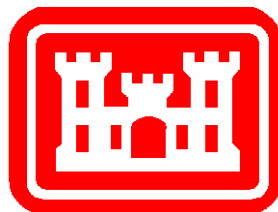


PUBLIC WORKS TECHNICAL BULLETIN 200-1-48
30 JUNE 2007

**OPPORTUNITIES FOR REDUCING
CONSTRUCTION AND DEMOLITION WASTE
FROM RESIDENTIAL COMMUNITIES
INITIATIVE (RCI) PROGRAMS**



Public Works Technical Bulletins are published by the U.S. Army Corps of Engineers, 441 G Street, NW, Washington, DC 20314-1000. They are intended to provide information on specific topics in areas of Facilities Engineering and Public Works. They are not intended to establish new DA policy.

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30 June 2007

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

CECW-CE

Public Works Technical Bulletin

30 June 2007

No. 200-1-48

Facilities Engineering
Environmental

OPPORTUNITIES FOR REDUCING CONSTRUCTION
AND DEMOLITION WASTE FROM RESIDENTIAL
COMMUNITIES INITIATIVE (RCI) PROGRAMS

1. Purpose.

a. This Public Works Technical Bulletin (PWTB) provides information for recovering, reusing, and recycling building materials typically disposed of as demolition waste. It will enable Army installations and Installation Management Command (IMCOM) offices and U.S. Army Corps of Engineers (USACE) districts to voluntarily implement practices, with their Residential Communities Initiative (RCI) Partners, to reduce the amount of demolition debris generated by the removal of surplus buildings throughout their various construction programs.

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 web page, which is accessible through URL:

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

2. Applicability. This PWTB applies to installation Directorates of Public Works, Public Works Business Centers, Directorates of Engineering, and other U.S. Army facilities' engineering activities where RCI housing redevelopment is taking place. This PWTB is not mandatory for RCI programs; rather it

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is an information resource that can be useful to both the installation and RCI Partner.

3. References.

a. Army Regulation (AR) 200-1, Environmental Protection and Enhancement, 21 February 1997.

b. Executive Order (EO) 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," 26 January 2007.

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

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

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

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

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

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

i. Enclosure to Reference g, 13 February 2006, Sustainable Management of Waste in Army Construction, Renovation, and Demolition Activities. Revised 5 July 2006.

j. Unified Federal Guide Specification (UFGS) 01572, "Construction and Demolition Waste Management." Now UFGS 02 41 00, July 2006. Preparatory agency: U.S. Army Corps of Engineers.

k. UFGS 02220, "Demolition." Now UFGS 02 41 00.00 40, June 2006. Preparatory agency: National Aeronautics and Space Administration.

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1. Headquarters, Air Force Center for Environmental Excellence (AFCEE), Brooks AFB, TX, "Construction and Demolition Waste Management Guide," March 2000.

4. Discussion.

a. In order to upgrade the quality of housing and neighborhoods for soldiers' families, Army Family Housing is being converted to private development under the Residential Communities Initiative. RCI Partners work with installations' Public Works Business Centers (PWBCs) or Directorates of Public Works (DPWs) to build new housing, remodel existing facilities, or replace obsolete units with contemporary housing. This program focuses not just on new homes but also the overall development of new neighborhoods and green spaces on military properties.

b. The Army's RCI Partners are not required by regulation or policy to divert any construction and demolition waste from community development sites. This approach allows the RCI Partners the flexibility and latitude they need to provide the Army with quality housing that is attractive to soldiers and their families without the burden of excessive requirements. Installations operating their own C&D landfills now face the challenge of accepting debris generated by RCI programs, while attempting to reduce other C&D waste streams and prolong the lives of their landfills.

c. Several RCI Partners have, however, been more than just sensitive to the installations' solid waste reduction goals and have implemented recycling measures on their own. In many cases, the Partners have found that salvaging useable materials and recycling debris creates no added burden and reduces hauling expenses. Waste reduction strategies can be appropriately discussed with RCI Partners when these efforts would be of mutual benefit. For example, the RCI Partners at Fort Bragg, NC, Leonard Wood, MO, and Schofield Barracks, HI, have initiated aggressive recycling practices. By being proactive in this way, the partners are not only being environmentally friendly but are also saving money through waste diversion. These companies are demonstrating that debris reduction goals and economic benefits can be achieved with no adverse impact to the RCI projects.

