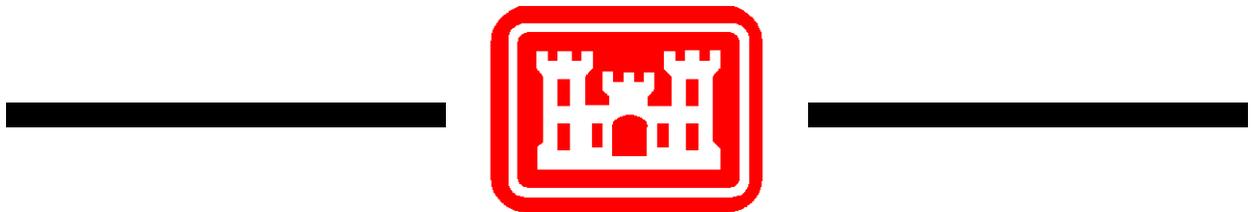


PUBLIC WORKS TECHNICAL BULLETIN 200-1-73
31 JULY 2010

**REUSE OF MATERIALS FROM MODULAR,
RELOCATABLE FACILITIES**



Public Works Technical Bulletins are published by the U.S. Army Corps of Engineers, Washington, DC. They are intended to provide information on specific topics in areas of Facilities Engineering and Public Works. They are not intended to establish new Department of Army (DA) policy.

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
441 G Street NW
Washington, DC 20314-1000

CECW-CE

Public Works Technical Bulletin

31 JULY 2010

No. PWTB 200-1-73

FACILITIES ENGINEERING
ENVIRONMENTAL

REUSE OF MATERIALS FROM MODULAR,
RELOCATABLE FACILITIES

1. Purpose.

a. This Public Works Technical Bulletin (PWTB) provides guidance for recovering, reusing, and recycling building materials typically found in modular, relocatable buildings installed under the Army transformation process. It will assist Army installations and the Installation Management Command (IMCOM) and U.S. Army Corps of Engineers (USACE) districts to implement practices to reduce the amount of demolition debris generated by the removal of these buildings once their temporary service life has concluded.

b. All PWTBs are available electronically in Adobe® Acrobat® portable document format [PDF]) through the World Wide Web (WWW) at the National Institute of Building Sciences' Whole Building Design Guide (WBDG) Web page, which is accessible through this Universal Resource Locator (URL):

http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability. This PWTB applies to installation Directorates of Public Works (DPW), Public Works Business Centers, Directorates of Engineering, and other U.S. Army facilities' engineering activities. This PWTB does not apply to modular, relocatable facilities that the Army is leasing and will be

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returning to the manufacturer when their interim requirement has been completed.

3. References.

a. Department of Defense (DOD) Instruction 4165.56, "Relocatable Buildings."

b. Engineer Manual 385-1-1, "Safety - Safety and Health Requirements," 4 November 2003.

c. Executive Order 13423 "Strengthening Federal Environmental, Energy, and Transportation Management," 26 January 2007.

d. Executive Order 13514 "Federal Leadership in Environmental, Energy, and Economic Performance," 8 October 2009.

e. Army Regulation (AR) 405-90, "Disposal of Real Estate."

f. AR 420-1, "Army Facilities Management," 12 February 2008.

g. AR 735-5, "Policies and Procedures for Property Accountability," 10 June 2002.

h. Memorandum, Deputy Under Secretary of Defense (Environmental Security), 13 May 1998, subject: New DOD Pollution Prevention Measure of Merit.

i. PWTB 420-49-30, "Alternatives to Demolition for Facility Reduction," 10 February 2000.

j. PWTB 420-49-32, "Selection of Methods for the Reduction, Reuse, and Recycling of Demolition Waste," 16 July 2001.

k. PWTB 200-1-17, "Recycling Interior Finish Materials - Carpet and Ceiling Tiles," 3 October 2003.

l. PWTB 200-1-23, "Guidance for the Reduction of Demolition Waste Through Reuse and Recycling," 3 October 2003.

m. PWTB 200-1-44, "Recycling Exterior Building Finish Materials," 2 January 2007.

n. Memorandum, Principal Deputy Secretary of the Army (Installations and Environment), 18 January 2001, subject: Deconstruction and Re-Use of Excess Army Buildings.

o. Memorandum, Assistant Chief of Staff for Installation Management (ACSIM), 26 May 2000, subject: Sustainable Design and Development (SDD) Policy.

p. Memorandum, ACSIM, 6 February 2006, Sustainable Management of Waste in Army Construction, Renovation, and Demolition Activities. Revised 11 July 2006.

q. Enclosure to Reference "p" above, 13 February 2006, Sustainable Management of Waste in Army Construction, Renovation, and Demolition Activities. Revised 5 July 2006.

r. Memorandum, ACSIM, 19 February 2008, Interim Policy Change on Relocatable Buildings for Paragraphs 6-3 through 6-17 in AR 420-1, Army Facilities Management.

4. Discussion.

a. In 2004, the Army began to construct temporary barracks and supporting facilities to accommodate troop units moving onto installations through Army Transformation, re-stationing from locations outside the continental United States (OCONUS), Base Closure and Realignment (BRAC), and other directives. Modular, relocatable buildings were constructed to satisfy this requirement as a temporary measure until permanent facilities can be constructed under Military Construction (MILCON) appropriations. The classification of "relocatable" requires they be removed within 6 years of their placement. The Army has approved almost 10 million sq ft of modular, relocatable facilities to be placed between 2004 and 2010. This, therefore, creates a requirement to remove roughly 10 million sq ft of buildings between 2010 and 2016. While the preference will be to relocate these buildings (either on-post or off-post), the potential supply is likely to be greater than the potential demand, which will require their disposal in some fashion.

b. Public Works personnel on installations have expressed concerns about modular, relocatable buildings becoming the new World War II-era temporary buildings that are still standing more than 60 years beyond their expected life. While there are regulatory provisions that the modular buildings be removed after their temporary service, this must still be accomplished in an economical and efficient manner that responds to Army policy. Disposing of this amount of building material in an environmentally sensitive manner will be a challenge.

c. Construction and Demolition (C&D) debris accounts for more than half of the Army's solid waste stream, up to 80

percent at some installations. This situation is most critical at installations where large Military Construction (MILCON) programs, Residential Communities Initiatives (RCI), and Facility Reduction Programs (FRP) are generating construction waste and demolition debris. Demolishing temporary modular buildings will increase this burden. Demolition is expensive in and of itself, even in on-post landfills. The costs to permit, construct or expand, operate and maintain, close, and monitor a landfill throughout its life are expenses attributable to demolition debris as well. Existing landfill capacity is a resource that cannot be wasted. Where an installation's landfill is closed, hauling costs and tipping fees will cost more than onsite landfilling. Alternatives to conventional demolition and landfilling have proven that diverting more than 75 percent of debris from the landfill is achievable.

d. Outlined in this PWTB are procedural guidance and supporting resources for removing temporary modular buildings once their interim requirement is concluded, while diverting debris from landfills, either on the installations or off-site. Building deconstruction (the disassembly of a building for the purposes of recovering components and materials for reuse), salvage, and recycling methods are addressed. Although fundamentally similar, there can be some differences in construction methods between site-built and factory fabricated buildings that would affect the potential for deconstruction and salvage. These differences are also described.

e. The Army has adopted the concept of Sustainable Design and Development (SDD) as described in the Memorandum, Assistant Chief of Staff for Installation Management (ACSIM), 26 May 2001. The ACSIM Memorandum of 6 February 2006 (revised 11 July 2006) provides guidance on the relationship of C&D waste management to SDD and requires installations to incorporate C&D waste management programs into their Integrated Solid Waste Management Plans, and divert a minimum of 50 percent of C&D materials from Army construction, remodeling, and demolition projects.

f. Appendix A to this PWTB describes the general guidance and advice for removing modular, relocatable buildings. Appendix B provides quantity figures and material component descriptions and quantities representing typical modular, relocatable facilities. Application of the modeled data to building types and special considerations are discussed. Appendix C provides information on creating a waste management plan. Appendix D contains resources for C&D waste management and outlets for C&D

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materials. Appendix E lists acronyms and abbreviations used throughout this document.

5. Points of Contact. Headquarters, U.S. Army Corps of Engineers (HQUSACE) is the proponent for this document. The POC at HQUSACE is Malcolm E. McLeod, CEMP-CEP, 202-761-4595, or e-mail: Malcolm.E.Mcleod@ usace.army.mil

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APPENDIX A

MODULAR, RELOCATABLE BUILDING REMOVAL METHODS

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Introduction

The Army is restructuring and transforming on a large scale both on installations in the continental United States (CONUS) and theaters outside CONUS (OCONUS). The Army is experiencing significant personnel growth, more than 50 percent in some cases, at 18 domestic bases through 2011 because of the effect of implementing base realignment and closure (BRAC), overseas force rebasing, and force modularity actions.* While the Army is restructuring, it must simultaneously execute the current mission. These missions affect all facets of facilities such as housing, motor pools, training ranges, hangars, parking aprons, battalion operational facilities, and company operational facilities. Furthermore, Army leadership is looking to Installation Commanders to find innovative solutions to support additional soldiers who will be training and living on installations in relatively short time periods. To adjust to new facility requirements, the installation renovates and upgrades all existing available facilities. In many cases, however, facilities are still not enough to meet requirements. In the event of a shortfall, the Assistant Chief of Staff for Installation Management (ACSIM) has directed installations to use temporary structures until permanent facilities are programmed and constructed.

The Army has authorized the purchase of approximately 9.8 million sq ft of temporary buildings. Based on the current authority status, those buildings will need to be disposed of within 6 years of their installation. In 2010 more than 1 million sq ft of buildings will start to expire each year. This suggests a real potential for disposal to become an issue of concern.

The Army builds the vast majority of these temporary buildings using modular construction methods, and they are intended to be relocated after 6 years. These buildings include barracks, dining facilities, administrative facilities, and other support buildings. Prefabricated, modular building systems were selected because of the industry's ability to provide a significant

* Government Accountability Office (GAO) report GAO-07-1007 entitled "Defense Infrastructure: Challenges Increase Risks for Providing Timely Infrastructure Support for Army Installations Expecting Substantial Personnel Growth," released 13 September 2007. Available at <http://www.gao.gov/new.items/d071007.pdf> (accessed July 2010).

quantity of buildings, economically, within a limited time. The relocatable feature is intended to expedite building removal once its interim requirement is concluded and offer the Army the flexibility to adapt to building requirements over time and across installations. Other construction types, such as pre-engineered metal buildings, architectural fabric structures, and precast concrete arms vaults, are also incorporated into the temporary facilities inventories. However, these represent a relatively small portion of the overall modular, relocatable building inventory.

While in service, installations must operate and maintain these modular building complexes through their Sustainment, Restoration, and Modernization (SRM) funding. Unfortunately, this draws resources from other operation and maintenance (O&M) requirements, so it is in the installation's best interest to vacate and remove these buildings.

Once permanent facilities are completed through MILCON appropriations, and the interim requirement for the modular building complexes has been completed, the complexes are to be removed. The Installation Management Command (IMCOM) will accomplish this by either cross-leveling or removal for disposal.

Description of Modular, Relocatable Facilities Construction

Modular buildings are constructed at one location (a fabricating facility), and then shipped and installed at another location. The "modular" description refers to the buildings being fabricated as three-dimensional, box-like components (as opposed to flat panels), with most interior and exterior finishes and equipment in place. Fabrication is performed in an industrial setting, which involves production line assembly, standardization of dimensions and components, and automation to some degree in most cases.

Manufacturers do not prefabricate an entire building as one piece; instead, the floor plan is broken into individual modules that can be shipped, placed on foundations, and joined on-site. Each module typically ranges in size from 10 to 18 ft wide to 36 to 76 ft long, with the module width depending on each state's over-the-road shipping regulations.

Modular buildings are essentially similar to conventional wood-framed construction. Floors, walls, ceilings, and roof frames are fabricated of dimensional lumber. Sheathing is typically oriented-strand board. The frames are then assembled into the

modular "boxes." Plumbing, HVAC (heating, ventilating, and air conditioning) and electrical distribution, and insulation are installed prior to the wall, floor, and ceiling surfaces being applied. Manufacturers offer a variety of interior and exterior finishes to commercial customers, although the Army's designs are more austere. Modules fabricated for the Army include pre-surfaced gypsum wallboard wall surfaces, which eliminate the need for taping and finishing seams. Vinyl and carpet floor finishes are standard. Aluminum exterior walls and either aluminum or membrane roofing are most common with Army projects. Interior finishes, fixtures, and cabinetry are similar to those offered to the commercial market, but generally include the less expensive models. Army modular building projects include both one- and two-story configurations.

Some differences occur in fabricating and materials selection that may affect opportunities for deconstruction and materials salvage. Laminated finish materials may be damaged when removed and no longer suitable for reuse. Use of adhesives in lieu of mechanical fastening makes disassembly difficult and will damage sheathing and framing members. Use of engineered wood products in lieu of solid lumber members may limit reuse options. Depending on the manufacturer, roof framing may consist of trusses made of smaller sized lumber, as opposed to deeper, solid wood rafters. However, some modular designs may include additional framing materials. Two-story designs may include both ceiling joists for the first floor modules, as well as floor joists for the second floor modules. Wall framing may also be redundant in places where modules are mated to each other. HVAC systems typically consist of electric packaged heating/cooling units, which are easily removed from the building. These require no ductwork to complicate deconstruction. If steel frames are integral with the modules, there will be significantly more recyclable ferrous metal than typically found in residential construction. Details depend on the manufacturer.

