measuring the pros and cons of maintenance costs, most users find that protecting against a weighing error can more than pay for a maintenance program and, often times, the cost of the scale itself.

What's the potential damage?

Two hundred pounds may appear miniscule in the aggregate business, where a typical truckload of sand or gravel can exceed 80,000 pounds. However, when one does the math, this seemingly minimal error can substantially cut into profits over time. See the example below for the Acme Aggregate Company.

Acme Aggregate Company

Weighing volume	500 trucks per day
Weighing frequency	Five days per week
Product value	$26.50 per ton
Scale inaccuracy	- 200 pounds
Lost annual revenue	**$345,500**

Initial certification

Once a scale is installed, it is tested by the governing state's weights and measures organization. This test ensures the scale's commercial accuracy and protects the scale buyer, scale seller, and scale installation company.

Upon state approval, the scale is certified and open for weighing. However, the initial calibration does not come with a guarantee for continued accuracy.

What every truck scale owner

s

hould know about scale maintenance

Why is periodic calibration necessary?

Calibration is never guaranteed because accuracy is highly dependent on the way a scale is cared for and used. Weather, use and electrical current are just a few of the factors that can change the accuracy of a weighing device.

Therefore, all scales need to be tested periodically. Test frequency depends on various factors:

Test

- Number of weighments per day
- Price of the product being weighed
- Number of days the scale is used annually
- Acceptable error rate

Five components of a good scale maintenance program

- State licensed service provider
- State certified test weights
- Thorough testing process
- Free inspection services
- Reporting

State licensed service providers

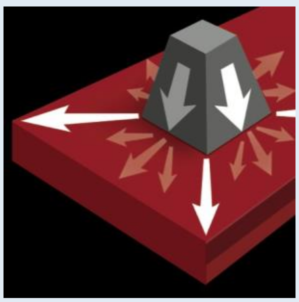
It is important for owners to understand that a commercial scale company cannot certify a scale. The only entities that can issue certification are state weights and measures organizations. However, a commercial scale company does have the authority to recalibrate and reinstate an inaccurate scale that has been "tagged-out*" by the state, as long as the company is state licensed and registered in good standing. Owners should always request to see the valid license.

**Tagged-out – When a scale fails a state weights and measures test for accuracy, the state attaches a lockout tag to the scale, rendering it unusable for commercial trade.*

Test

State certified test weights

Calibration is completed using state certified test weights. An established scale service company typically has its entire inventory of test weights tested and certified annually, in accordance with state weights and measures standards. Other service companies, however, may have only a portion of their overall weight inventory tested each year. The reason for this lack of certification is typically cost. Weight testing requires an enormous amount of time and money to prepare the weights and deliver them to a metrology laboratory for testing. Often,



It is critical accuracy of load is maintained, weight is applied transferred evenly.

weights are condemned and un-certifiable. This is why it is important to verify with your service provider that the weights have been certified.

All test weights have a stamp provided by the governing state weights and measures entity. It is also common practice, among companies that value quality, to request a copy of the test weight certification from the scale service provider. Weight serial numbers will be present on the certifications, and the customer can verify these numbers against the serial numbers on the test weights used by the service company.

Thorough testing process

To test a weighing device properly, one must first determine the length of the platform and the total number of sections along that length.

A scale section is determined by the presence of a load point, which is simply the location of a load sensor (also known as a load cell or strain gauge). Load points are where weight is transferred from the load to the scale and where scale accuracy is maintained.

It is of critical importance, and mandated by the testing procedure of National Institute of Standards and Technology's (NIST) Handbook 44, that the accuracy of load points are maintained, so as weight is applied, it is transferred evenly. If a load point or section fails a strain test, then it must be calibrated to conform to requirements by making a mechanical or electronic adjustment.

The load point is not calibrated to a certified weight, but rather calibrated to assure all sections weigh exactly the same or within government specifications outlined in Handbook 44 and/or issued by a state sanctioned weights and measures organization.

Value added service
Vehicle owners cannot avoid vehicle maintenance. The same is true for scale owners.

While calibration is the critical component of a scale maintenance program, a good service company will also conduct a free visual inspection and have the ability to provide any minor repairs while on site for the maintenance visit.

What every truck scale owner
s
hould know about scale maintenance

Visual inspection

A visual inspection should include:

- Condition of scale
- Any damages
- Clearance
- Mud/debris build-up
- Corrosion
- Regulatory conformance issues
- Safety
- Grounding
- Use issues
- Electrical conditions

A reputable service company will look at these items, as well as others, and offer solutions to any issues that are discovered

Most scale owners understand that it is better to repair and address issues when they are small, rather than wait until they are big and expensive.