d. Under existing RCI Agreements, waste diversion can be pursued on a voluntary basis, unless there is a state, county, or local ordinance or regulation that requires recycling or diversion. Where such regulations exist, the Garrison Commander

can apply the methods of compliance described in the Engineering Management Plan to ensure the required diversion levels are observed. For new Agreements, recycling or diversion requirements can be incorporated into the Engineering Management Plan, with the Garrison Commander's approval.

e. Outlined in this PWTB are procedures and supporting data for assessing the material content of buildings, to enable a relatively quick quantity take-off to be established in order to determine opportunities for debris reduction. Building descriptions and information pertaining to quantities of material to be expected per gross floor area of building are addressed. It is important to note that no single quantity for material content is applicable to all buildings, construction types, and locations. Therefore, several building categories are described to address a range of project-specific conditions.

f. C&D debris accounts for up to 80 percent of some installations' solid waste streams, as reported by solid waste managers at several of the Army's largest troop installations. This situation is most critical where an installation is removing large numbers of World War II-era wood buildings and where new construction programs require the demolition of existing facilities. Even if Facility Reduction and new Military Construction (MILCON) programs are more modest, C&D debris constitutes a significant solid waste burden. Demolition is expensive in and of itself. However, the costs to permit, construct or expand, operate and maintain, close, and monitor a landfill throughout its life are expenses incurred by demolition debris as well. Where an installation's landfill is closed, hauling costs and tipping fees will cost more than onsite landfilling. When considered, these life cycle costs will make the demolition process even more expensive. Alternatives to conventional demolition and landfilling have proven that diverting more than 75 percent of debris from the landfill is achievable, saving money over time.

g. The Principal Deputy Assistant Secretary of the Army (PDASA) has entered into discussions with Habitat for Humanity (HfH) and other Federal agencies, including inexpensive and less wasteful avenues to dispose of surplus buildings by moving them off installations, or deconstructing them to salvage building materials for reuse. The PDASA has committed the Army to supporting initiatives whereby the Army and surrounding communities can benefit from the reuse of excess Army buildings.

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h. The Army has adopted the concept of Sustainable Design and Development (SDD), as described in the memorandum from the Assistant Chief of Staff for Installation Management (ACSIM), 26 May 2001. The 6 February 2006 memorandum from ACSIM 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.

i. Appendix A to this PWTB describes the general applicability of this PWTB specifically pertaining to residential-type facilities. Appendix B provides quantity figures and material component descriptions pertaining to former Army Family Housing Units. Application of the modeled data to building types and special considerations are discussed. Appendix C provides information on creation of a waste management plan. Appendix D contains resources for finding outlets for C&D materials.

5. Points of Contact. HQUSACE is the proponent for this document. The POC at HQUSACE is Mr. Malcolm E. McLeod, CEMP-II, 202-761-0632, or e-mail: Malcolm.E.Mcleod@hq02.usace.army.mil.

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Appendix A

General

Construction and Demolition (C&D) debris disposal has become problematic at Army installations in both economic and environmental terms. Installations with Facility Reduction Program (FRP) requirements, active Military Construction (MILCON) programs, and Residential Communities Initiatives (RCI) are facing a significant C&D debris burden. Some installations report C&D debris to be roughly 80 percent of their solid waste stream.

The major cost components of demolition are loading, hauling, and tipping the debris at landfills. Costs for landfilling debris off-post can be thousands of dollars for a two-story family housing unit. The diminishing numbers of C&D landfills across the United States, and regulatory constraints being placed on C&D debris disposal indicate off-post landfilling will only become more expensive in the future. Installations with on-post C&D landfills typically allow tipping at no cost to the contractor. However, the landfill's operation, maintenance, closure, and long-term monitoring are still the installation's responsibility. While so-called "free" tipping reduces the initial cost of demolition, the life-cycle landfill cost is still borne by the installation. Army solid waste managers have reported costs of up to \$50 per ton of C&D debris over the life of their landfills. When on-post C&D landfills close, off-post landfilling will be the only option.