Modular buildings are transported to the site on trailers, lifted off, and set on permanent foundations, which at Army sites are typically masonry or concrete piers. Alternatively, a steel chassis and running gear are integrated into the building, which allows the building to roll over the piers and be lowered onto them. Once set, the running gear is removed and stored for the next move.

Smaller buildings, such as storage or administrative buildings, are constructed with as few as two modules (i.e., "double-wide" fashion). Barracks are typically constructed with 12 or more

modules, two modules wide and six modules or more in length. Modules are joined along their unfinished walls. The placement of a module within a building plan also dictates whether there are one, two, or three exterior wall surfaces.

Figure A-1 through Figure A-7 illustrate typical modular building construction and configuration. These photographs were taken during the Fort Stewart, GA, 4th Brigade, 3rd Infantry Division (Mechanized) Barracks Project.



Figure A-1. Modular unit arrives at Fort Stewart, GA.



Figure A-2. "Matched" modular units.



Figure A-3. Modular units being prepared to be joined together.



Figure A-4. Joined modular units awaiting exterior work.



Figure A-5. Aerial view of modular units.



Figure A-6. Typical kitchen in modular units.



Figure A-7. Typical bedroom in modular unit.

Disposal Problem

After the permanent facilities are constructed and the temporary facilities are no longer required, the modular, relocatable buildings can present a disposal problem. Table A-1 shows the square footage of modular buildings expected to need disposition in the next few years. Once a building is vacated, typical disposition is to demolish it and haul the debris to a landfill. The potential waste stream from the modular buildings Army-wide is roughly 123,000 tons of debris, not counting foundation, paving, or utilities.

Disposal of modular buildings incurs costs to both the installation and the environment, such as decrease of available landfill capacity, energy and cost of the disposal, and loss of resources/materials and embodied energy of materials. Reuse of these buildings, whole or in part, is feasible and presents an opportunity to the Army, and the Department of Defense (DOD) as a whole, to maximize use of resources and reduce cost.

Table A-1. Army's total modular square footage by state and by year that authority expires.

State	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
AK									403,875		403,875
AR									24,000		24,000
AZ				34,272	1,440						35,712
CA				213,093							213,093
CO								13,440	10,080		23,520
GA				21,000	33,516	4,676	723,900		254,330		1,037,422
HI									68,800		68,800
IN	2,000										2,000
KS								521,680			521,680
KY								15,171	338,655		353,826
LA					229,200						229,200
MO							303,624				303,624
NC			7,960	14,025		0	19,345	13,440	772,972		827,742
NJ					81,000						81,000
NY							6,048	479,277			485,325
PA						1,024					1,024
TX					93,856		95,328	620,626	1,186,106	1,229,979	3,225,895
UT						2,184					2,184
VA			0	8,288	7,000				118,048		133,336
WA						11,088			560,999		572,087
WI						6,825					6,825
Multiple								189,000			189,000
Total	2,000	0	7,960	290,678	446,012	25,797	1,148,245	1,852,634	3,737,865	1,229,979	8,741,170

Source: Smith, Eddy. 2006. Relocatable Building Assessment Report, 1 November 2006 (unpublished ERDC-CERL contract report).

Most relocatable buildings have a useful life of 20-25 years. If purchased for a temporary purpose, however, a modular, relocatable building must be procured and disposed of within 6 years. Thus, these buildings also represent a potential resource that can be reused by other military and private sector customers. The need to maximize the reuse of these buildings once the primary function has been satisfied is a logical step in the Army's commitment to sustainability. The reuse and/or reselling of these buildings or building components to other users will effectively help support the triple bottom line of mission, community, and environment.

Disposal Methods

The IMCOM Commander has the authority to allow continued occupancy of the temporary complexes or have them relocated elsewhere on post. Otherwise, the installation must remove the buildings. Ideally, the IMCOM can cross-level the buildings; that is, identify another installation where temporary facilities are required. An installation's first preference should be to notify IMCOM of the numbers and types of buildings

that will be vacated and offer them for reuse at another Army installation.

If IMCOM cannot cross-level the buildings, there are two options: relocate the buildings off the installation or demolish them. Given the number of buildings at a given installation, it is unlikely that any one strategy will result in all buildings being removed. It is most likely that several methods will be applied. Some demolition will most likely be required after all alternatives have been exercised.

Several factors will contribute to determining the most feasible method or methods of disposal. These include:

- whether the buildings were purchased and placed as equipment (typically personal property)
- whether the buildings were constructed under MILCON appropriations (typically real property)
- types and quantity of buildings to be removed
- potential uses by homeless agencies through the McKinney Homeless Assistance Act
- local/regional markets and potential demand for the buildings
- local/regional used building material, salvage, resale, and recycling markets and demand for materials
- building construction details and condition after use.

At minimum, the installation must divert 50 percent of the non-hazardous building materials from landfill disposal, per the ACSIM Policy Memorandum of 6 February 2006 (revised 11 July 2006) and accompanying enclosure of 13 February 2006 (revised 5 July 2006).

Removing Buildings from the Installation

The waste reduction hierarchy places reuse as the preferred method for waste diversion. As the modular buildings were intended to be relocated, this should be the first option considered.

Personal Property

If the temporary buildings are classified as personal property, standard personal property disposal practices apply per Army Regulation (AR) 735-5, "Policies and Procedures for Property Accountability." Such disposal practices would typically be the case if the buildings were procured and installed under O&M or SRM funding. No further discussion of such standard practice is

given in this document. Considerations specific to modular buildings follow.

The building must be deemed excess. Excess personal property is any personal property that is no longer required by the holding agency for the discharge of its responsibilities. If the installation still has a need for the building, but the term or the original intent for the building will change, then a new request for approval needs to be submitted in accordance with guidance for relocatable buildings per Memorandum, ACSIM, 19 February 2008, Interim Policy Change on Relocatable Buildings for Paragraphs 6-3 through 6-17 in AR 420-1, Army Facilities Management.

If the installation commander does designate the building as excess and no longer needed on the installation, then the item (building) needs to be reported to the local Defense Reutilization and Marketing Service (DRMS) office. As part of the reporting process, the installation will need to classify the building based on its condition. Upon receipt, the Defense Reutilization and Marketing Office (DRMO) will also inspect the building and will finalize the condition code. The codes help facilitate the screening process for potential end users of the excess item.

Once the item has been coded, the local DRMS office reports the item to DRMO headquarters in Battle Creek, MI. DRMO Battle Creek then does a DOD-wide screening for other organizations that can use the property. If no organizations within the DOD can use the excess property, then the item is reported to the General Service Administration (GSA) to screen for use by other (non-DOD) Federal agencies first. Then state and local agencies will be screened for applicability for the item to be donated. If DRMO cannot find any buyers, they will dispose of the buildings as scrap for recycling.

As the authorizing agency, the Army always has the option to transfer the property within its organization (i.e., from one installation to another) prior to reporting it to a DRMS office as being excess. Once the installation designates the property as excess and reports it to DRMO, however, it is considered excess Army property. Under the current policy for personal property, the Army cannot sell the item to a private company or organization without the item first being offered to other Federal, state, and local organizations. Transfers between Federal agencies are normally made without charge for the

property itself; care, handling, and transportation are paid by the receiving agency.

In the case of Army relocatable buildings, however, it should be noted that the installation is responsible for transporting the item to the appropriate DRMO location. Therefore, a transfer from the DRMS to another DOD organization would result in the receiving organization being responsible for transportation of the item from the DRMO location to their location. For large items such as relocatable buildings, it is possible that DRMS would allow the installation to "Receipt-in-Place," which means that the building would not have to be physically turned into a DRMS office.

The potential for installations to not have to transport the buildings to DRMS has potentially both positive and negative impacts on the installation. On one hand, the installation would not have to pay to transport the buildings; however, Receipt-in-Place means that the buildings would have to remain on the installation using space that might be needed for other uses.

If DRMS does not identify an end user for the excess property from within DOD, then DRMO reports the item to GSA for additional screening of potential end users. GSA uses an electronic system, GSAXcess[®], for recording, tracking, and controlling the inventory of Federal excess, surplus, and exchange/sale property. If excess personal property is not desired by other Federal agencies, it is declared "surplus." It is then offered to state agencies for donation. If surplus personal property is determined not to be needed through the donation process, the surplus property is made available to the public for sale through GSA Auctions[®] for electronic bidding or through Surplus Sales of Personal Property for non-electronic bidding.

Figure A-8 displays the location of all DRMO locations in CONUS. Physically moving the buildings to a DRMO office would require that the installation procure services to detach the utilities, detach the modules from each other, place the modules on trailers (or reinstall the running gear), and transport them. This, of course, represents an expense to the installation. Furthermore, not all DRMO locations will be able to accommodate what could be several hundred thousand square feet of relocatable buildings. However, once the modules are off the installation, they are DRMO's responsibility and of no further concern to the installation.

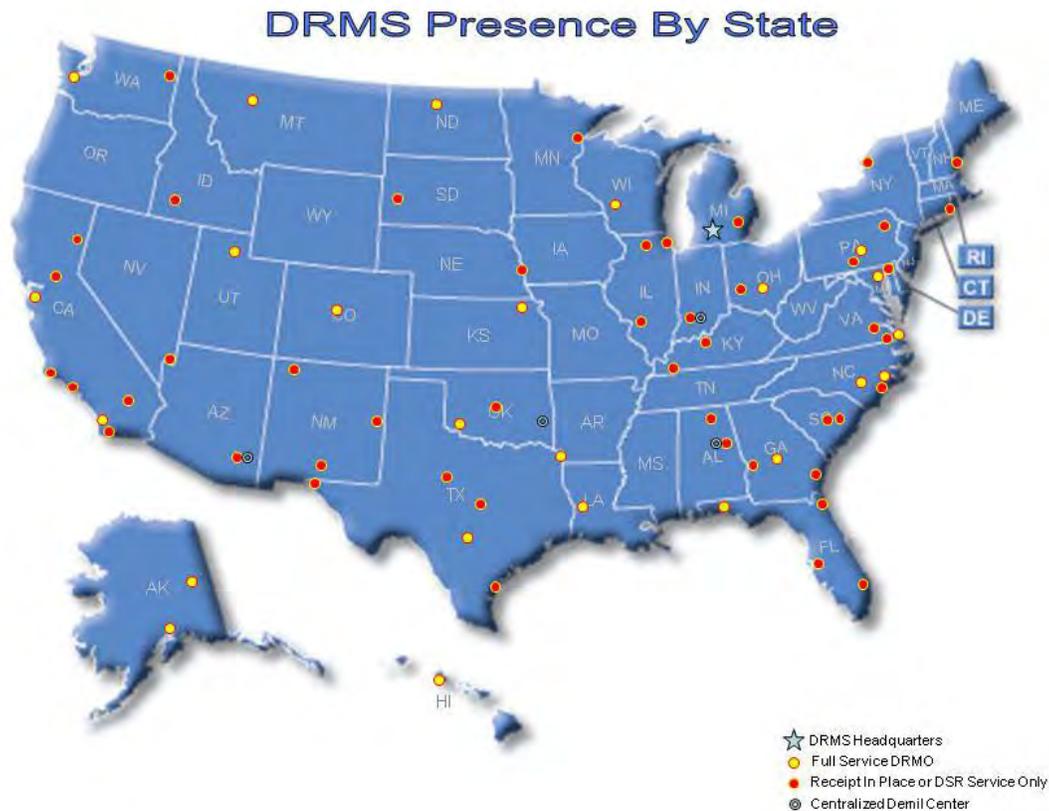


Figure A-8. CONUS DRMO locations. (Map and searchable link by state is available at <http://www.drms.dla.mil/drmo/drmo-locations.shtml>.)

If the installation elects to turn the buildings over to DRMO on a "Receipt-in-Place" status, DRMS offers the buildings in "as-is" conditions, and future buyers will be responsible for detaching and transporting the buildings to their new location. While this reduces cost to the installation, it also may limit the market for the buildings. Furthermore, the installation must police the buildings to prevent vandalism and to ensure that condition and value are not diminished while the buildings are sitting vacant. If buildings are purchased module-by-module, the installation must protect the exposed interiors once some of the modules are removed.

If DRMS does not find buyers for the modules, they will sell the buildings for scrap. The buyers will dismantle the buildings, retrieve the recyclable materials, and dispose of the debris.

The installation must ensure the salvage and recycling achieves the ACSIM-required 50 percent debris diversion criterion.

Note that DRMS retains the right of refusal. If DRMS elects not to take the buildings, the installation will have to dispose of them on their own. However, selling the buildings through the installation's Recycling Center or their Qualified Recycling Program (QRP) can generate revenue for the installation. These procedures are the same as described below.

Real Property

If the temporary buildings are classified as real property, only the U.S. Army Corps of Engineers (USACE) can dispose of them. AR 405-90, "Disposal of Real Estate," describes these procedures. As with personal property, this PWTB contains no further discussion of standard practice related to real property. Considerations specific to modular buildings are as follows.