Reporting

A good scale maintenance program will provide thorough reporting for its client. Each maintenance inspection should include a written report that documents test results, both before and after calibration, as well as a summary of finding and recommendations, based on a free visual inspection.

About Fairbanks

In 1830, Fairbanks Scales was founded in St. Johnsbury, Vermont, by Thaddeus Fairbanks, inventor of the world's first platform scale. Fairbanks manufactures technology-based scale products, provides nationwide service solutions and is a proud "Made in the U.S.A." company with more than 300 field service personnel.

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www.fairbanks.com.

TOTAL COST OF OWNERSHIP

Spend time now comparing Total Cost of Ownership (TCO) of a Rice Lake SURVIVOR® truck scale and save time and overhead costs in your future.

Total Cost of Ownership is a method developed by the Gartner Group[1] in the late 1980s to identify, estimate and appraise costs related to capital equipment investment. Gartner first applied this methodology, to the process of purchasing, owning and using personal computers. Business professionals were surprised to learn that a PC initially costing less than $1,000 averages a TCO over $5,000 per year.

Today, TCO is accepted as a standard approach to evaluating the true cost of equipment ownership from purchase to retirement; a "cradle-to-grave" financial analysis. When TCO is applied to truck scales, the numbers are magnified by many powers.

Properly maintaining a poorly designed truck scale can cost $7,000 or more per year. Scheduling regular predictive maintenance when it is convenient and least costly, rather than requiring reactive maintenance, makes that $7,000 a bargain compared to revenue loss caused by inaccurate weighments. A food processor weighing 900 million tons of product annually across a vehicle scale with a discrepancy of -1%, could put their enterprise in financial jeopardy. One hour of downtime can cost $10,000 in lost revenue to a busy asphalt company, where the truck scale functions as a cash register.

A few short years ago, a truck scale could be expected to last a generation or longer. Scale weighbridges were simply designed however utilized massive main girders, complex cast iron levers, heavy concrete decks, and finely machined tool steel components. Weighbridges were built like highway bridges with heavy iron I-beam construction to withstand years and years of heavy, constant traffic.

These scales however had to be installed in expensive deep wet pits, accuracy was difficult to maintain, and these products required intensive maintenance to insure consistent performance.

It was not until the early 1970s that manufacturers took a new approach to truck scale bridge designs that would eventually revolutionize the truck scale industry. The first totally electronic truck scales consisted of massive side rail I-Beams and compression type load cells, but they could be installed on simpler and less expensive concrete foundations on top of the ground—a tremendous breakthrough in technology.

CAD/CAM software permitted them to optimize the use of steel components and still meet the maximum load requirements by using structural support shapes of sheet metal instead of heavy I-beams. What most manufacturers failed to realize was that traffic was increasing and trucks were getting bigger and heavier, adding additional axles to carry more cargo with fewer trips.

As the sales of truck scale products became more cost competitive, and the cost of steel increased, manufacturers developed lower cost weighbridge designs resulting in lower-priced truck scales. New terminology was introduced like "Concentrated Load Capacity", the "r" factor, and "Span Deflection Ratios" to establish the integrity of the high-strength to lower-weight ratio CAD/CAM designs. Manufacturers offered "Super Warranties" to cover minimal parts and labor. Based on these claims, many less informed buyers invested in lower priced, lighter-weight truck scales.

Hard lessons were learned in a short time. While some of these new ratings had value, they did not address the longevity of the equipment, which buyers were taking for granted. Steel welds popped, weighbridges twisted, scales literally broke in half, steel plates peeled or warped, and concrete decks cracked. The cost of weighment inaccuracies, repairs, and downtime not covered by "super warranties" far exceeded the perceived cost savings on purchasing a low cost truck scale with less steel content.

In seven to eight years "bargain" scales had to be replaced. Then the essential question became "How much will it cost?" Again, the common mistake buyers made was in considering only the purchase price of the replacement scale and ignoring the associated costs such as torching the weighbridge and modules down to manageable pieces, extra labor, crane charges, disposal fees, scale house construction and permits, site preparation, wiring and initial calibration to meet NTEP Handbook-44 requirements.

Conclusion: The single most important consideration in selection of a properly designed truck scale, is the structural integrity of the weighbridge.