Landfilling C&D debris has environmental consequences. The U.S. Environmental Protection Agency (EPA) has identified C&D debris as a contributor to greenhouse gas emissions. That debris is a cause of greenhouse gases is just one concern. Consider the life-cycle environmental effects of extracting materials, depleting resources, manufacturing, transporting, and disposing of virgin materials in lieu of reusing or recycling materials that are already on-hand. On average, 75 percent of the dimension lumber can be recovered from a wood-framed building.

It is, therefore, imperative that installations and USACE Districts supporting installations adopt practices to reduce the quantities of demolition debris generated through building removal activities, and where possible utilize these materials as resources instead of waste. Executive Office, Department of

Defense, Army, and Corps of Engineers policy and guidance all reinforce this requirement.

Problem Statement

Knowing the content of buildings and structures to be removed is fundamental to assessing the feasibility of recovering or recycling components and materials. The content of Army buildings and structures, specifically with regard to their potential as resources and useable materials, is largely unknown within the Directorate of Public Works (DPW) and U.S. Army Corps of Engineers (USACE). Without recognizing value and opportunity, incentive for diversion is absent. Given sufficient value, some additional cost or schedule adjustment may be acceptable in order to recover or recycle materials, or some net cost savings may be achieved by virtue of the materials' value. Without sufficient value, any increase in cost or extension of schedule, compared with conventional demolition, will not be justifiable. Even advocates of debris diversion may be reluctant to initiate deconstruction or aggressive recycling if they feel uncertainty is high and risk may be greater than the reward.

Availability of Data

In 1998 the EPA published "Characterization of Building Related Construction and Demolition Waste in the United States." This report was meant to characterize the quantity and composition of building-related C&D debris generated in the United States, and to summarize waste management practices for this waste stream (see <http://www.epa.gov/epaoswer/hazwaste/sqg/c&d-rpt.pdf>). The U.S. Air Force Center of Environmental Excellence has included this study's data in its Construction & Demolition Waste Management Guide as the basis for estimating the amount of wood, dry-wall, metals, concrete, cardboard, and plastic debris generated from residential and nonresidential demolition. (See <http://www.afcee.brooks.af.mil/eq/programs/summary.asp?rscID=870>).

Two issues are of note with regard to this EPA report. First, the sample of buildings upon which the demolition debris characterization was based was quite small; 4 residential projects and 17 nonresidential projects. Residential buildings, however, are more likely to be similar between military and commercial markets, so the residential building data would be reasonably representative. No Army buildings were included in the EPA sample. Second, the report describes all materials coming out of the buildings as waste. No distinction is made among items that may be reused or recycled, or those of no

further use that should be landfilled. While the EPA report is helpful for determining the waste generated by a building, its uses are limited when determining the potential materials diversion of a building's materials.

Twelve Army Family Housing unit designs taken from four Army and one Air Force properties were used as the basis of this PWTB's material and quantity models.

Applicability of this PWTB

It is impractical for the RCI Partner, or installation Public Works or USACE personnel, to perform surveys of every housing unit to be removed in order to determine opportunities for debris reduction. This PWTB enables installation USACE or RCI Partner personnel to quickly estimate the types and amounts of materials present in these buildings, and determine in general terms the opportunities for debris reduction through salvage, reuse, and recycling. Essentially, the characterizations should reveal whether (1) a significant opportunity for debris reduction exists, (2) little opportunity for debris reduction exists, or (3) further detailed evaluation of the building would be advisable. With this information, the appropriate method of building removal can be implemented.

The buildings described in this PWTB represent a large portion of the family housing buildings to be removed at Army installations, now and in the foreseeable future. As redevelopment of existing family housing is typically the responsibility of the RCI Partner, not the Government, this PWTB will provide guidance on how the installation and RCI Partner can collaborate in reducing demolition debris from RCI programs. Removal of other WWII-era buildings and demolition of buildings under MILCON programs is discussed in a separate PWTB report.

Appendix B provides data on residential-type construction. Two basic family housing building types are defined; detached units (i.e., single family or duplex) or multifamily units (i.e., town house apartments). All building types within a category are of similar enough characteristics that they can be included within the same descriptions. For each category of building, components and materials are characterized by type and quantity.

The following material types are included in the characterization of wood-framed housing units. Further detail as to specific material type is given in Appendix B, where it is useful in the feasibility determination.

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- Concrete
- Reinforcing steel
- Lumber
- Exterior materials (roofing, siding materials, insulation, doors, and windows)
- Interior construction materials (framing, doors)
- Plumbing fixtures, equipment, and materials
- Heat generating equipment
- Heating and ventilating equipment and materials
- Electrical components and materials

Quantities are modeled on a per-square-foot per unit of building basis to the extent possible. Quantities represent a typical building in its standing condition; that is the building as originally constructed, and items that have most commonly been added to, or removed from the building over its life. Materials are represented in their common units of measure, as well as weight. Unit measures for each material or component, and for the total building, are given. The total weight of the standing building would represent the potential debris burden, assuming no other diversion takes place. This figure can be used as the basis of comparison for diversion.

The quantities are further annotated as to whether the material or component is most commonly reusable, either reusable or recyclable, or most commonly recyclable. To provide the most accurate estimations, the Potential Diversion factors take into account deterioration and damage upon removal of the materials.

The "typical" content of the basic individual housing unit, therefore, can be estimated by multiplying the unit quantity for each material by the square foot floor area of the individual housing unit. A reasonable yield of these materials can be determined by applying the appropriate Potential Diversion factors. To estimate the total amount of material present in the entire building, the values found per individual housing unit should be multiplied by the total number of housing unit per building.

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Assumptions have been made about the quantities of materials, components, and finishes for each of these variations. While not precisely accurate for an individual building, quantity differences will be minor with respect to the total building mass, and will be appropriate for the purposes. The quantities of these additional materials must then be added to the basic building's reusable materials, recyclable materials, and debris quantities.

The condition of materials and components is critical to their potential for reuse or recycling. The effects of age (with regard to functionality or performance), physical condition (with regard to damage or deterioration), and the presence of contamination are described. These conditions will be unique to each building and therefore cannot be generalized. Where they apply to building materials or components, the effects on reuse, recycling, and debris generation are described in qualitative (usually "if ... then") terms. For example, if a component is damaged or may be functionally obsolete and is no longer reusable, its potential for recycling is described. Or, if a contaminate is present on otherwise recyclable material, the requirement for disposing as debris is described. Such conditions may effect all or part of a material's quantity in the standing building.

To summarize, a characterization of the content of a wood-framed house can be performed by using the data in Appendix B as follows.

- Multiply the unit weight for the individual housing unit by the building unit's square-foot floor area. The total weight represents the potential building debris burden per unit. Multiply the total weight found for the unit by the number of units per building to find the total weight represented for the entire housing unit building.
- Multiply the unit quantity for each component and material by the square-foot floor area of the building unit to estimate material quantities. Identify what materials are reusable, recyclable, and debris. Apply the appropriate Potential Diversion factors and estimate a total weight of each reusable material and recyclable material; include lost materials in the debris total. Multiply the total weight found for each component and material for the individual unit by the number of units per building to find the total weight for each component

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and material represented for the entire housing unit building.

- Identify conditions that apply to the building or materials. Where the conditions would suggest all, or some portion, of the materials would not be reusable or recyclable, subtract that amount from the reusable and recyclable totals, and add it to the debris total.
- Compare the total diversion potential (reusable and recyclable quantities) with the total potential debris burden. This ratio defines the potential debris diversion rate.

Appendix B

Building Categories

The majority of wood-framed houses can be represented by two basic categories: detached housing (i.e., single family or duplex), and multifamily (i.e., townhouse-type apartments). Each of these types may have one of the following foundations: slab-on-grade, crawl space, or a full basement. This categorization is primarily based on if the building is one or two stories. Proper categorization is the most significant feature in modeling quantities on a unit basis (i.e., quantity per square foot of building). It should be noted that all quantity estimates are based on gross square feet, which includes the basement.

Light-frame, one and two story housing: These buildings are constructed with common dimensional lumber members (2x4 through 2x12 joists, studs, and rafters). One unit is typically 35 to 44 ft wide in nominal dimension, average about 30 ft in depth, and range from 1050 to 1320 square feet. Most buildings consist of a single housing unit or two units per building with mirrored plans. Examples of typical wood-framed housing are shown in Figures B1 through B6.



Figure B1. Exterior façade of an eight-unit family housing building.



Figure B2. Exterior entry façade of one individual housing unit.



Figure B3. Exterior rear façade of one individual housing unit.



Figure B4. Typical aluminum window.



Figure B5. One story slab-on-grade housing unit.



Figure B6. One story slab-on-grade housing unit
(front door).

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These buildings' contents are summarized as follows:

- *Foundation:* One story houses are built either with a slab-on-grade or continuous concrete wall footings. Two story units are built either with a basement or as slab-on-grade. Carports are typical, but if a garage is present its foundation is a slab-on-grade.
- *Floor framing:* Slab-on-grade foundations act as the floor system for some housing units with either 3/4 in. plywood sheets or 1 in. boards (in immediate post-war buildings) as subflooring. Where a basement or crawl space is present, the floors are either 2x8 or 2x10 floor joists with 3/4 in. plywood sheets as subflooring.
- *Exterior walls:* 2x4 studs are spaced at 16 in. on center (O.C.). Exterior sheathing is either 3/4 in. plywood sheets or 1x8 boards in immediate post-war buildings. Siding is 8 or 12 in. wood lap siding. Vinyl, aluminum, or steel siding is typically applied over the original wood siding, and insulation board frequently accompanies the added siding. Other areas may have a brick veneer. Aluminum soffits and gutters are typically present.
- *Doors and windows:* Insulated hollow metal doors have often replaced the original exterior doors. The original wood frames typically remain. Windows are typically vinyl or aluminum-framed double hung replacement type, which may be single- or double-glazed.
- *Roof:* Gable and hip roofs are framed from 2x6 rafters 16 in. O.C. One-half-inch plywood sheathing is placed on the rafters. Roofing is three-tab asphalt shingle on roofing felt. One layer of shingle is common, although up to three layers may be present.
- *Interior construction:* Partitions are framed with 2x4 studs and finished with painted 1/2 in. gypsum wallboard (GWB). Ceilings are painted 1/2 in. GWB. The original flooring at framed floors is 3 in. tongue-and-groove (T&G) hardwood wood strip flooring; carpeting or vinyl tile or sheets with particleboard or plywood underlayment may have been added over the original wood strip flooring. Flooring on slabs is most often vinyl sheet or carpet, although hardwood flooring does appear on occasion. Interior doors are typically hollow core wood veneer doors.

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- *Mechanical / Electrical / Plumbing:* A forced air furnace typically supplies heat, and is located in a utility closet at an outside wall. In regions where air conditioning is provided, heat pumps or compressor/condenser units are often mounted near the patio area at the back side of the unit. Ductwork is most commonly strung in the crawlspace or attic of one-story units, depending on whether the floor is built on a crawlspace or slab. Standard light fixtures are present in the ceilings of each room; duplex receptacles are present within any enclosed spaces. Load centers and distribution are typically upgraded over original materials. Bathrooms typically include one toilet, one tub/shower, and one porcelain sink. Some units have powder rooms that include one toilet and one porcelain sink. Kitchens contain one stainless steel sink, range/oven, refrigerator, and dishwasher.

Potential Contaminants

The presence or absence of contaminants will have a significant effect on the feasibility of reusing or recycling building materials. Intentions to minimize waste must be tempered with human health and safety considerations.

Asbestos Containing Materials

In most states, and therefore at most Army installations, all asbestos-containing materials (ACM) must be removed prior to building removal regardless of whether the building is mechanically demolished or manually deconstructed. This task is the responsibility of the RCI Partner. The demolition (or deconstruction) contractor will be allowed to proceed only after abatement work is completed, and the building is certified to be safe. Therefore, no ACM should be present if and when personnel salvage or recycle materials. The only time ACM becomes a problem with demolition or deconstruction is when undetected ACM is found, at which point demolition, salvage, or deconstruction activities must stop until the ACM is removed. While the presence of ACM is of concern, it is not problematic to the issue of salvage and recycling if it is abated as a standard practice.

In those locations where non-friable ACM is allowed to remain commingled with demolition debris, salvage and recycling become more problematic.

- Items may be removed prior to abatement (i.e., "soft stripping" or "cherry picking") if removal does not disturb

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any ACM. However, if removing items will disturb ACM and release fibers into the air, removal must be accomplished under controlled conditions. The most common scenario is that these items will be removed as part of the abatement process. But as the abatement crew's task is removing ACM, not salvage, the attached items are most frequently destroyed during the abatement process. For example, kitchen cabinets, countertops, fixtures, and appliances are desirable for salvage, but may be anchored to walls with asbestos containing wallboard or joint compound. The abatement crews typically rip out the cabinetry to remove wallboard, damaging the otherwise salvageable items to the extent where they are no longer useful. Abatement crews would have to be instructed, encouraged, or given incentives to recover these items intact, but possibly at the expense of a protracted abatement schedule.

- If otherwise salvageable materials were inaccessible because of non-friable ACM, the ACM would either have to be abated, or the materials would be abandoned as demolition debris. For example, if vinyl asbestos tile (VAT) flooring were present, the underlying hardwood strip flooring and floor framing could not be salvaged unless the floor tile were removed, which would be an additional task not required by prevailing regulations. Another example would be where VAT was applied to a concrete slab-on-grade. Unless the VAT was removed, the concrete could not be recycled.

Lead-Based Paint

Concern is frequently expressed about salvaging materials that have been coated by lead-based paint (LBP). Any building removal activities, whether demolition, salvage, or deconstruction, must observe the Code of Federal Regulations (CFR) 29 CFR 1926, the Occupational Safety and Health Administration (OSHA) Construction Safety Standards, specifically Section 62, Lead in Construction. All occupational protection requirements are described in these standards. However, previous Army deconstruction projects suggest personal exposure to lead is not problematic. Exposure Assessments typically result in no more than nondetectable levels of lead being found through personal and ambient air monitoring, even when removing lead-based painted siding by hand.

Consideration must be given to what materials have and have not been painted throughout the buildings' life. Typically, roof, wall and floor framing has never been painted, and these

materials constitute the vast majority of lumber in residential buildings.

The Resource Conservation and Recovery Act (RCRA) does not apply to materials until they have been deposited into the waste stream. Salvaging or recycling building materials is not covered under RCRA. Furthermore, no Federal regulation or standard prohibits the salvage, sale, or reuse of lead-based painted materials.

If LBP is present, it may or may not be a hazard. 40 CFR Part 745.61; "Identification Of Dangerous Levels Of Lead; Final Rule" defines lead hazard in target housing and child-occupied facilities as damaged or deteriorated paint on an impact surface, any chewable LBP where there is evidence of teeth marks, or any other deteriorated paint on the interior or exterior of a residential dwelling or child-occupied facility. LBP that is intact and otherwise not subject to detaching from the underlying wood is not defined as an LBP hazard.

Prudent practice dictates, however, that the installation and RCI Partner show due diligence when allowing lead-based painted materials to be removed for possible resale. This practice would include disclosing the likely presence of LBP and requiring the contractor to disclose the likely presence of LBP to whomever they sell or donate these materials. Housing and Urban Development (HUD) 24 CFR Part 35, EPA 40 CFR Part 745 "Lead; Requirements For Disclosure Of Known Lead-Based Paint And/Or Lead-Based Paint Hazards In Housing; Final Rule" may provide an appropriate model for this disclosure. This document also requires a reference to the EPA pamphlet "Protect Your Family From Lead In Your Home" as part of this disclosure. Adopting similar information and disclosure practices would be advisable.