McKinney Act screening. Similar to any building removal (demolition) requirement, buildings to be removed must be screened through the McKinney Homeless Assistance Act process. This ordinarily does not result in buildings being transferred to housing authorities or organizations, as occupying the buildings on-post is impossible, and moving them off-post is not an easy task. Furthermore, the McKinney Act screening process is extremely cumbersome and difficult to follow for most small homeless advocacy organizations or providers such as Habitat for Humanity affiliates. However, as the temporary buildings were designed to be relocatable, relocation for the intended purpose should be feasible.

The installation and the supporting USACE district should perform outreach to local, regional, and state housing authorities and providers well in advance of the interim requirement being completed. The installation and district should also collaborate with the HQUSACE Installation Support Division, which is the USACE clearinghouse for matters pertaining to the McKinney Act process. Typically, installations want to obtain clearance as soon as possible so that demolition can proceed. With the modular buildings, however, there is a real potential to fulfill the McKinney Act's intent of providing facilities to the homeless. The McKinney Act screening should be used as an opportunity to find an outlet for these buildings and not simply a pro-forma exercise required for demolition. It would be in the installation's best interest for the buildings to be moved by others. HQUSACE should request the U.S. Department of Health and Human Services (HHS) to advertise in

the Federal Register beyond the mandatory 60-day clearance cycle until a recipient can be found. HQUSACE should also encourage HHS to advertise and broadcast the availability of the modular, relocatable buildings through additional media and networks and to encourage applications by homeless providers.

Building sale. As the preferred method of disposal is reuse, the installation's supporting USACE district can sell the real property. The modular, relocatable buildings can be offered to the public for sale. This is typically accomplished by advertisement and sealed bidding, although conducting a live auction is also allowed. Alternatively, the USACE district Commander may delegate sales authority to the installation.

Selling several hundred building modules will be a greater challenge than selling a modest number of single-wide or double-wide mobile or modular buildings. It will be in the installation's best interest for the installation and district to publicize the sale of the buildings and attract as broad an interest as possible. Developing a list of potential bidders well in advance of the buildings' interim requirement being concluded is encouraged. These may include:

- general public
- local, regional, and state housing authorities
- homeless support and advocacy organizations
- school districts and other institutional owners requiring temporary or expansion space
- residential developers
- local, regional, and state homebuilders associations
- local, regional, and state construction contractor associations

Relocatable building manufacturers generally do not offer buy-back programs for products they sell outright. However, there is currently a demand within the industry for construction camp building fabrication. These facilities are similar to the Army's temporary complexes. The installation and/or district should contact the building manufacturer and assess whether there is interest in buying back modules. Manufacturers would have to compete with others in the bidding or auction process.

It may be to the installation's advantage to cannibalize some buildings and use materials and components to upgrade other buildings and improve their appearance, condition, and marketability. Typically, useable components should be taken from the most damaged or least attractive buildings and donated to upgrade, repair, or restore the more attractive buildings.

Furthermore, components found in the temporary buildings may be useful for remodeling or upgrading existing buildings. Rather than sell or demolish buildings with useable materials, the installation can selectively salvage components (a practice also known as "cherry picking" and "soft stripping"). Examples of items useful for repair and replacement are: doors, windows, and hardware; mechanical and plumbing equipment and fixtures; and lighting, power, electrical distribution equipment. Such salvage, however, should be confined to selected buildings and still preserve the value and attractiveness of the total building inventory.

DRMS cannot sell real property. However, the installation and USACE districts can solicit DRMS' assistance in surveying their customers for temporary or relocatable building requirements and identifying potential bidders for the buildings.

The building sale process consists of the following general steps.

- DOD Form 337 (DD337) is completed to indicate the approved disposal method is building sale. The building is vacated.
- The government removes all building components and contents that can be reclaimed for reuse in an economical manner. The buildings are screened and cleared for disposal through the McKinney Act prior to the sale.
- As these are relatively new buildings, lead and asbestos abatement will not be necessary. However, a survey should be conducted for any other hazardous materials; these should/must be abated.
- Develop a scope of work, contract provisions, and bid schedule for the buildings' sale and removal.
- The USACE district (or Directorate of Public Works/ Public Works Business Center [DPW/PWBC], if so delegated), advertises the buildings for sale. A 30- to 60-day advertisement is recommended. A follow-up advertisement midway through the advertising period is also recommended.
- Schedule a site walk for bidders, within the advertisement period.
- Receive bids at the designated location (either district office or the installation's DPW/PWBC).
- Identify successful bidders.
- Successful bidders sign a contract and make payment to the Treasurer of the United States.
- Purchasers (successful bidders) submit safety plans, deposits, and other required submittals as required by the contract.

- Contractors disconnect the modules and remove them, dispose of scrap, and perform other duties within the time limits described in the contract.
- Once each contractor's obligations are met, the district closes out the contract.
- The installation's DPW or PWBC complete removal of foundation and utilities, site grading, and other tasks not included within the contractor's scope of work.
- Remove the buildings from the real property inventory.

The contract between the USACE district and the parties removing the building should include the following:

- scope of work: tasks required of the contractor and tasks that will be performed by the installation
- bidding procedures and basis of contract award
- bid schedule
- security
- insurance requirements
- availability of drawings, installation manuals, and other documentation about the buildings
- work area and boundary definition
- access to the site: security, daily access, equipment access
- removal of the modules: routes and time-of-day provisions (Because the modules are designed to travel over-the-road, hauling them out the installation's construction contractors' gate should be permissible in most cases.)
- safety management requirements
- environmental protection
- protection of streets, grounds, utilities, and other infrastructure

It also will be in the installation's best interest to make it as easy as possible for potential buyers to remove the buildings. Some tasks may be accomplished by DPW personnel and therefore be omitted from the purchasers' scope of work. These tasks include terminating utilities (especially electrical) and removing foundation piers and slabs. The DPW/PWBC could also provide temporary electrical power, toilet facilities and potable water stations, or waste receptacles and disposal service. As the modules are one-story, vertical clearance during transport should not generally be problematic. However, if any overhead utilities will require termination or moving, this is best accomplished through the DPW/PWBC.

It is unlikely any one party will bid for the entire complex. Rather, the installation should divide the complex and modules into lots so that bidders may identify the types and numbers of modules on which they are bidding.

The installation must protect itself in the event that a purchaser does not complete their work, or that they are in chronic nonconformance with safety or other provisions and are dismissed from the installation. On the other hand, requiring a conventional performance bond for the value of the project may discourage participation in the building sale. Previous building sale experience indicates requiring a deposit or imposing a penalty equal to the amount the installation would pay a contractor to complete the scope of work is too much and discourages participation. The installation will have to determine a meaningful deposit or penalty amount based the markets and nature of prospective bidders.

Under no circumstances should safety be compromised. First, any vacant modular relocatable buildings must be protected or guarded to prevent unauthorized occupancy, which may lead to vandalism and personal injury. Then, application of safety standards (either Occupational Safety and Health Administration [OSHA] Construction Safety Standards or Engineer Manual 385-1-1) should be applied. Development of a safety management plan, training, inspections, emergency response, and documentation must all be maintained.

Prospective bidders should also be notified that they are subject to state vehicle, licensing, and over-the-road hauling regulations and laws.

Not all buildings for sale are the same, but procedures are similar. For instance, World War II era buildings are typically disassembled on site for the lumber and other useful materials, although some have been removed intact. While the modular, relocatable buildings are different products, the sales procedure should generally be the same. Fort McCoy, WI, Fort Knox, KY, and Fort Campbell, KY, sell World War II (WWII)-era buildings. PWTB 420-49-30 describes the Fort McCoy process and provides contract examples. PWTB 200-1-23 provides sample contract documents from Forts McCoy, Knox, and Campbell building sales.

Demolition/Deconstruction

If the installation elects not to sell any buildings – or for buildings that have not sold – the next preferable alternative

to landfill disposal is reuse and recycling of materials. The ACSIM-mandated 50 percent minimum debris diversion criterion applies.

When completing the DD337, which declares the buildings are of no further use to the government, the term "demolition" is commonly used as the intended means of real property disposal. Some interpret this word literally to mean mechanical wrecking, with no consideration for any alternative means of removing the building. In fact, "deconstruction" or "salvage" are practices within the broader term "demolition" and need not be precluded simply because the DD337 uses the term "demolition." To avoid confusion or conflict when preparing to remove the temporary facilities, DPW personnel completing the DD337 (typically Master Planning Division) should indicate that disposal may be accomplished by deconstruction, salvage, recycling, and/or demolition. In this way, a semantic nuance does not preclude useable components and materials from being diverted from landfill disposal nor jeopardize observance of the ACSIM guidance.

When requiring deconstruction, salvage, or recycling, the installation must verify that the contents of the buildings will have some value to the deconstruction/demolition contractor, and the contractor must be comfortable that a sufficient value can be extracted from the buildings to make deconstruction or salvage worthwhile. Otherwise, all the risk of recovering costs by virtue of the salvage and recycling potential is borne by the contractor, which will result in higher contingency factors being built into their bids. Appendix B provides data on materials that can be salvaged for reuse, recycled, or landfilled as debris from four modular, relocatable facility types.

The installation or USACE district can take two basic approaches when contracting for services to demolish/deconstruct the modular buildings: solicit competitive bids for demolition/deconstruction services, or solicit best value proposals for building removal.

Competitive Bidding

The installation or Corps District should initiate a demolition /deconstruction contract according to their standard practice. Issues specific to the removal of the modular, relocatable buildings would include the following points.

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- A minimum of 50 percent of the building's nonhazardous materials, by weight, must be: salvaged for reuse, recycled, or otherwise diverted from landfill disposal.
- The Army installation and USACE district should perform outreach to ensure that firms engaging in deconstruction, salvage, and recycling are informed of the project and can make the appropriate associations to achieve the required diversion. Appendix D provides resources to identify these types of services.
- A C&D Waste Management Plan should be required in the contract. It is at least as valuable to achieving the required diversion as a specification criterion. Appendix C provides further guidance for developing C&D Waste Management Plans.
- Title for all materials should be given to the contractor. Otherwise, there is no incentive for the contractor to invest in salvage or recycling.
- The contractor should be allowed to accrue proceeds from recycled and salvaged materials and to benefit from cost avoidance through reduced landfill tipping fees.
- Bidders will develop their bids considering the salvage or recycling value of the contents as the buildings stand during their pre-bid site visit. The installation must police the buildings once they are vacated to guard against damage and theft.
- Disposal of salvaged, recycled, and debris materials must be monitored as the project proceeds.

PWTB 200-1-23 provides further information on including diversion criteria in a demolition contract, and specifying deconstruction as the means of building removal. Example contract documents are also provided in that PWTB.

One variation on competitive bidding that USACE has recently been practicing is providing multiple bid line items for successively higher actual diversion above and beyond the 50 percent minimum. Each line item represents another increment of diversion (i.e., 51-65 percent, 66-80 percent, etc.). The government assigns a dollar amount for each diversion range as an encouragement and compensation for greater diversion. This method will be especially useful when the installation operates a C&D landfill and reducing the debris stream (and preserving capacity) has an economic benefit to the installation.

Best Value Source Selection

It can be advantageous for the installation to issue a Request for Proposal (RFP) to the construction industry at large. The

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RFP solicits proposals for removing the buildings, as opposed to requiring demolition, deconstruction, or salvage of some minimum quantity of materials. Any strategy or method would be acceptable, within the parameters defined in the RFP. The installation would evaluate proposals and enter into an agreement with the proposer offering the best value for performing the work in terms of price and technical merit. The installation must establish priorities and preferences, and must define them in the RFP as evaluation criteria. These criteria may include:

- building removal methods and techniques to maximize material recovery and minimize debris
- waste management plan
- proposer qualifications
- project management plan
- project schedule
- price – considering the initial contract cost and other life-cycle cost benefits to the installation

In this way, the prevailing economies and resources would allow the most favorable strategy to emerge, similar to a "design-build" project. In this case, the "design" consists of the building removal method, and the "build" consists of the buildings' removal. PWTB 200-1-23 provides additional guidance and an example RFP.

APPENDIX B

**MODULAR, RELOCATABLE SALVAGE, RECYCLING, AND WASTE
CHARACTERIZATION**

Contents

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Introduction

This appendix gives some examples of how an installation can recover, recycle, and reuse the facilities and their components.

Typical Facilities

Creighton Brower from COMARK Building Systems, Inc. provided the following facility types to assist CERL in document preparation: (a) battalion headquarters building/company administration building, (b) company/battalion storage facility that is similar to a warehouse, (c) battalion and warehouse combination facility, and (d) barracks. Personnel at CERL then back-calculated a possible component amount for each facility, based on information provided by COMARK. Each category shows a typical layout and the typical types of components, with their respective quantities. These tables, which were the basis of the material in this appendix, do not take into account which materials can be recovered, recycled, or reused. This PWTB discusses the recovery, recycling, and reuse of the components in other sections.

Company/Battalion Administration Facilities

Figure B-1 shows what a typical company/battalion administration facility could look like on an installation. This facility has approximately 2157 sq ft of area. Table B-1 shows typical materials that one might encounter for an average sized facility based on the Figure B-1 layout.

B-3

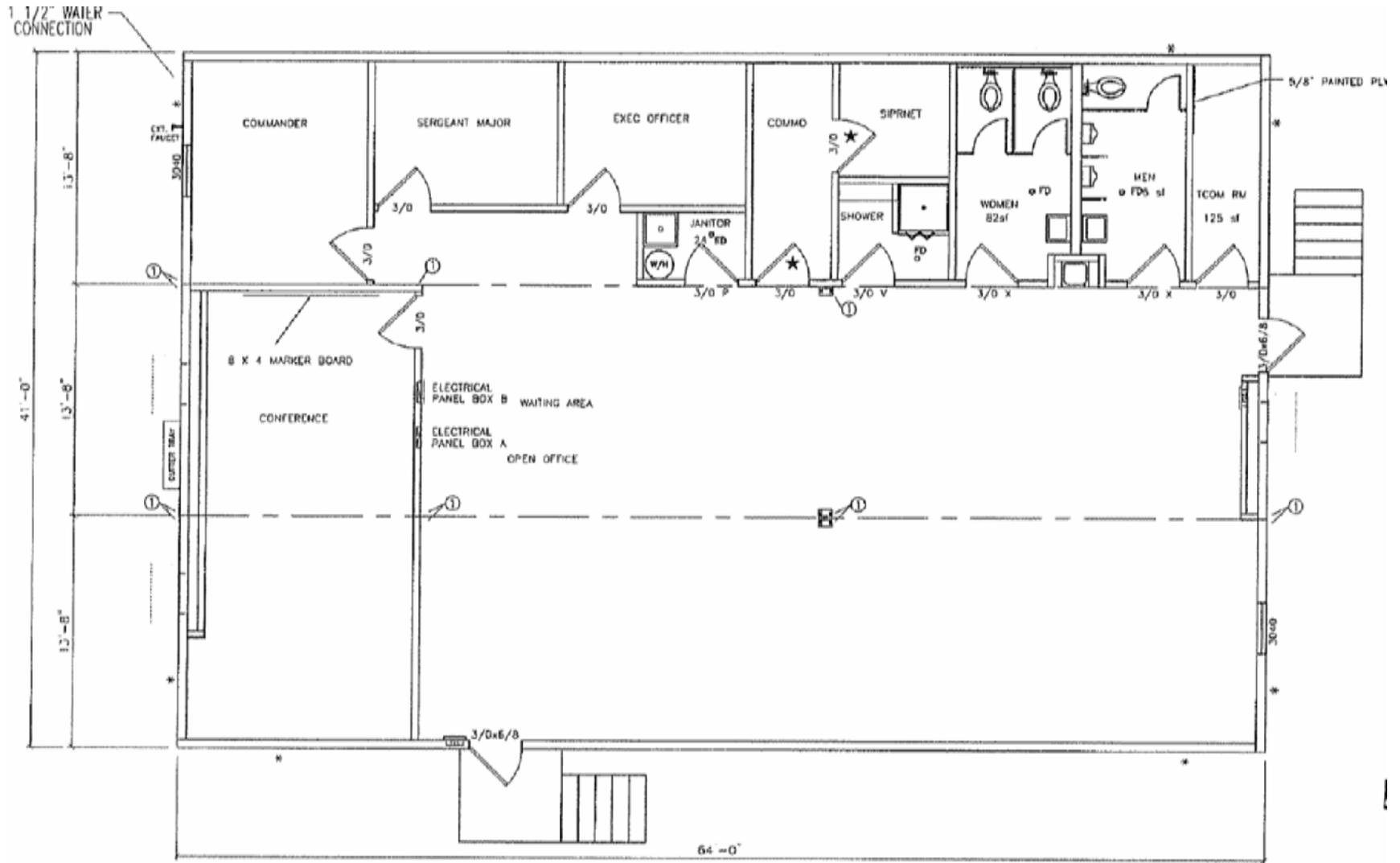


Figure B-1. Example of a company/battalion administration facility.

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Table B-1. Typical materials for an average sized administration facility of 2157 sq ft.

Item	Quantity	Unit of Measure*
1X1 ft Returns	1	ea
2X2 ft Returns	2	ea
8-in. Flex duct	69.82	lf
Batt Insulation	7476.75	sf
Beam Metal Floor Beam/Girder 12-in. metal	416	lf
Drinking Fountain Metal	1	ea
Ductwork Insulated (Aluminum)	1551	lf
Electrical Conductors	2128	lf
Electrical Conduit	709.25	lf
Electrical Panels 200-400 Amp	2	ea
Exit Lights	2	ea
Exterior Door Metal Personnel	2	ea
Exterior Stair/step Concrete	41	ea
Exterior Wall Finish/Covering Clapboard-Smart Panel Siding	2336.25	sf
Exterior Window Metal Double Hung	2	ea
Fire Alarms/Emergency Lights	2	ea
Fire/Smoke Alarm Smoke Detectors	8	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	1998	sf
Fluorescent Interior Lights	18	ea
Heating Unit/Plant Furnace Electric <10.2 MBH	3	ea
Incandescent Exterior Lights	3	ea
Interior Ceiling Acoustical	1796	sf
Interior Door Wood Personnel	7	ea
Interior Floor Finish/Covering Linoleum	17.75	sf
Interior Floor Finish/Covering Vinyl Tile	1980	sf
Interior Wall Finish/Covering Drywall 5/8-in. Prefinished Sheetrock	3310.75	sf
Interior Wall Finish/Covering Drywall 5/8-in. Sheetrock	749.25	sf
Interior Wall Finish/Covering Fiberglass Reinforced Plastic	749.25	sf
Lavatory Sink Ceramic	3	ea
Light Switches	8	ea
Nails	2727.25	ea
Partition/Screen Metal Toilet Unit	2.5	ea
Pier Metal	49	ea
PVC< 2-in. Pipe	187	lf
Receptacles	36	ea
Roof Deck Metal	2158.75	sf
Roof Drainage Metal Downspout	48.75	lf
Roof Drainage Metal Gutter	67.5	lf
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	2158.75	sf

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Item	Quantity	Unit of Measure*
Roof Surface Single-Ply w/no-surface FR-50 Slipsheet	2158.75	sf
Roof Truss Wood – Plywood	2636.75	sf
Service Sink Floor-Ceramic	1	ea
Shower Ceramic	1	ea
Supply Air Diffusers	13	ea
Toilet Ceramic	3	ea
Urinal Ceramic	2	ea
Ventilation/Exhaust Equipment General Bathroom	2.5	ea
Waste Piping Vinyl/Plastic	313.5	lf
Water Heater Commercial	1	ea
Wood 2X10-in.	104.5	bf
Wood 2X4-in.	127.75	bf
Wood 2X6-in.	203.75	bf
Wood 2X8-in.	175.9	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet		

Company/Battalion Storage Facilities or Warehouses

Figure B-2 shows what a typical company storage facility or a warehouse could look like on an installation. This facility will be approximately 1749 sq ft. Table B-2 lists typical materials that one might encounter based on the Figure B-2 layout.

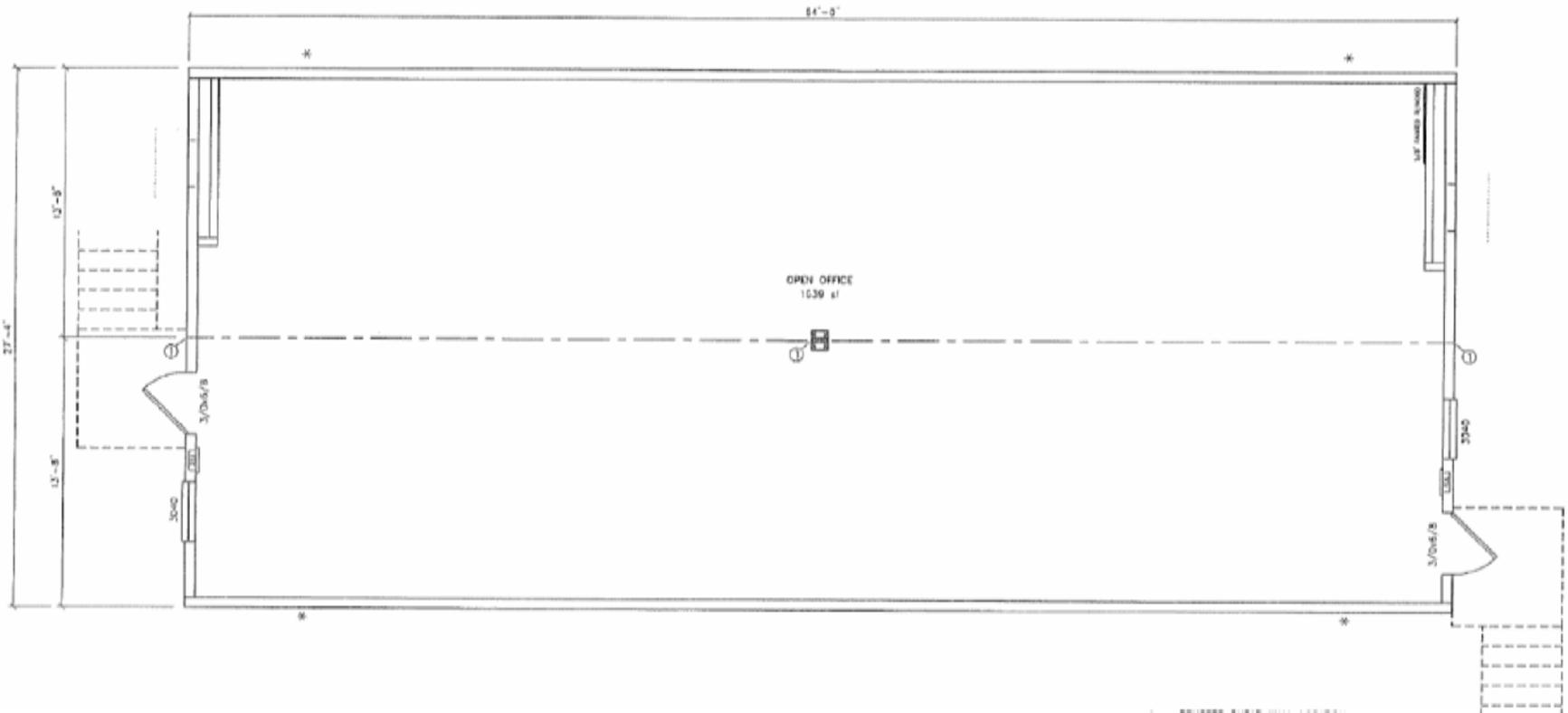


Figure B-2. Example of a typical company storage facility or warehouse.

Table B-2. Typical materials for an averaged sized storage facility of 1749 sq ft.

Item	Quantity	Unit of Measure*
8-in. Flex Duct	49.755	lf
Batt Insulation	5070	sf
Beam Metal Floor Beam/Girder 12-in. metal	320	lf
Ductwork Insulated (Aluminum)	1470.5	lf
Electrical Conductors	1654.5	lf
Electrical Conduit	551.5	lf
Electrical Panels 200-400 Amp	1.5	ea
Exit Lights	2.5	ea
Exterior Door Metal Personnel	2.5	ea
Exterior Stair/Step Concrete	41	cf
Exterior wall Finish/Covering Clapboard-Smart Panel Siding	2110.5	sf
Exterior Window Metal Double Hung	1.5	ea
Fire Alarms/Emergency Lights	1	ea
Fire/Smoke Alarm Smoke Detectors	3	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	1627	sf
Fluorescent Interior Lights	15	ea
Heating Unit/Plant Furnace Electric <10.2 MBH	2	ea
Incandescent Exterior Lights	2.5	ea
Interior Ceiling Acoustical	1473	sf
Interior Door Wood Personnel	2	ea
Interior Floor Finish/Covering Vinyl Tile	1627	sf
Interior Wall Finish/Covering Drywall 5/8-in. Prefinished Sheetrock	2561	sf
Light Switches	3	ea
Nails	2156	ea
Pier Metal	52.5	ea
Receptacles	27.5	ea
Roof Deck Metal	1750.5	sf
Roof Drainage Metal Downspout	47.5	lf
Roof Drainage Metal Gutter	55	lf
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	1750.5	sf
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	1750.5	sf
Roof Truss Wood - Plywood	1857	sf
Supply air diffusers	8.5	ea
Wood 2x10 in.	95	bf
Wood 2x4 in.	55.5	bf
Wood 2x6 in.	207	bf
Wood 2x8 in.	143.36	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet		

Full Complement Company/Battalion Facilities

Figure B-3 shows what a typical full complement company facility could look like on an installation. This facility will be approximately 5365 sq ft. Table B-3 lists typical materials that one might encounter based on the Figure B-3 layout.

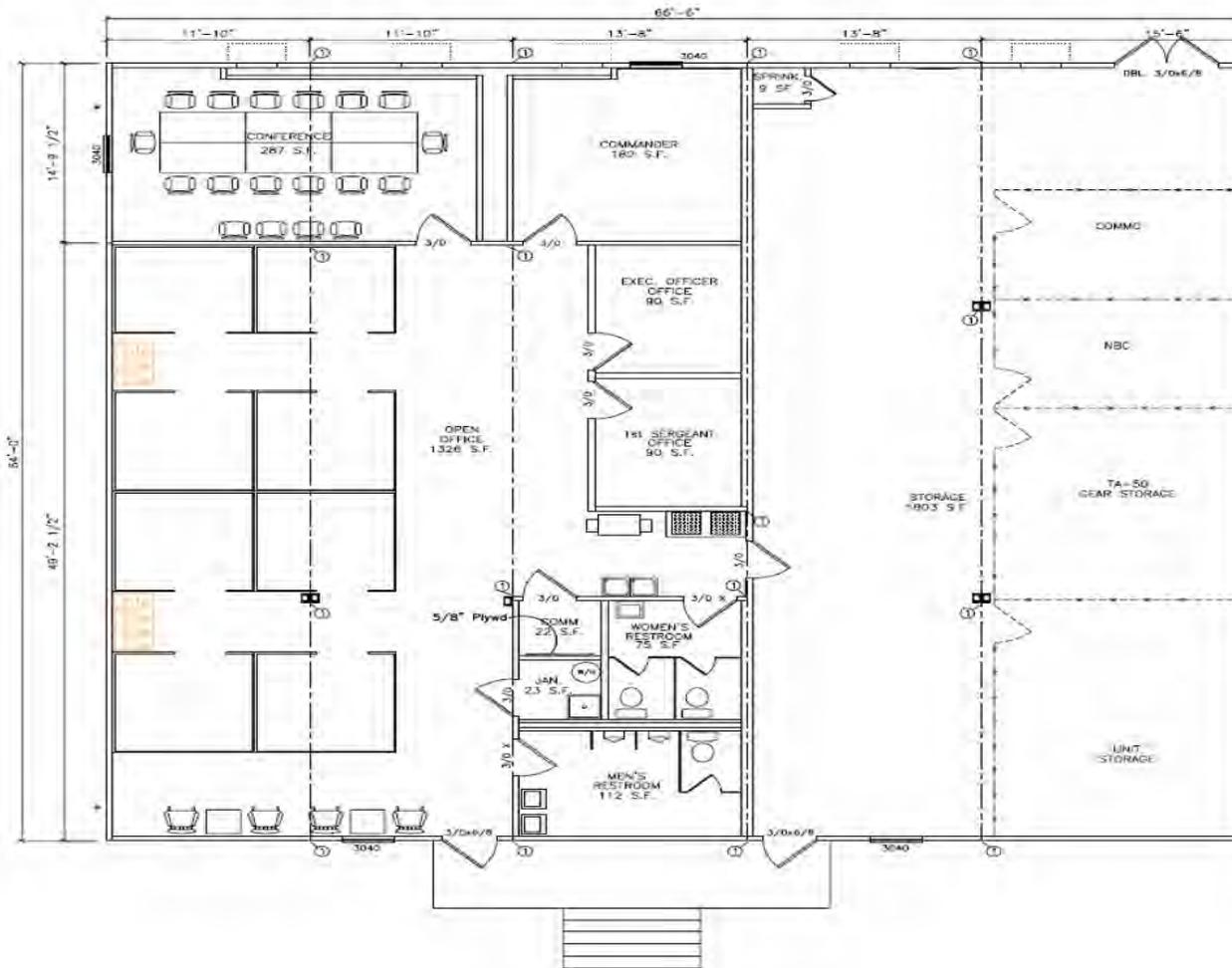


Figure B-3. Example of a typical full-complement company facility.

Table B-3. Typical materials for an average sized company facility of approximately 5365 sq ft.

Item	Quantity	Unit of Measure*
2X2 ft Returns	6	ea
8-in. Flex Duct	136.075	lf
Batt Insulation	16663.5	sf
Beam Metal Floor Beam/Girder 12-in. Metal	896	lf
Drinking Fountain Metal	1	ea
Ductwork Insulated (Aluminum)	3775	lf
Electrical Conductors	2121.5	lf
Electrical Conduit	707	lf
Electrical Panels 200-400 Amp	2	ea
Exit Lights	4	ea
Exterior Door Metal Personnel	4	ea
Exterior Stair/Step Concrete	41	cf
Exterior wall Finish/Covering Clapboard-Smart Panel Siding	3327.5	sf
Exterior Window Metal Double Hung	4	ea
Fire Alarms/Emergency Lights	2	ea
Fire/Smoke Alarm Smoke Detectors	13.5	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	5123.5	sf
Fluorescent Interior Lights	33	ea
Heating Unit/Plant Furnace Electric <10.2 MBH	5	ea
Incandescent Exterior Lights	4	ea
Interior Ceiling Acoustical	4751.5	sf
Interior Door Wood Personnel	12	ea
Interior Floor Finish/Covering Linoleum	398.5	sf
Interior Floor Finish/Covering Vinyl Tile	4725.5	sf
Interior Wall Finish/Covering Drywall 5/8-in. Prefinished Sheetrock	8090.5	sf
Interior Wall Finish/Covering Drywall 5/8-in. Sheetrock	1362	sf
Interior Wall Finish/Covering Fiberglass Reinforced Plastic	1362	sf
Lavatory Sink Ceramic	3	ea
Light Switches	16	ea
Nails	5619.5	ea
Partition/Screen Metal Privacy	2	ea
Partition/Screen Metal Toilet Unit	3	ea
Pier Metal	90	ea
Piping (Fire Suppression) Black/Galvanized <1-in.	365.33	lf
Piping (Fire Suppression) Black/Galvanized <4-in.	12	lf
Piping (Fire Suppression) Black/Galvanized Backflow Preventer	1	ea
Piping (Fire Suppression) Black/Galvanized Sprinkler Heads	54	ea
PVC< 2-in. Pipe	304.5	lf

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Item	Quantity	Unit of Measure*
Receptacles	35.5	ea
Roof Deck Metal	5370	sf
Roof Drainage Metal Downspout	47	lf
Roof Drainage Metal Gutter	167.5	lf
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	5370	sf
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	5370	sf
Roof Truss Wood - Plywood	4784	sf
Service Sink Floor-Ceramic	1	ea
Shower Ceramic	1	ea
Supply Air Diffusers	21	ea
Toilet Ceramic	3	ea
Urinal Ceramic	2	ea
Ventilation/Exhaust Equipment Exhaust General Bathroom	4	ea
Waste Piping Vinyl/Plastic	419.5	lf
Water Heater Commercial	1	ea
Wood 2x10-in.	272.3333	bf
Wood 2x4-in.	353.5	bf
Wood 2x6-in.	163	bf
Wood 2x8-in.	431.56	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet		

Barracks

Figure B-4 shows what a typical barracks facility could look like on an installation. These facilities will be approximately 1530 sq ft. Table B-4 lists typical materials that one might encounter based on the Figure B-4 layout.

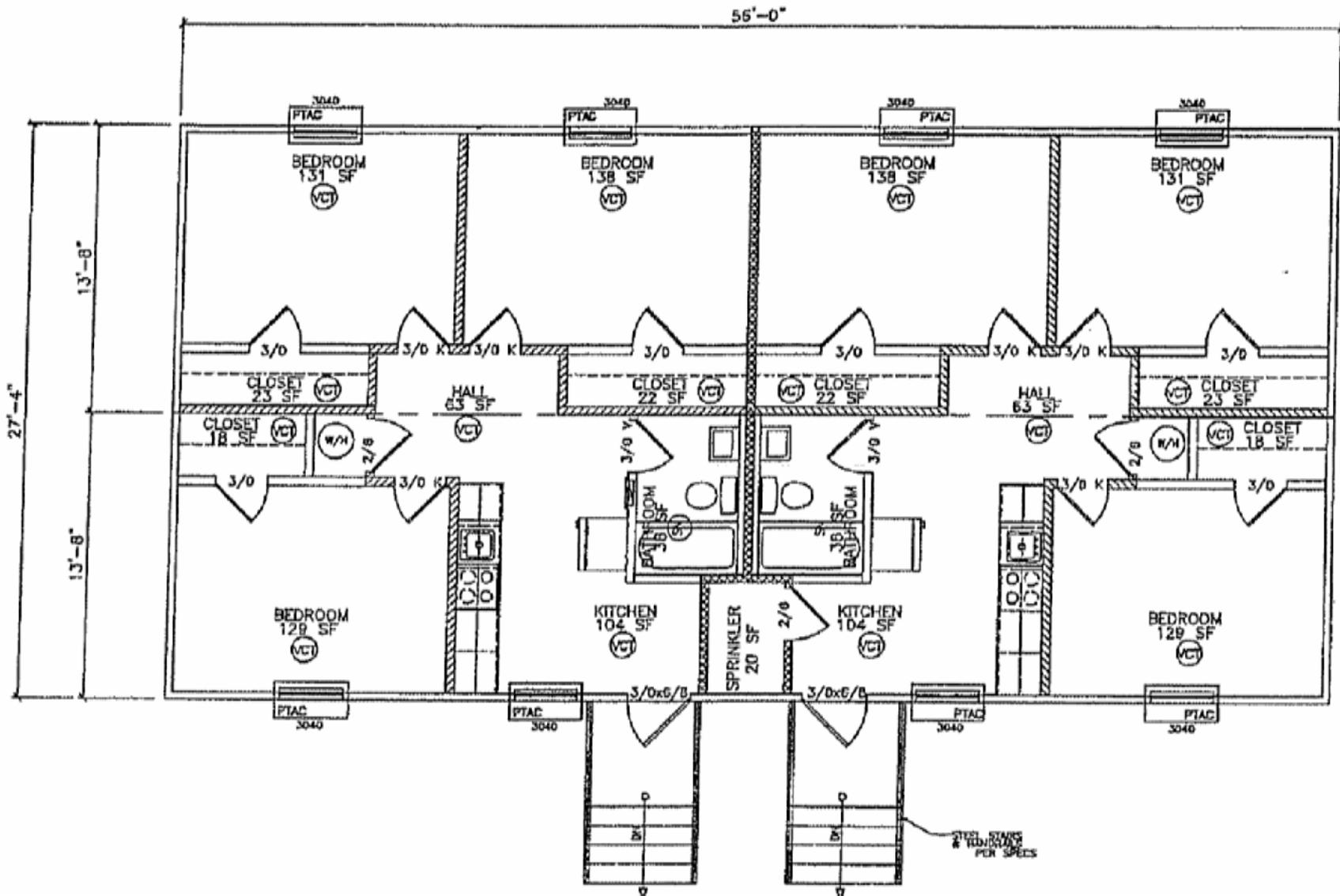


Figure B-4. Example of a typical barracks layout.

Table B-4. Typical materials for an average sized barracks of
 1530 sq ft.

Item	Quantity	Unit of Measure*
2X2 ft Returns	6	ea
8-in. Flex Duct	66	lf
Batt Insulation	7912	sf
Beam Metal Floor Beam/Girder 12-in. metal	280	lf
Cabinet Wood Base	10	ea
Cabinet Wood Wall	10	ea
Countertop Laminated Plastic	9.75	sf
Ductwork Insulated (Aluminum)	1469	lf
Electrical Conductors	2508	lf
Electrical Conduit	836	lf
Electrical Panels 200-400 Amp	2	ea
Exit Lights	2	ea
Exterior Door Metal Personnel	2	ea
Exterior Stair/Step Concrete	41	cf
Exterior Wall Finish/Covering Clapboard-Smart Panel Siding	2160	sf
Fire Alarms/Emergency Lights	3	ea
Fire Suppression Sprinkler (Light Hazard)	0	lf
Fire/Smoke Alarm Smoke Detectors	19	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	1394	sf
Fluorescent Interior Lights	10	ea
Heating Unit/Plant Furnace Electric <10.2 MBH	8	ea
Incandescent Exterior Lights	16	ea
Interior Ceiling Acoustical	1226	sf
Interior Door Wood Personnel	16	ea
Interior Floor Finish/Covering Linoleum	78	sf
Interior Floor Finish/Covering Vinyl Tile	1317	sf
Interior Wall Finish/Covering Drywall 5/8-in. Prefinished Sheetrock	4983	sf
Interior Wall Finish/Covering Drywall 5/8-in. Sheetrock	4983	sf
Interior Wall Finish/Covering Fiberglass Reinforced Plastic	408	sf
Lavatory Sink Ceramic	408	ea
Light Switches	4	ea
Nails	2653	ea
Pier Metal	33	ea
Piping (Fire Suppression) Black/Galvanized <1-in.	174.26	lf
Piping (Fire Suppression) Black/Galvanized <4-in.	13	lf
Piping (Fire Suppression) Black/Galvanized Backflow preventer	1	ea
Piping (Fire Suppression) Black/Galvanized Sprinkler Heads	15	ea
PVC< 2-in. Pipe	264	lf

Item	Quantity	Unit of Measure*
Receptacles	42	ea
Roof Deck Metal	1552	sf
Roof Drainage Metal Downspout	53	lf
Roof Drainage Metal Gutter	55	lf
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	1552	sf
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	1552	sf
Roof Truss Wood - Plywood	1744	sf
Shower Ceramic	2	ea
Supply Air Diffusers	16	ea
Toilet Ceramic	2	ea
Ventilation/Exhaust Equipment Exhaust General Bathroom	2	ea
Waste Piping Vinyl/Plastic	270	lf
Water Heater Commercial	2	ea
Wood 2x10-in.	83.125	bf
Wood 2x4-in.	213	bf
Wood 2x6-in.	184	bf
Wood 2x8-in.	125.7	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet		

Recovering Building Components

First, "cherry pick" those components that will be cannibalized by DPW for parts and retain those components that are not excess or that can be reused easily. Wall and base cabinets, plumbing fixtures, suspended acoustical ceiling, and light fixtures are good examples of such components. The tables below show examples of what one could cherry pick to recover and reuse. The column "Salvage for reuse %" is the percent probability that the particular building component can be recovered. For example, under 1x1 ft returns, it is estimated that all returns can be recovered and reused at some other location. However, under Ductwork Insulated Aluminum, it is estimated that only 20 percent of the existing ductwork can be recovered and reused as ductwork at some other location. The percentages are based on the author's best engineering judgment.

Company/Battalion Administration Facilities

Table B-5 lists typical materials that one might recover based on the above layout and a 2157 sq ft, average-size facility.

Table B-5. Typical recoverable items from administration facility of 2157 sq ft.

Typical recoverable items from administration facilities	Salvage for reuse %	Quantity	Unit of Measure*
1X1 ft Returns	100%	1	ea
2X2 ft Returns	100%	2	ea
8-in. Flex Duct	45%	31	lf
Beam Metal Floor Beam/Girder 12-in. Metal	10%	42	lf
Ductwork Insulated (Aluminum)	20%	310	lf
Electrical Conductors	10%	213	lf
Electrical Conduit	20%	142	lf
Electrical Panels 200-400 Amp	90%	2	ea
Exit Lights	100%	2	ea
Exterior Door Metal Personnel	100%	2	ea
Exterior Window Metal Double Hung	75%	2	ea
Fire Alarms/Emergency Lights	70%	1	ea
Fire/Smoke Alarm Smoke Detectors	80%	6	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	60%	1199	sf
Fluorescent Interior Lights	60%	11	ea
Heating Unit/Plant Furnace Electric <10.2 MBH	33%	1	ea
Incandescent Exterior Lights	75%	2	ea
Interior Ceiling Acoustical	50%	898	sf
Interior Door Wood Personnel	90%	6	ea
Interior Floor Finish/Covering Vinyl Tile	35%	693	sf
Lavatory Sink Ceramic	100%	3	ea
Light Switches	90%	7	ea
Partition/Screen Metal Toilet Unit	25%	1	ea
Pier Metal	60%	29	ea
PVC < 2-in. Pipe	25%	47	lf
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	25%	540	sf
Roof Truss Wood - Plywood	60%	659	sf
Service Sink Floor-Ceramic	100%	1	ea
Shower Ceramic	80%	1	ea
Supply Air Diffusers	75%	10	ea
Toilet Ceramic	75%	2	ea
Urinal Ceramic	75%	2	ea
Ventilation/Exhaust Equipment Exhaust General Bathroom	75%	2	ea
Waste Piping Vinyl/Plastic	50%	235	lf
Water Heater Commercial	100%	1	ea
Wood 2x10-in.	60%	105	bf
Wood 2x4-in.	60%	77	bf
Wood 2x6-in.	60%	122	bf
Wood 2x8-in.	60%	106	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet			

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Company/Battalion Storage Facilities or Warehouses

Table B-6 lists materials one might recover from the above layout of a company/battalion storage facility or a warehouse of 1749 sq ft average size.

Table B-6. Typical recoverable items from a storage facility of 1749 sq ft.

Typical recoverable items from storage facilities	Salvage for reuse %	Quantity	Unit of Measure*
8-in. Flex Duct	45%	22	lf
Beam Metal Floor Beam/Girder 12-in. Metal	10%	32	lf
Ductwork Insulated (Aluminum)	20%	294	lf
Electrical Conductors	10%	165	lf
Electrical Conduit	20%	110	lf
Electrical Panels 200-400 Amp	90%	1	ea
Exit Lights	100%	3	ea
Exterior Door Metal Personnel	100%	3	ea
Exterior Window Metal Double Hung	75%	1	ea
Fire Alarms/Emergency Lights	70%	1	ea
Fire/Smoke Alarm Smoke Detectors	80%	2	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	60%	976	sf
Fluorescent Interior Lights	60%	9	ea
Heating Unit/Plant Furnace Electric <10.2 MBH	33%	1	ea
Incandescent Exterior Lights	75%	2	ea
Interior Ceiling Acoustical	50%	737	sf
Interior Door Wood Personnel	90%	2	ea
Interior Floor Finish/Covering Vinyl Tile	35%	569	sf
Light Switches	90%	3	ea
Pier Metal	60%	32	ea
Roof Deck Metal	25%	438	sf
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	25%	438	sf
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	25%	438	sf
Roof Truss Wood - Plywood	60%	1114	sf
Supply Air Diffusers	75%	6	ea
Wood 2X10-in.	60%	57	bf
Wood 2X4-in.	60%	33	bf
Wood 2X6-in.	60%	124	bf
Wood 2X8-in.	60%	86	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet			

Full Complement Company/Battalion Facilities

Table B-7 lists materials one might recover from the above layout of a typical full complement company facility of a 5365 sq ft average size.

Table B-7. Typical recoverable items from a full complement company facility of 5365 sq ft.

Typical recoverable items from 'full' complement facilities	Salvage for reuse %	Quantity	Unit of Measure*
2X2 ft Returns	100%	6	ea
8-in. Flex Duct	45%	61	lf
Beam Metal Floor Beam/Girder 12-in. Metal	10%	90	lf
Ductwork Insulated (Aluminum)	20%	755	lf
Electrical Conductors	10%	212	lf
Electrical Conduit	20%	141	lf
Electrical Panels 200-400 Amp	90%	2	ea
Exit Lights	100%	4	ea
Exterior Door Metal Personnel	100%	4	ea
Exterior Window Metal Double Hung	75%	3	ea
Fire Alarms/Emergency Lights	70%	1	ea
Fire/Smoke Alarm Smoke Detectors	80%	11	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	60%	3074	sf
Fluorescent Interior Lights	60%	20	ea
Heating Unit/Plant Furnace Electric <10.2 MBH	33%	2	ea
Incandescent Exterior Lights	75%	3	ea
Interior Ceiling Acoustical	50%	2376	sf
Interior Door Wood Personnel	90%	11	ea
Interior Floor Finish/Covering Vinyl Tile	35%	1654	sf
Lavatory Sink Ceramic	100%	3	ea
Light Switches	90%	14	ea
Partition/Screen Metal Privacy	25%	1	ea
Partition/Screen Metal Toilet Unit	25%	1	ea
Pier Metal	60%	54	ea
Piping (Fire Suppression) Black/Galvanized <1-in.	25%	91	lf
Piping (Fire Suppression) Black/Galvanized <4-in.	25%	3	lf
Piping (Fire Suppression) Black/Galvanized Backflow Preventer	100%	1	ea
Piping (Fire Suppression) Black/Galvanized sprinkler Heads	25%	14	ea
PVC < 2-in. Pipe	25%	76	lf
Roof Deck Metal	25%	1343	sf
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	25%	1343	sf
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	25%	1343	sf
Roof Truss Wood - Plywood	60%	2870	sf
Service Sink Floor-Ceramic	100%	1	ea

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Typical recoverable items from 'full' complement facilities	Salvage for reuse %	Quantity	Unit of Measure*
Shower Ceramic	80%	1	ea
Supply Air Diffusers	75%	16	ea
Toilet Ceramic	75%	2	ea
Urinal Ceramic	75%	2	ea
Ventilation/Exhaust Equipment Exhaust General Bathroom	75%	3	ea
Waste Piping Vinyl/Plastic	50%	210	lf
Water Heater Commercial	100%	1	ea
Wood 2X10-in.	60%	163	bf
Wood 2X4-in.	60%	212	bf
Wood 2X6-in.	60%	98	bf
Wood 2X8-in.	60%	259	bf
*sf= "square feet"; lf = "linear feet"; ea = "each"; bf = "board feet"			

Barracks

Table B-8 lists items one might recover from the above layout of a typical barracks facility of 1530 sq ft average size.

Table B-8. Typical recoverable items from a barracks of 1530 sq ft.

Typical recoverable items from barracks facilities	Salvage for reuse %	Quantity	Unit of Measure*
2X2 ft returns	100%	6	ea
8-in. Flex duct	45%	30	lf
Beam Metal Floor Beam/Girder 12-in. Metal	10%	28	lf
Cabinet Wood Base	10%	1	ea
Cabinet Wood Wall	10%	1	ea
Ductwork Insulated (Aluminum)	20%	294	lf
Electrical Conductors	10%	251	lf
Electrical Conduit	20%	167	lf
Electrical Panels 200-400 Amp	90%	2	ea
Exit Lights	100%	2	ea
Exterior Door Metal Personnel	100%	2	ea
Fire Alarms/Emergency Lights	70%	2	ea
Fire/Smoke Alarm Smoke Detectors	80%	15	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	60%	836	sf
Fluorescent Interior Lights	60%	6	ea
Heating Unit/Plant Furnace Electric <10.2 MBH	33%	3	ea
Incandescent Exterior Lights	75%	12	ea
Interior Ceiling Acoustical	50%	613	sf
Interior Door Wood Personnel	90%	14	ea
Interior Floor Finish/Covering Vinyl Tile	35%	461	sf
Lavatory Sink Ceramic	100%	408	ea
Light Switches	90%	4	ea

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Typical recoverable items from barracks facilities	Salvage for reuse %	Quantity	Unit of Measure*
Pier Metal	60%	20	ea
Piping (Fire Suppression) Black/Galvanized <1-in.	25%	44	lf
Piping (Fire Suppression) Black/Galvanized <4-in.	25%	3	lf
Piping (Fire Suppression) Black/Galvanized Backflow Preventer	100%	1	ea
Piping (Fire Suppression) Black/Galvanized Sprinkler Heads	25%	4	ea
PVC < 2-in. Pipe	25%	66	lf
Receptacles	0%	0	ea
Roof Deck Metal	25%	388	sf
Roof Surface Single-Ply w/no-surface 45 mil EPDM	25%	388	sf
Roof Surface Single-Ply w/no-surface FR-50 Slipsheet	25%	388	sf
Roof Truss Wood - Plywood	60%	1046	sf
Shower Ceramic	80%	2	ea
Supply Air Diffusers	75%	12	ea
Toilet Ceramic	75%	2	ea
Ventilation/Exhaust Equipment Exhaust General Bathroom	75%	2	ea
Waste Piping Vinyl/Plastic	50%	135	lf
Water Heater Commercial	100%	2	ea
Wood 2X10-in.	60%	50	bf
Wood 2X4-in.	60%	128	bf
Wood 2X6-in.	60%	110	bf
Wood 2X8-in.	60%	75	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet			

Recycling Building Components

Recycle facility components are what one can still possibly use in one form or another after the "cherry picking" or "soft stripping" is done. Recycling in this case means that one will take the building component and reuse it as something other than its original designated use or as feedstock to create new building components.

Company/Battalion Administration Facilities

Table B-9 lists typical components that can be recycled from a 2157 average sized company administrative building.

Table B-9. Typical recyclable items from a barracks of 1530 sq ft.

Typical recyclable items from administration facilities	Salvage for recycle %	Quantity	Unit of Measure *
8-in. Flex Duct	20%	14	lf
Beam Metal Floor Beam/Girder 12-in. Metal	90%	374	lf
Ductwork Insulated (Aluminum)	80%	1241	lf
Electrical Conductors	80%	1702	lf
Electrical Conduit	60%	426	lf
Exterior Stair/step Concrete	75%	31	ea
Fire/Smoke Alarm Smoke Detectors	15%	1	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	20%	400	Sf
Heating Unit/Plant Furnace Electric <10.2 MBH	33%	1	ea
Interior Ceiling Acoustical	30%	539	Sf
Interior Floor Finish/Covering Vinyl Tile	35%	693	Sf
Interior Wall Finish/Covering Drywall 5/8-in. Sheetrock	70%	524	Sf
Nails	100%	2727	ea
Partition/Screen Metal Toilet Unit	75%	2	ea
Pier Metal	40%	20	ea
Roof Deck Metal	75%	1619	Sf
Roof Drainage Metal Downspout	100%	49	lf
Roof Drainage Metal Gutter	100%	68	lf
Roof Truss Wood - Plywood	40%	1055	Sf
Supply Air Diffusers	15%	2	ea
Waste Piping Vinyl/Plastic	15%	47	lf
Wood 2X10-in.	40%	42	bf
Wood 2X4-in.	40%	51	bf
Wood 2X6-in.	40%	82	bf
Wood 2X8-in.	40%	70	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet			

Company/Battalion Storage Facilities or Warehouses

Table B-10 lists items that might be recycled from the above layout of a company/battalion storage facility or a warehouse of a 1749 sq ft average size.

Table B-10. Typical recyclable items from a storage facility or warehouse of 1749 sq ft.