HOW TO USE TCO TO COMPARE TRUCK SCALES:

A. Direct Costs

Add the following and divide by the expected truck scale life*.

- Initial purchase price or lease payment
- Site preparation
- Installation

B. Indirect Costs

Add the following and multiply total indirect costs by expected truck scale life*.

Maintenance

- Preventive maintenance contracts
- Periodic calibration checks
- Spare parts, supplies and materials

Operations

- Labor (scale house operator, weigh ticket or bill of lading processor and related costs and fringe benefits)
- Scale house operation (value/share of site space, furnishings and equipment, network fees for modems, routers, T-1, wireless or ISD lines)

Estimated Downtime

- Interruption of use by scale and/or component mechanical or electrical problems
- Routine scheduled maintenance and calibration checks

Administrative Overhead

- Training, human resources
- Administrative
- Financial costs

*Expected truck scale life of a SURVIVOR truck scale - 30 years. Expected truck scale life of a lighter weight truck scale - 10 years.

C. Total Cost of Ownership = A + B

[1]Gartner, Inc. is an information and technology research and advisory firm headquartered in Stamford, Connecticut. It was known as The Gartner Group until 2001. Gartner clients include many large corporations and government agencies, as well as technology companies and the investment community. Founded in 1979, Gartner has 3,700 associates, including 1,200 research analysts and consultants in 75 countries worldwide.

FAC 8924 Miscellaneous Pump Station

FY25 SUC:	$974.36 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8926 Hazardous Waste Storage Or Disposal Facility

FY25 SUC:	$5,236.24 / EA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8927 Utility Vault

FY25 SUC:	$266.04 / EA
Source:	Set to FAC 8910 Cost Works Model. UM adjustment for 6'x6' vault

FAC 8928 Loading Platform/Ramp

FY25 SUC:	$209.22 / EA
Source:	Calculated using R.S. Means CostWorks 2024 Qtr 3 component prices

FAC 8928 Loading Platform/Ramp

Release:	2024 Qtr 3	FY25 SUC:	$209.22
Zip Code Prefix:	222	UM:	EA
Type:	MR	Expected Service Life:	30
		Model Size:	1

Adjusted Occurences are the occurrences remaining after subtracting Repair/Replacement Overlaps. Overlap reduction removes a repair when it occurs the same year as a replacement.

Description	Frequency	Qty Unit	Total In-House	Total Incl OP	Service Life/Frequency	Occurrences	Adjusted Occurrences	Life Cost	Adjusted Cost
Minor repairs to concrete floor unfinished	15	15.00 S.F.	$610.27	$743.26	2.0000	2	2	$1,486.51	$1,486.51
Replace steel decking	30	5.00 S.F.	$30.02	$34.89	1.0000	1	1	$34.89	$34.89
Remove and replace hydraulic dock leveler lift cylinder	15	0.20 Ea.	$1,660.58	$1,891.21	2.0000	2	2	$3,782.41	$3,782.41
Remove and replace hydraulic dock leveler hydraulic pump	20	0.20 Ea.	$435.09	$497.63	1.5000	1	1	$497.63	$497.63
			$2,735.96	$3,166.99				MR Subtotal:	$5,801.44
								MR Per Year:	$193.38
								PM Total:	$15.84
								Subtotal:	$209.22
								Total Per Unit:	$209.22

FAC 8928 Loading Platform/Ramp

Release: 2024 Qtr 3
Zip Code Prefix: 222
Type: PM
FY25 SUC: $209.22
UM: EA
Expected Service Life: 30
Model Size: 1

Description	Qty	Labor Hours	Bare Mat	Bare Labor	Bare Equip	Bare Total	Total In-House	Total Incl OP
Hydraulic lift, loading dock, annualized	0.1	0.16	$4.70	$6.23	$0.0000	10.93	13.26	15.84
						$10.93	$13.26	$15.84

FAC 8930 Installation Gas Distribution Line

FY25 SUC:	$0.11 / LF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8931 Utility Tunnel

FY25 SUC:	$1.01 / LF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8932 Utility Channels

FY25 SUC:	$0.23 / LF
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 8951 Miscellaneous Storage Tank and Basin

FY25 SUC:	$0.0207 / GA
Source:	Calculated based on the FY24 SUC, with an inflation adjustment applied using ENR labor and material indices.

FAC 9110 Land

FY25 SUC: $0.00 / AC

Source:

FAC 9900 Land Rights

FY25 SUC: $0.00 / AC

Source: