

- 2.4.6.5 Joint Mortar
- 2.4.7 Vitrified Clay Pipe (VCP)
- 2.4.8 Plastic Piping
 - 2.4.8.1 Acrylonitrile-Butadene-Styrene (ABS) Composite Pipe
 - 2.4.8.2 ABS Composite Pipe Joints
 - 2.4.8.3 Type PSM Poly(Vinyl Chloride) (PVC) Pipe
 - 2.4.8.4 PVC Pipe Joints
- 2.5 FRAMES, COVERS AND GRATINGS
 - 2.5.1 Manhole Frames [, Covers] [, and Gratings]
 - 2.5.2 Catch-Basin Frames and Gratings
 - 2.5.3 Sump Frame and Grating
- 2.6 PRECAST CONCRETE MANHOLES, RISERS AND PRECAST CONCRETE BASE SECTIONS
 - 2.6.1 Manhole Gaskets
 - 2.6.2 Manhole Connectors
- 2.7 MANHOLE AND CATCH-BASIN ACCESS [STEPS] [LADDER]

PART 3 EXECUTION

- 3.1 EXCAVATION AND BACKFILL
- 3.2 GRADING
- 3.3 PIPE INSTALLATION
 - 3.3.1 Pipe Installation
 - 3.3.2 [Cast-Iron] [and] [Ductile-Iron] Pipe Installation
 - 3.3.3 Corrugated Metal Pipe Installation
 - 3.3.4 Reinforced Concrete Pipe Installation
 - 3.3.5 Vitrified Clay Pipe Installation
 - 3.3.6 ABS Composite Plastic Pipe Installation
 - 3.3.7 PVC Plastic Pipe Installation
- 3.4 PIPE BEDDING
 - 3.4.1 Bedding
 - 3.4.2 Trench Pipe Cradle
 - 3.4.3 Concrete Encasement
 - 3.4.4 Compaction
- 3.5 JACKING PIPE
- 3.6 UNDERGROUND STRUCTURES
 - 3.6.1 Structures
 - 3.6.2 Concrete Construction
 - 3.6.3 Invert Channel Installation
- 3.7 STORM SEWER CONNECTIONS AND WYES
- 3.8 FIELD QUALITY CONTROL
 - 3.8.1 Tests
 - 3.8.1.1 Infiltration Test/Exfiltration Test
 - 3.8.1.2 Hydrostatic Test on Watertight Joints
 - 3.8.1.3 Low Pressure Air Test of Conduit
 - 3.8.2 Interior Inspection of Pipe

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEA / NASA UFGS-33 40 00.00 40 (April 2007)

Preparing Activity: NASA Superseding
 UFGS-33 40 00.00 40 (October 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2007

SECTION 33 40 00.00 40

STORM DRAINAGE UTILITIES 04/07

NOTE: This specification covers the requirements for gravity drainage of surface water in the project site area not associated with any structure.

Drawing details shall include sizes, conduit materials, frames and covers, concrete encasement, and pads.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

- | | |
|--------------|---|
| AASHTO M 198 | (2005) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| AASHTO M 288 | (2006) Standard Specification for Geotextile Specification for Highway Applications |
| AASHTO M 306 | (2007) Standard Specification for Drainage, Sewer, Utility, and Related Castings |

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

- | | |
|-------------|--|
| ACPA 01-103 | (2000) Concrete Pipe Installation Manual |
|-------------|--|

AMERICAN WATER WORKS ASSOCIATION (AWWA)

- | | |
|------------------|---|
| AWWA C110/A21.10 | (2003) Ductile-Iron and Gray-Iron Fittings for Water |
| AWWA C111/A21.11 | (2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C210 | (2003; R 2004) Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines |

ASTM INTERNATIONAL (ASTM)

- | | |
|-----------------|--|
| ASTM A 48/A 48M | (2003) Standard Specification for Gray Iron Castings |
| ASTM A 74 | (2006) Standard Specification for Cast Iron Soil Pipe and Fittings |
| ASTM A 746 | (2003) Standard Specification for Ductile Iron Gravity Sewer Pipe |