Typical recyclable items from storage facilities	Salvage for recycle %	Quantity	Unit of Measure*
8-in. Flex Duct	20%	10	lf
Beam Metal Floor Beam/Girder 12-in. Metal	90%	288	lf
Ductwork Insulated (Aluminum)	80%	1176	lf
Electrical conductors	80%	1324	lf
Electrical Conduit	60%	331	lf
Exterior Stair/Step Concrete	75%	31	Cf
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	20%	325	Sf
Heating Unit/Plant Furnace Electric <10.2 MBH	33%	1	ea
Interior Ceiling Acoustical	30%	442	Sf
Interior Floor Finish/Covering Vinyl Tile	35%	569	Sf
Nails	100%	2156	ea
Pier Metal	40%	21	ea
Roof Deck Metal	75%	1313	Sf
Roof Drainage Metal Downspout	100%	48	lf
Roof Drainage Metal Gutter	100%	55	lf
Roof Truss Wood - Plywood	40%	743	Sf
Supply Air Diffusers	15%	1	ea
Wood 2X10-in.	40%	38	bf
Wood 2X4-in.	40%	22	bf
Wood 2X6-in.	40%	83	bf
Wood 2X8-in.	40%	57	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet			

Full Complement Company/battalion Facilities

Table B-11 lists items that might be recycled from the above layout of a typical full complement company facility of 5365 sq ft average size.

Table B-11. Typical recyclable items from a full complement company/battalion facility of 1749 sq ft.

Typical recoverable items from 'full' complement facilities	Salvage for recycle %	Quantity	Unit of Measure*
8-in. Flex Duct	20%	27	lf
Beam Metal Floor Beam/Girder 12-in. Metal	90%	806	lf
Ductwork Insulated (Aluminum)	80%	3020	lf
Electrical Conductors	80%	1697	lf
Electrical Conduit	60%	424	lf
Exterior Stair/Step Concrete	75%	31	cf
Fire/Smoke Alarm Smoke Detectors	15%	2	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	20%	1025	sf
Heating Unit/Plant Furnace Electric <10.2 MBH	33%	2	ea
Interior Ceiling Acoustical	30%	1425	sf
Interior Floor Finish/Covering Vinyl Tile	35%	1654	sf
Interior Wall Finish/Covering Drywall 5/8-in. Sheetrock	70%	953	sf
Nails	100%	5620	ea
Partition/Screen Metal Toilet Unit	75%	2	ea
Pier Metal	40%	36	ea
Piping (Fire Suppression) Black/Galvanized <1-in.	75%	274	lf
Piping (Fire Suppression) Black/Galvanized <4-in.	75%	9	lf
Piping (Fire Suppression) Black/Galvanized Sprinkler Heads	75%	41	ea
Roof Deck Metal	75%	4028	sf
Roof Drainage Metal Downspout	100%	47	lf
Roof Drainage Metal Gutter	100%	168	lf
Roof Truss Wood - Plywood	40%	1914	sf
Supply Air Diffusers	15%	3	ea
Ventilation/Exhaust Equipment Exhaust General Bathroom	15%	1	ea
Waste Piping Vinyl/Plastic	15%	63	lf
Wood 2X10-in.	40%	109	bf
Wood 2X4-in.	40%	141	bf
Wood 2X6-in.	40%	65	bf
Wood 2X8-in.	40%	173	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet			

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Barracks

Table B-12 lists what one might recycle from the above layout of a typical barracks facility of a 1530 sq sf average size.

Table B-12. Typical recyclable items from a barracks facility of 1749 sq ft.

Typical recyclable items from barracks facilities	Salvage for recycle %	Quantity	Unit of Measure*
8-in. Flex Duct	20%	13	lf
Beam Metal Floor Beam/Girder 12-in. Metal	90%	252	lf
Cabinet Wood Base	80%	8	ea
Cabinet Wood Wall	80%	8	ea
Countertop Laminated Plastic	100%	10	sf
Ductwork Insulated (Aluminum)	80%	1175	lf
Electrical Conductors	80%	2006	lf
Electrical Conduit	60%	502	lf
Exterior Stair/Step Concrete	75%	31	cf
Fire Alarms/Emergency Lights	20%	1	ea
Fire/Smoke Alarm Smoke Detectors	15%	3	ea
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	20%	279	sf
Heating Unit/Plant Furnace Electric <10.2 MBH	33%	3	ea
Interior Ceiling Acoustical	30%	368	sf
Interior Floor Finish/Covering Vinyl Tile	35%	461	sf
Interior Wall Finish/Covering Drywall 5/8-in. Sheetrock	70%	3488	sf
Nails	100%	2653	ea
Pier Metal	40%	13	ea
Piping (Fire Suppression) Black/Galvanized <1-in.	75%	131	lf
Piping (Fire Suppression) Black/Galvanized <4-in.	75%	10	lf
Piping (Fire Suppression) Black/Galvanized Sprinkler Heads	75%	11	ea
Roof Deck Metal	75%	1164	sf
Roof Drainage Metal Downspout	100%	53	lf
Roof Drainage Metal Gutter	100%	55	lf
Roof Truss Wood – Plywood	40%	698	sf
Supply Air Diffusers	15%	2	ea
Waste Piping Vinyl/Plastic	15%	41	lf
Wood 2X10-in.	40%	33	bf
Wood 2X4-in.	40%	85	bf
Wood 2X6-in.	40%	74	bf
Wood 2X8-in.	40%	50	bf
*sf= square feet; lf = linear feet; ea = each; bf = board feet			

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Demolition

Debris: After cherry picking and extracting recyclable materials, all that is left is material that will have to go to the landfill because there is no other practical use for it. Examples of this are batt insulation, exterior concrete stairs, and waste piping. Some items, even though they appear to be recoverable or reused, are not. These include exterior siding and prefinished sheetrock.

Company/Battalion Administration Facilities

Table B-13 lists examples of components that will end up as debris from the above layout based on a 2157 sq ft average size company/battalion administrative building.

Table B-13. Typical debris items from a 2157 sq ft administrative facility.

Typical items from administration facilities	Quantity	Unit of Measure
8-in. Flex Duct	6.24	lb
Batt Insulation	1,495.40	lb
Drinking Fountain Metal	58.00	lb
Electrical Conductors	42.60	lb
Electrical Conduit	62.48	lb
Exterior Stair/Step Concrete	1,500.00	lb
Exterior Wall Finish/Covering Clapboard-Smart Panel Siding	4,204.80	lb
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	875.00	lb
Fluorescent Interior Lights	154.00	lb
Heating Unit/Plant Furnace Electric <10.2 MBH	193.00	lb
Incandescent Exterior Lights	5.40	lb
Interior Ceiling Acoustical	359.00	lb
Interior Door Wood Personnel	50.00	lb
Interior Floor Finish/Covering Linoleum	27.00	lb
Interior Floor Finish/Covering Vinyl Tile	891.00	lb
Interior Wall Finish/Covering Drywall 5/8-in. prefinished sheetrock	8,608.60	lb
Interior Wall Finish/Covering Drywall 5/8-in. Sheetrock	585.00	lb
Interior Wall Finish/Covering Fiberglass Reinforced Plastic	491.53	lb
Light Switches	0.10	lb
PVC< 2-in. Pipe	98.00	lb
Receptacles	5.40	lb
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	534.27	lb
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	304.37	lb
Supply Air Diffusers	7.92	lb
Waste Piping Vinyl/Plastic	460.90	lb
Total	21,020.01	lb

Company/Battalion Storage Facilities or Warehouses

Table B-14 lists examples of components that may end up as debris from the above layout of a company/battalion storage facility or a warehouse of 1749 sq ft average size.

Table B-14. Typical debris items from a 1749 sq ft storage facility or warehouse.

Typical items from storage facilities	Quantity	Unit
8-in. Flex Duct	4.42	lb
Batt Insulation	1,014.00	lb
Electrical Conductors	33.00	lb
Electrical Conduit	48.40	lb
Exterior Stair/Step Concrete	1,500.00	lb
Exterior wall Finish/Covering Clapboard-Smart Panel Siding	3,799.80	lb
Flooring Wood ¾-in. STURD-I-FLOOR floor Decking All Rooms	710.94	lb
Fluorescent Interior Lights	132.00	lb
Heating Unit/Plant Furnace Electric <10.2 MBH	193.00	lb
Incandescent Exterior Lights	5.40	lb
Interior Ceiling Acoustical	295.00	lb
Interior Floor Finish/Covering Vinyl Tile	732.00	lb
Interior Wall Finish/Covering Drywall 5/8-in. Prefinished Sheetrock	6,658.60	lb
Receptacles	4.20	lb
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	433.29	lb
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	246.84	lb
Supply Air Diffusers	7.92	lb
Total	15,818.81	lb

Full Complement Company/Battalion Facilities

Table B-15 lists examples of components may end up as debris from the above layout of a typical full complement company facility of 5365 square foot average size.

Table B-15. Typical debris items from a 5365 sq ft full complement company/battalion facility.

Typical items from full complement facilities	Quantity	Unit of Measure
8-in. Flex Duct	12.48	lb
Batt Insulation	3,332.80	lb
Drinking Fountain Metal	58.00	lb
Electrical Conductors	42.40	lb
Electrical Conduit	62.04	lb
Exterior Stair/Step Concrete	1,500.00	lb
Exterior wall Finish/Covering Clapboard-Smart Panel Siding	5,990.40	lb
Exterior Window Metal Double Hung	82.00	lb
Fire/Smoke Alarm Smoke Detectors	1.00	lb
Flooring Wood ¾-in. STURD-I-FLOOR Floor Decking All Rooms	2,242.19	lb
Fluorescent Interior Lights	286.00	lb
Heating Unit/Plant Furnace Electric <10.2 MBH	386.00	lb
Incandescent Exterior Lights	5.40	lb
Interior Ceiling Acoustical	950.00	lb
Interior Door Wood Personnel	50.00	lb
Interior Floor Finish/Covering Linoleum	598.50	lb
Interior Floor Finish/Covering Vinyl Tile	2,127.00	lb
Interior Wall Finish/Covering Drywall 5/8-in. Prefinished Sheetrock	21,036.60	lb
Interior Wall Finish/Covering Drywall 5/8-in. Sheetrock	1,063.40	lb
Interior Wall Finish/Covering Fiberglass Reinforced Plastic	893.81	lb
Light Switches	0.20	lb
Partition/Screen Metal Privacy	94.00	lb
PVC< 2-in. Pipe	159.60	lb
Receptacles	5.40	lb
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	1,329.24	lb
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	757.26	lb
Supply Air Diffusers	15.84	lb
Waste Piping Vinyl/Plastic	615.93	lb
Total	43,697.49	lb

Barracks

Table B-16 lists what one might recycle from the above layout of a typical barracks facility of 1530 sq ft average size.

Table B-16. Typical debris items from a 1530 sq ft barracks facility.

Typical items from barracks facilities	Quantity	Unit of Measure
8-in. Flex Duct	5.98	lb
Batt Insulation	1,582.40	lb
Electrical Conductors	50.20	lb
Electrical Conduit	73.48	lb
Exterior Stair/Step Concrete	1,500.00	lb
Exterior wall Finish/Covering Clapboard-Smart Panel Siding	3,888.00	lb
Fire/Smoke Alarm Smoke Detectors	1.00	lb
Flooring Wood ¾-in. STURD-I-FLOOR floor Decking All Rooms	610.31	lb
Fluorescent Interior Lights	88.00	lb
Heating Unit/Plant Furnace Electric <10.2 MBH	579.00	lb
Incandescent Exterior Lights	21.60	lb
Interior Ceiling Acoustical	245.00	lb
Interior Door Wood Personnel	100.00	lb
Interior Floor Finish/Covering Linoleum	117.00	lb
Interior Floor Finish/Covering Vinyl Tile	592.50	lb
Interior Wall Finish/Covering Drywall 5/8-in. Prefinished Sheetrock	12,955.80	lb
Interior Wall Finish/Covering Drywall 5/8-in. Sheetrock	3,887.00	lb
Interior Wall Finish/Covering Fiberglass Reinforced Plastic	267.75	lb
PVC< 2-in. Pipe	138.60	lb
Receptacles	6.30	lb
Roof Surface Single-Ply w/No-Surface 45 mil EPDM	384.12	lb
Roof Surface Single-Ply w/No-Surface FR-50 Slipsheet	218.83	lb
Supply Air Diffusers	15.84	lb
Waste Piping Vinyl/Plastic	398.05	lb
Total	27,726.76	lb

Findings

Table B-17 lists, for each facility type described in this appendix, the savings possible by recovering, recycling, and reusing the building materials.

Table B-17. Potential savings realized from recovering, recycling, and reusing building materials.

Facility	Savings (lb)
Company/Battalion Administration Building	>57,000
Company/Battalion Storage Facility/Warehouse	>47,000
Full Complement Company/Battalion Facility	>119,000
Barracks	>67,000

APPENDIX C

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

Purpose

The purpose of developing a waste management plan for demolishing/deconstructing temporary modular, relocatable building complexes is to proactively plan the building removal process to maximize materials reuse and recycling, and to minimize waste to the greatest extent practical under specific site and project conditions. This purpose is opposed to simply disposing of materials on an ad-hoc basis without fully considering the value, methods, or end state of the materials as they stand in the buildings.

Creating a waste management plan allows contractors to determine exactly what materials can be diverted and how diversion can be accomplished, according to local resources and the reuse and recycling marketplace. It also allows the USACE district or Army installation to verify the contractor is making a good-faith effort to accomplish diversion requirements and to fully exercise the resources available to them. It also enables the district and installation to support the contractors through their own knowledge of available resources.

Creating a waste management plan also allows the Corps or installation to monitor and verify compliance proactively, as the project progresses. This is opposed to attempting to tabulate diversion and disposal data after-the-fact when supporting data are lost, and noncompliance would become problematic.