ASTM A 760/A 760M	(2006) Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 762/A 762M	(2000) Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A 798/A 798M	(2001) Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM A 849	(2000; R 2005) Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B 745/B 745M	(1997; R 2005) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C 12	(2007) Standard Practice for Installing Vitrified Clay Pipe Lines
ASTM C 139	(2005) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 14	(2007) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 14M	(2005a) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 270	(2007) Standard Specification for Mortar for Unit Masonry
ASTM C 32	(2005) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 361	(2005e1) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
ASTM C 361M	(2005) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe (Metric)
ASTM C 387/C 387M	(2006a) Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
ASTM C 425	(2004) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

ASTM C 443M	(2007) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM C 478	(2007) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(2007) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 506	(2007) Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C 506M	(2007) Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 507	(2007) Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C 507M	(2007) Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 564	(2003a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 700	(2007) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 76	(2007) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 76M	(2007) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 923	(2007) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C 923M	(2007) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric)
ASTM C 969	(2002) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C 969M	(2002) Standard Practice for Infiltration

and Exfiltration Acceptance Testing of
Installed Precast Concrete Pipe Sewer
Lines (Metric)

ASTM D 2321 (2005) Standard Practice for Underground
Installation of Thermoplastic Pipe for
Sewers and Other Gravity-Flow Applications

ASTM D 2680 (2001) Standard Specification for
Acrylonitrile-Butadiene-Styrene (ABS) and
Poly(Vinyl Chloride) (PVC) Composite Sewer
Piping

ASTM D 2855 (1996; R 2002) Standard Practice for
Making Solvent-Cemented Joints with
Poly(Vinyl Chloride) (PVC) Pipe and
Fittings

ASTM D 3034 (2006) Standard Specification for Type PSM
Poly(Vinyl Chloride) (PVC) Sewer Pipe and
Fittings

ASTM D 3212 (1996a; R 2003e1) Standard Specification
for Joints for Drain and Sewer Plastic
Pipes Using Flexible Elastomeric Seals

ASTM F 1417 (1992; R 2005) Standard Test Method for
Installation Acceptance of Plastic Gravity
Sewer Lines Using Low Pressure Air

ASTM F 477 (2007) Standard Specification for
Elastomeric Seals (Gaskets) for Joining
Plastic Pipe

ASTM F 794 (2003) Standard Specification for
Poly(Vinyl Chloride) (PVC) Profile Gravity
Sewer Pipe and Fittings Based on
Controlled Inside Diameter

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-60005 (Basic) Frames.Covers, Gratings, Steps,
Sump and Catch Basin, Manhole

1.2 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions
in Section 01 33 00 SUBMITTAL PROCEDURES and edit
the following list to reflect only the submittals
required for the project. Submittals should be kept
to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the
submittal requires Government approval. Some
submittals are already marked with a "G". Only
delete an existing "G" if the submittal item is not
complex and can be reviewed through the Contractor's
Quality Control system. Only add a "G" if the

submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Coordination Drawings in accordance with paragraph entitled, "Drawings," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following:

Conduit Piping
Concrete Mortar
Brick Mortar
Gaskets
Compression Joints
Frames, Covers and Gratings
Precast Concrete Manholes
Precast Concrete Base Sections
Concrete Block
Brick
Bituminous Coating
Cold Bituminous Mastic Sealer

SD-04 Samples

Samples shall be submitted for the following items:

Conduit Piping
Gaskets
Compression Joints
Frames, Covers and Gratings
Precast Concrete Manholes

Precast Concrete Base Sections
Concrete Block
Brick
Bituminous Coating
Cold Bituminous Mastic Sealer
Concrete Block

SD-05 Design Data

Mix designs for **Concrete** shall be submitted in accordance with paragraph entitled, "Concrete Construction," of this section.

SD-06 Test Reports

Test reports shall be submitted in accordance with paragraph entitled, "Tests," of this section.

Infiltration Test
Exfiltration Test
Hydrostatic Test

SD-07 Certificates

Certificates for the following items shall be submitted in accordance with the applicable paragraphs of this section for:

Conduit Piping
Concrete Mortar
Brick Mortar
Gaskets
Compression Joints
Frames, Covers and Gratings
Precast Concrete Manholes
Precast Concrete Base Sections
Concrete Block
Brick
Bituminous Coating
Cold Bituminous Mastic Sealer

A **Work Plan** shall be submitted in accordance with paragraph entitled, "Plans," of this section.

Proposed Schedules
Methods
Materials
Equipment

1.3 BEDDING AND BACKFILL

[Bedding and backfill shall be clean native soil.] [Bedding and backfill shall conform to Section 31 00 00 EARTHWORK.]

1.4 DRAWINGS

Contractor shall submit **Coordination Drawings** interferences for construction. Details of catch basins and manholes shall be shown with proper elevations.

1.5 PLANS

A [Work Plan](#) shall be submitted when sewer flow is to be interrupted, noting [Proposed Schedules](#), [Methods](#), [Materials](#) and [Equipment](#).

PART 2 PRODUCTS

2.1 BONDING AND SEALING MATERIALS

2.1.1 [Bituminous Coating](#) and Sealing

Coating shall be in accordance with [ASTM A 849](#).

Coating shall be in accordance with [ASTM A 849](#), when using materials previously coal-tar coated and for each uncoated ferrous piece used underground.

[Cold Bituminous Mastic Sealer](#) shall be in accordance with [ASTM A 849](#) [trowel] [_____] consistency.

2.1.2 Epoxy Bonding

Epoxy adhesive shall be in accordance with [AWWA C210](#).

2.2 FILTER MATERIAL

2.2.1 Filter Fabric

Fabric shall be in accordance with [AASHTO M 288](#), and be water pervious, made of [polyester] [_____] materials.

2.2.2 Filter Aggregate

Aggregate shall be clean [gravel] [sand] [_____] free from organic materials, clay, [_____] , or other deleterious materials, graded to the following minimal limits:

SIEVE SIZE	PERCENT PASSING
4.75 millimeter [_____]	No. 4 15 to 30 [_____] to [_____]

2.3 MANHOLE AND CATCH-BASIN MATERIALS

Water, for use with concrete block and brick, shall be clean and potable.

2.3.1 [Concrete Block](#) and Mortar

Concrete block shall be in accordance with [ASTM C 139](#).

[Concrete Mortar](#) shall be in accordance with [[ASTM C 387/C 387M](#), Type [M] [_____]] [[ASTM C 270](#), Type [S] [_____]]].

2.3.2 [Brick](#) and Mortar

Brick shall conform to [[ASTM C 32](#), Grade [_____]] [_____].

[Brick Mortar](#) shall conform to [[ASTM C 387/C 387M](#), Type [_____]] [[ASTM C 270](#), Type [_____]]].

2.4 CONDUIT PIPING, JOINTS, FITTINGS AND GASKETS

2.4.1 Cast-Iron Soil Pipe (CISP) and Fittings

Pipe and fittings shall be in accordance with ASTM A 74, [service] [extra heavy] weight, with bell and spigot ends.

2.4.2 Cast-Iron Soil Pipe Joints

Joints shall be in accordance with AWWA C111/A21.11 push-on type.

Gaskets shall be in accordance with ASTM C 564, [neoprene] [_____] type.

2.4.3 Ductile-Iron Pipe and Fittings

Pipe shall be in accordance with ASTM A 746.

Fittings shall be in accordance with AWWA C110/A21.10 for DN75 to DN1220 3 to 48 inch.

2.4.4 Ductile-Iron Pipe Joints

Joints shall be in accordance with AWWA C111/A21.11, [mechanical joint] [push-on] type.

Gaskets shall be in accordance with ASTM C 564, [neoprene] [_____] type.

2.4.5 Corrugated [Steel Pipe (CMP)] [Aluminum Pipe (CAP)]

Lifting lugs or markings shall be provided for placement of factory elongated corrugated pipe.

2.4.5.1 Metallic-Coated Corrugated Steel Pipe

Pipe shall be in accordance with ASTM A 760/A 760M, Type [_____] Pipe shall be [lined] [unlined] steel having [annular] [helical] corrugations.

Corrugations shall be [_____] by [_____] millimeter inch.

Pipe shall be [aluminum] [zinc] [or] [aluminum-zinc alloy]-coated.

[Liner sheet thickness shall be [_____] millimeter inch.]

[Perforations shall be class [_____] .]

2.4.5.2 Polymer Precoated Corrugated Steel Pipe

Pipe shall be in accordance with ASTM A 762/A 762M, Type [_____] .

Pipe shall be [lined] [unlined] steel having [annular] [helical] corrugations.

Pipe shall be [zinc] [aluminum] [or] [aluminum-zinc alloy]-coated.

Corrugations shall be [_____] by [_____] millimeter inch.

Polymer pre-coating shall be grade [_____] .

[Liner sheet thickness shall be [_____] millimeter inch.]

[Perforations shall be class [_____] .]

2.4.5.3 Corrugated Aluminum Pipe

Pipe shall be in accordance with ASTM B 745/B 745M, Type [_____] . Pipe shall be [lined] [unlined] aluminum having [annular] [helical] corrugations.

Corrugations shall be [_____] by [_____] millimeter inch.

[Liner sheet thickness shall be [_____] millimeter inch.]

[Perforations shall be class [_____] .]

2.4.5.4 Metal Pipe Fittings

Pipe fittings of same type and class as pipe material shall be provided. Fittings shall be sized and shaped to match conduit corrugations.

2.4.5.5 Gaskets and Coupling Bands

Gaskets and coupling bands shall be provided.

[Coupling bands shall be bituminous-coated to a minimum thickness of [1.27] millimeter [0.05] inch [_____] .]

[Coupling bands for polymer precoated pipe shall have [the same polymer precoating as the pipe] [bituminous coating] [the same metallic coating as the pipe] only.]

2.4.6 Concrete Pipe

2.4.6.1 Nonreinforced Concrete Pipe and Fittings

Pipe shall be in accordance with ASTM C 14M ASTM C 14 Class [1] [_____] [bell and spigot] [_____] ends.

Acceptability shall be in accordance with ASTM C 14M ASTM C 14 [strength] [_____] requirements.

2.4.6.2 Reinforced Concrete Pipe (RCP)

Round RCP shall conform to ASTM C 76 ASTM C 76M, be of Class [_____] , with wall type [_____] and with [wire fabric] [_____] reinforcement and [bell and spigot] [_____] ends.

Lifting holes shall be provided when using elliptical reinforcement.

Acceptability shall be in accordance with ASTM A 746.

Elliptical RCP shall conform to ASTM C 507M ASTM C 507, and be of the [Horizontal] [Vertical] type, and Class [_____] with [wire fabric] [_____] reinforcement, and [bell and spigot] [_____] ends.

Lifting holes shall be provided.

Acceptability shall be in accordance with ASTM C 507M ASTM C 507.

Arch RCP shall be in accordance with [ASTM C 506M](#) [ASTM C 506](#) be of Class [____], with [wire fabric] [____] reinforcement, and [bell and spigot] [____] ends.

Lifting holes shall be provided.

Acceptability shall be in accordance with [ASTM C 507M](#) [ASTM C 507](#).

2.4.6.3 Reinforced Concrete Pressure Pipe (RCPP)

Pipe shall be in accordance with [ASTM C 361M](#) [ASTM C 361](#), be of Class [____], [Wire fabric] [____] reinforcement, and [bell and spigot] [____] pipe end joints.

Lifting holes shall be provided when elliptical reinforcement is used.

2.4.6.4 Gaskets

Gaskets shall be in accordance with [ASTM C 443M](#) [ASTM C 443](#) [except Shore A durometer hardness shall be 40 to 55].

2.4.6.5 Joint Mortar

Mortar shall be in accordance with [ASTM C 270](#) for each pipe joint and connection.

2.4.7 Vitrified Clay Pipe (VCP)

Pipe shall be in accordance with [ASTM C 700](#), [extra] [standard] strength [perforated] with [bell and spigot] [____] ends.

[Compression Joints](#) shall be in accordance with [ASTM C 425](#).

2.4.8 Plastic Piping

2.4.8.1 Acrylonitrile-Butadene-Styrene (ABS) Composite Pipe

Pipe and fittings shall be in accordance with [ASTM D 2680](#).

2.4.8.2 ABS Composite Pipe Joints

Solvent cement and primer shall be in accordance with [ASTM D 2680](#).

2.4.8.3 Type PSM Poly(Vinyl Chloride) (PVC) Pipe

Pipe shall be in accordance with [ASTM D 3034](#), SDR [35] [____], up to [DN375 15 inch](#) diameter.

Pipe ends made for joints shall be [elastomeric gasket] [solvent cement] type.

PSM PVC Pipe, [450 to 1200 millimeter 18 to 48 inch](#) diameter shall be in accordance with [ASTM F 794](#).

2.4.8.4 PVC Pipe Joints

Joints shall be in accordance with [ASTM D 3212](#), [push-on] [mechanical joint] type.

[Gaskets shall be in accordance with ASTM F 477].

[Solvent cement shall be in accordance with ASTM D 2855].

2.5 FRAMES, COVERS AND GRATINGS

Manhole, catch-basin, and sump frames, covers, and gratings shall be in accordance with AASHTO M 306 FS A-A-60005.

[Cast iron] [_____] materials shall be provided. The following legends shall be cast-in on every cover: [STORM] [_____] . Cast iron shall conform to ASTM A 48/A 48M, Class 30B, minimum.

2.5.1 Manhole Frames [, Covers] [, and Gratings]

Frames shall be Type [I] [_____] , Style [A] , [_____] , Size [_____] .

Covers shall be Type [A] [_____] , Size [_____] .

[Gratings shall be Type F, Style [1] [_____] , Size [_____] .]

2.5.2 Catch-Basin Frames and Gratings

Frames shall be Type VI [_____] , Size [_____] .

Gratings shall be Type G, Style [1] [], Size [_____] .

2.5.3 Sump Frame and Grating

Frame shall be Type VII [_____] .

Grating shall be Type I [_____] .

2.6 PRECAST CONCRETE MANHOLES, RISERS AND PRECAST CONCRETE BASE SECTIONS

Concrete manholes, risers, base sections, and tops shall be pre-cast and conform to ASTM C 478M. ASTM C 478.

Precast parts shall contain [wire fabric] [_____] reinforcement.

Risers and grade rings shall be of the [_____] type.

Base sections shall be of the [_____] type.

[Acceptability for tops shall be based upon [proof of design testing] [_____] .]

2.6.1 Manhole Gaskets

Gaskets shall be in accordance with ASTM C 443M ASTM C 443 for joints between manhole sections.

2.6.2 Manhole Connectors

Connectors shall be in accordance with ASTM C 923M ASTM C 923 for joints between manhole and pipes.

2.7 MANHOLE AND CATCH-BASIN ACCESS [STEPS] [LADDER]

Access shall be in accordance with [ASTM C 478M] [ASTM C 478], using [steps] [ladders] for manholes or catch basins at least [1200] millimeter [four] feet [_____] deep.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL

Excavation, backfill, and removal of unsatisfactory materials shall be in accordance with Section 31 00 00 EARTHWORK.

3.2 GRADING

Grading shall be performed in accordance with Section 31 00 00 EARTHWORK.

3.3 PIPE INSTALLATION

3.3.1 Pipe Installation

Excavations shall be trimmed to required elevations. Objects which impair backfilling or compaction shall be removed. Over-excavation shall be corrected with [fill material of [fine] [coarse] aggregate.] [lean concrete.]

Pipe and fittings shall be inspected for defects before installing. Defective materials shall be removed from site.

Pipe interior shall be cleaned before installation. Pipe ends shall be sealed when work is not in progress.

Pipe shall be laid to line and grade, with bell end upstream.

[Maximum variation from true slope shall not exceed [3.2] millimeter [1/8] inch [_____] in [3048] millimeter [10] feet [_____] .]

[Maximum deviation from design elevation shall not exceed [12.2] millimeter [0.04] feet [_____] at any point in the system.]

Maximum deviation from true line shall not exceed [6.1] millimeter [0.20] feet [_____] for pipe [DN375] [15] inches [_____] in diameter and smaller, [12.2] millimeter [0.40] feet [_____] for pipe larger than [DN375] [15] inches [_____] in diameter.

[Corrections shall be made at a rate not to exceed [30.5] millimeter [0.10] foot [_____] for one length of conduit].

3.3.2 [Cast-Iron] [and] [Ductile-Iron] Pipe Installation

Install [cast iron] [and] [ductile iron] pipe and fittings in accordance with manufacturer's instructions. [Mechanical joints shall be assembled in accordance with AWWA C111/A21.11, Appendix A.]

3.3.3 Corrugated Metal Pipe Installation

[Corrugated steel] [and] [Corrugated aluminum] pipe with fittings shall be installed in accordance with manufacturer's instructions, and in accordance with ASTM A 798/A 798M.

3.3.4 Reinforced Concrete Pipe Installation

Reinforced concrete pipe and fittings shall be installed in accordance with manufacturer's instructions, and ACPA 01-103.

3.3.5 Vitrified Clay Pipe Installation

Clay pipe and fittings shall be installed in accordance with manufacturer's instructions and in accordance with ASTM C 12.