In a competitive bidding procurement, developing a waste management plan should be required by the contract. The contractor develops the plan as a pre-demolition/deconstruction submittal. The district or installation reviews the plan, and approves the plan if it will be in their best interest. The plan is then incorporated into the contract, similar to a Contractor Quality Control Plan or Safety Management Plan. In a best-value source-selection procurement, a waste management plan can be incorporated into the proposal requirements and evaluation criteria, and then, into the contract.

Waste Diversion / Reduction Resources

The USACE district or Army installation should use their on-post recycling capabilities to the fullest extent practical, and allow the demolition/deconstruction contractor to deposit materials there. The waste management requirements in the contract should include descriptions of the materials accepted by the installation's Recycling Center or through the installation's Qualified Recycling Program (QRP) and the procedures involved in depositing materials there. Using the Recycling Center and/or the QRP should not be required, however, if the contractor finds it to their advantage to sell materials to commercial reuse or recycling businesses. Other materials useful to the DPW/PWBC, such as aggregate fill or clean wood for mulching or composting, should also be described in the waste management plan requirements.

The government site and contractor should also be familiar with the resources available through state, county, and local solid waste and recycling agencies. These agencies should be instrumental in identifying outlets for materials and other diversion resources.

Appendix D of this PWTB provides references to C&D waste management planning resources. These include guides to waste management plans; directories, databases, and references for salvage, reuse, and recycling services and materials; and organizations that should be instrumental in identifying services and outlets. Both government and contractor should be familiar with these resources available locally and regionally.

Components of the Plan

There is no universally accepted standard plan for C&D Waste Management. However, any competent plan should include the following information in some fashion.

- Contractor Information: Provide identifying information for the contractor. A single individual responsible for waste management should be identified, along with their contact information. If more than one contractor will be present on the site, define the boundaries of that contractor's work and responsibilities.
- Materials Identification: Take-off each material, component, and product present in the buildings in-place, by type and quantity. Estimate the total weight of each material, component, or product. Include building plans, sections, sketches, and other material useful in determining quantities.

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- Materials Disposition: Of the material totals present in the buildings, identify by type and quantity the materials that will be salvaged for reuse, recycled, or disposed of as debris. Quantities may be calculated by percentage (or other means, as determined by the contractor) but should be entered in the plan by weight.
- Diversion Estimate: Estimate the potential diversion by total weight and by percentage, the latter done by calculating the total weight of diverted materials divided by the total weight of the materials in-place.
- Work Plan: For each material or category of materials, describe how the material, component, or product will be removed from the buildings, handled on-site, and transported to its destination. Complete this description for each salvaged, recycled, and debris material. For items being removed for reuse, describe measures to be taken to avoid damage and to preserve their value. Describe any hazard associated with this work, and confirm it is addressed in the project's Hazard Analysis and Safety Plan.
- Destination: For each material, identify the potential reuse, recycling, and solid waste disposal facilities. Verify that the solid waste disposal facility is appropriately permitted by the prevailing authority (typically the state) for subject materials.
- Regulatory Issues: Describe any regulatory issues associated with the types of materials, handling, or transportation methods. Verify that subcontractors, personnel, and/or outlets will be in compliance.

Appendix B provides quantities representing typical mobile, relocatable building configurations. These may be used as an example or template, but must be applied to the specific buildings being demolished/deconstructed.

It is common practice, though not universal, to include a cost/revenue analysis in the waste management plan. If the government determines this will be a useful exercise, the following should be included:

- Disposal Cost: Indicate the cost per ton, total number of tons, and total cost for landfill disposal of all materials present in the buildings. Include loading and transportation costs.
- Salvage Cost: For each material, component, or product to be salvaged, indicate costs associated with salvaging, handling, and transportation. Indicate revenues accrued (unit price and total) through sale or donation of salvaged materials.

Indicate the cost avoidance by not loading, transporting, and tipping salvaged material in the landfill.

- Recycling Cost: For each material, component, or product that is to be recycled, indicate costs associated with salvaging, handling, and transportation. Indicate revenues accrued (unit price and total) through sale of recycled materials. If materials are deposited at a recycling facility at a reduced price, indicate the cost avoidance by recycling instead of landfilling. Include the cost avoidance by not loading, transporting, and tipping recycled material in the landfill.
- Debris Handling Cost: For each material, component, or product to be disposed of as debris, indicate costs associated with removal, loading, transportation, and tipping.
- Net Estimated Cost or Savings: Calculate the total estimated costs associated with salvage and recycling, savings and cost avoidance associated with salvage and recycling, and costs associated with landfilling the residual debris materials. Calculate the total net difference between the cost of total landfill disposal and the costs and savings associated with salvage, reuse, and recycling.

Actual disposal and diversion performance must be monitored throughout the project's duration. A waste management monitoring or progress reporting scheme should be developed as part of the C&D Waste Management Plan. It should include data similar to the estimated waste management data, but will represent the actual quantities, methods, destinations, and costs and savings experienced with the project. The format of the actual monitoring or progress reporting data must enable a direct comparison to the estimated data.

Execution/Monitoring

The C&D Waste Management Plan must also include descriptions of how the plan will be applied and actual data will be recorded. Periodic reporting to the government and submittal of supporting data (summaries, landfill tickets, recycling income receipts, etc.) should be addressed.

Some jurisdictions require waste diversion data to be compiled and submitted with payment invoices, and that payment may be withheld if diversion criteria are not met. While this practice may not be necessary for relatively small demolition/deconstruction projects, it may be advisable for larger projects involving 100 or more modules.

Adjustment

There may be cases in which the actual diversion performance cannot meet the estimated performance. If reasons are valid, and both the contractor and government concur, the waste management plan can be modified. The highest diversion rate reasonable under project conditions should be sought. In no case should either the contractor or government simply ignore or dismiss the performance levels established by the waste management plan.

APPENDIX D

WASTE DIVERSION RESOURCES

The following references are intended to provide further information on the subject of C&D Waste Management. This list is only a sampling of available information. Most resources are available through the hyperlinks provided.

Federal Guidance

Federal Green Construction Guide for Specifiers

- [01 74 19 \(01351\) Construction Waste Management](#)
- [02 41 13 \(02220\) Selective Site Demolition](#)
- [31 10 00 \(02230\) Site Clearing](#)

Unified Federal Guide Specifications:

- [UFGS 02 41 00 \[Demolition\] \[and\] \[Deconstruction\]](#)
- [UFGS 01 57 20.00 10 Environmental Protection](#)
- [UFGS 01 74 19 Construction and Demolition Waste Management](#)

Unified Federal Criteria

- [UFC 1-900-01 Selection of Methods for the Reduction, Reuse and Recycling of Demolition Waste](#)

Executive Orders

[Executive Order 13423 Technical Guidance for Implementing the Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings](#)

U.S. Army Corps of Engineers Public Works Technical Bulletins

- [PWTB 200-1-17 Recycling Interior Finish Materials - Carpet and Ceiling Tiles](#)
- [PWTB 200-1-23 Guidance for the Reduction of Demolition Waste Through Reuse and Recycling](#)
- [PWTB 200-1-24 Quantifying Waste Generated From Building Remodeling](#)

- [PWTB 200-1-26 Market Valuation of Demolition Salvage Materials](#)
- [PWTB 200-1-27 Reuse of Concrete Materials From Building Demolition](#)
- [PWTB 200-1-40 Characterizing Demolition Debris for Diversion Opportunities: WWII-Era and Korean War-Era Buildings](#)
- [PWTB 420-49-30 Alternatives to Demolition for Facility Reduction](#)
- [PWTB 420-49-32 Selection of Methods for the Reduction, Reuse, and Recycling of Demolition Waste](#)

General C&D Waste Management Information

- [Characterization of Building-Related Construction and Demolition Debris in the United States](#), U.S. Environmental Protection Agency, Municipal and Industrial Solid Waste Division. Office of Solid Waste, Report No. EPA530-R-98-010
- [Construction & Demolition Recycling Magazine](#)
- *Cradle to Cradle* by William McDonough & Michael Braungart. New York, NY: North Point Press, 2002.
- King County, WA Solid Waste Division, [Construction Recycling](#)
- [National Demolition Association, Position Paper promoting C&D waste material recycling](#)
- [North Carolina Division of Pollution Prevention & Environmental Assistance](#)
- ["A Report on the Feasibility of Deconstruction: An Investigation of Deconstruction Activity in Four Cities"](#) by U.S. Department of Housing and Urban Development
- Resource Venture, [Sustainable Building Publications](#)
- U.S. EPA [Construction and Demolition \(C&D\) Debris](#)
- U.S. EPA C&D Debris, [Resources by Debris Type](#)
- WasteCap Massachusetts, [Information on Recycling Construction and Demolition Debris](#)

Environmental Life Cycle Information

- EPA [Waste Reduction Model \(WARM\)](#)

Selected C&D Waste Management Guides

- [California Integrated Waste Management Board](#)
- [C&D Guide](#), Air Force Center for Engineering and Environment
- [Deconstruction Guides](#), National Association of Home Builders Research Center
- ["A Guide to Deconstruction"](#) Deconstruction Institute
- King County, WA, Solid Waste Division: [Design Specifications & Waste Management Plans Contractors Guide](#)
- [Massachusetts Department of Environmental Protection / Boston Society of Architects](#)
- [Residential Construction Waste Management: A Builder's Field Guide](#), National Association of Home Builders Research Center
- [Solid Waste Agency of Lake County, IL](#)
- [State of Hawaii, Department of Business & Economic Development](#)
- ["WasteSpec," Triangle J Council of Governments, NC Model Specifications for Construction Waste Reduction, Reuse, and Recycling](#)

C&D Recycling Databases and Building Materials Exchanges

- California Integrated Waste Management Board, [C&D Debris Recyclers Database](#)
- Georgia Pollution Prevention Assistance Division, [Recycling & Waste Exchange Resources](#)
- King County, WA Solid Waste Division [C&D materials recycling database](#)
- King County, WA Solid Waste Division [Reusable Building Materials Exchange](#)

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- [North Carolina Department of Natural Resources, Division of Pollution Prevention & Environmental Assistance](#)
- [Recycler's World](#)
- [Southern Waste Exchange Information](#)
- U.S. Department of Agriculture, Forest Products Laboratory [Directory of Wood Framed Building Deconstruction and Reused Building Materials Companies](#)
- U.S. EPA national database of [Materials and Waste Exchanges](#)

Selected State, County, and Local Agencies

- Alameda County, CA [Waste Management Authority](#)
- [California Integrated Waste Management Board](#)
- City of Austin, TX [Greenbuilder Program](#)
- Georgia [Pollution Prevention Assistance Division](#)
- King County, WA Solid Waste Division, [Construction Recycling](#)
- Minnesota Office of Environmental Assistance, [C&D Recycling](#)
- North Carolina Department of Natural Resources, [Division of Pollution Prevention & Environmental Assistance](#)

Recycling and Waste Management Councils

- [Association of State and Territorial Solid Waste Management Officials](#). See also [links](#) to state and other federal solid waste management contacts
- [National Recycling Coalition](#)
- [Northeast Recycling Council](#)
- [Mid-America Council of Recycling Officials](#)
- [Mid-Atlantic Consortium of Recycling and Economic Development Officials](#)
- [Waste Reduction Resource Center](#)

Associations

- [Building Materials Reuse Association](#)
- [Construction Materials Recycling Association](#)
- [National Demolition Association](#)

Organizations

- [The Deconstruction Institute](#)
- [greenGoat](#)
- [The Green Institute](#)
- [Habitat for Humanity ReStore network](#)
- [The Loading Dock](#)
- [Reuse Development Organization](#)

Miscellaneous References

["U.S. Army Concepts for Reuse & Recycling of Construction & Demolition Waste"](#) USACERL Technical Report 97/58.

APPENDIX E

ACRONYMS AND ABBREVIATIONS

Term	Spellout
ACSIM	Assistant Chief of Staff for Installation Management
AR	Army Regulation
BRAC	Base Realignment and Closure
C&D	construction and demolition
CEERD	U.S. Army Corps of Engineers, Engineer Research and Development Center
CONUS	Continental United States
DA	Department of the Army
DC	District of Columbia
DOD	U.S. Department of Defense
DPW	Directorate of Public Works
DRMO	Defense Reutilization and Marketing Office
DRMS	Defense Reutilization and Marketing Service
EPDM	ethylene propylene diene Monomer (M-clas) rubber
FRP	Facility Reduction Program
GAO	Government Accountability Office
GSA	General Services Administration
HHS	U.S. Department of Health and Human Services
HQUSACE	Headquarters, U.S. Army Corps of Engineers
HVAC	heating, ventilating, and air-conditioning
IMCOM	Installation Management Command
MBH	thousands of BTUs per hour
MILCON	Military Construction
OCONUS	outside continental United States
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
PDF	Portable Document Format
POC	point of contact
PWBC	Public Works Business Center
PWTB	Public Works Technical Bulletin
QRP	Qualified Recycling Program
RCI	Residential Communities Initiative
RFP	request for proposal
SDD	Sustainable Design and Development
SRM	sustainment, restoration, and modernization
URL	Universal Resource Locator
USACE	U.S. Army Corps of Engineers
WBDG	Whole Building Design Guide
WWW	World Wide Web

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