3.3.6 ABS Composite Plastic Pipe Installation

ABS Composite plastic pipe and fittings shall be installed in accordance with manufacturer's instructions.

3.3.7 PVC Plastic Pipe Installation

PVC pipe and fittings shall be installed in accordance with manufacturer's instructions and in accordance with ASTM D 2321.

3.4 PIPE BEDDING

3.4.1 Bedding

Minimum compacted bedding under installed pipe shall be one-fourth of the pipe diameter in thickness, and in no case less than [100] millimeter [4] inches [_____] or more than [300] millimeter [12] inches [_____] .

Bedding shall be placed in layers not exceeding 150 millimeter 6 inches in depth and compacted. Additional layers shall be added until a minimum elevation of [300] millimeter [12] inches [_____] above the pipe is achieved.

3.4.2 Trench Pipe Cradle

Trench pipe cradle shall be constructed monolithically of [21 Megapascal 3000 psi, air-entrained] [_____] concrete.

3.4.3 Concrete Encasement

Pipe shall be encased in [21] Megapascal [3000 psi] air-entrained [_____] concrete to a level of not less than [150] millimeter [6] inches [_____] above the top of pipe.

3.4.4 Compaction

Puddling or jetting shall not be permitted when compacting bedding materials.

3.5 JACKING PIPE

Jacking pipe shall [not] be used.

3.6 UNDERGROUND STRUCTURES

3.6.1 Structures

[13] millimeter [1/2] inch [_____] thick ASTM C 387/C 387M, Type M mortar

shall be applied to both interior and exterior surfaces.

Top of manhole and catch basin covers shall be set flush with finished pavement surfaces. Elsewhere, tops shall be set [75] millimeter [3] inches [_____] above finished surface.

Attach steps into manhole walls with [epoxy compound] [_____] .

Preformed bituminous expansion joint material shall be provided 19 millimeter [3/4] inch [_____] thickness around drainage structures in pavements.

Joints for concrete risers and tops shall be [bedded in mortar and smoothed to uniform surface on both interior and exterior of structure] [made with flexible watertight rubber-type gaskets] .

Catch basins and curb drop inlets shall be constructed.

3.6.2 Concrete Construction

Concrete shall be in accordance with Section 03 30 53.00 40 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

3.6.3 Invert Channel Installation

Invert channels shall be smooth and fitted to each inlet, outlet, or transition for correct hydraulic flow.

3.7 STORM SEWER CONNECTIONS AND WYES

Pipe connections to existing conduit and manholes shall be provided.

Wyes for branch connections shall be provided. Field-cutting into conduit shall not be permitted. Wyes shall be sprung into existing lines. Entire wye shall be encased in concrete.

Epoxy shall be used to secure each interface connecting new and existing conduit.

3.8 FIELD QUALITY CONTROL

3.8.1 Tests

Contractor shall provide test equipment or engage the services of a firm to provide the necessary testing.

3.8.1.1 Infiltration Test/Exfiltration Test

[Infiltration] [and] [exfiltration] tests for installed concrete pipe shall be performed in accordance with ASTM C 969M ASTM C 969.

3.8.1.2 Hydrostatic Test on Watertight Joints

Hydrostatic tests shall be upon one sample for each type of joint to be installed. When the sample joint fails, an additional joint of the same type shall be re-tested.

Joints shall be protected from temperatures which adversely affect the joining materials.

Test results for concrete pipe shall conform to [ASTM C 443M] [ASTM C 443] [AASHTO M 198].

Hydrostatic Pressure tests shall be performed at a pressure of 69 kilopascal 10 pounds per square inch (psi) for 24 hours. Cement or corrugated-metal pipes joined straight shall withstand 69 kilopascal 10 psi for 24 hours without failure. When test is completed test sections shall be angled and retested at 69 kilopascal 10 psi for an additional 24 hours.

Test results for clay pipe shall conform to ASTM C 425.

3.8.1.3 Low Pressure Air Test of Conduit

Acceptance tests for installed ferrous and plastic piping shall be in accordance with ASTM F 1417.

3.8.2 Interior Inspection of Pipe

Installed pipe shall be inspected [when 600 millimeter 2 feet of earth cover is in place] [and] [upon completion of project]. Displaced or misaligned pipe, infiltration, accumulation of debris, or other defects shall be corrected by the Contractor at no additional cost to the Government.

-- End of Section --