Family Housing Quantity Models

Table B1. Light-Framed, Detached House with Crawl Space

(Quantities are based on per-square-foot per one individual housing unit)

| Building Component Categories | Description | Average Quantity per Gross SF of Building | Units | Potential Diversion | | | | | | | | |
|--------------------------------|--|---|--------|---------------------|--------------|--------|---------|--------------|--------|---------|--------------|--------|
| | | | | Salvage for Reuse | | | Recycle | | | Debris | | |
| | | | | Percent | Quantity | Units | Percent | Quantity | Units | Percent | Quantity | Units |
| Dim. Lumber | Framing lumber greater than 6 ft in length | 5.30 | bf/gsf | 75 | 3.98 | bf/gsf | 20 | 1.06 | bf/gsf | 5 | 0.30 | bf/gsf |
| | | 12.70 | lb/gsf | | 9.54 | lb/gsf | | 2.54 | lb/gsf | | 0.64 | lb/gsf |
| Scrap Lumber | Framing lumber less than 6 ft in length | 0.60 | bf/gsf | 0 | 0.00 | bf/gsf | 90 | 0.54 | bf/gsf | 10 | 0.10 | bf/gsf |
| | | 1.40 | lb/gsf | | 0.00 | lb/gsf | | 1.30 | lb/gsf | | 0.14 | lb/gsf |
| Siding | Metal siding | 1.00 | lb/gsf | 75 | 0.76 | lb/gsf | 20 | 0.20 | lb/gsf | 5 | 0.10 | lb/gsf |
| Sheathing | Plywood | 3.70 | bf/gsf | 75 | 2.78 | bf/gsf | 20 | 0.74 | bf/gsf | 5 | 0.20 | bf/gsf |
| | | 8.90 | lb/gsf | | 6.66 | lb/gsf | | 0.00 | lb/gsf | | 0.44 | lb/gsf |
| Plywood | 1/4 in. plywood sheathing | 5.30 | lb/gsf | 90 | 4.79 | lb/gsf | 5 | 0.27 | lb/gsf | | 0.00 | lb/gsf |
| T&G Flooring | 1x T&G flooring | 0.20 | bf/gsf | 90 | 0.15 | bf/gsf | 5 | 0.01 | bf/gsf | 5 | 0.00 | bf/gsf |
| | | 0.40 | lb/gsf | | 0.36 | lb/gsf | | 0.00 | lb/gsf | | 0.02 | lb/gsf |
| Drywall | 1/2 in. GWB | 3.70 | sf/gsf | 0 | 0.00 | sf/gsf | 0 | 0.00 | sf/gsf | 100 | 3.70 | sf/gsf |
| | | 7.80 | lb/gsf | | 0.00 | lb/gsf | | 0.00 | lb/gsf | | 7.81 | lb/gsf |
| Asphalt Shingles & Felt Paper* | 235 lb Shingles | 2.50 | sf/gsf | 0 | 0.00 | sf/gsf | 99 | 2.48 | sf/gsf | 1 | 0.03 | sf/gsf |
| | | 6.00 | lb/gsf | | 0.00 | lb/gsf | | 0.00 | lb/gsf | | 0.06 | lb/gsf |
| Concrete | RC foundation slabs & piers | 71.00 | lb/gsf | 0 | 0.00 | lb/gsf | 99 | 70.29 | lb/gsf | 1 | 0.71 | lb/gsf |
| Reinforcing Steel | Typical steel reinforcement | 0.30 | lb/gsf | 0 | 0.00 | lb/gsf | 99 | 0.31 | lb/gsf | 1 | 0.00 | lb/gsf |
| Plumbing | Fixtures, Piping, misc. | 0.00 | lb/gsf | 50 | 0.00 | lb/gsf | 50 | 0.00 | lb/gsf | 0 | 0.00 | lb/gsf |
| HVAC** | Equipment, Ductwork, misc. | 1.00 | lb/gsf | 50 | 0.50 | lb/gsf | 50 | 0.50 | lb/gsf | 0 | 0.00 | lb/gsf |
| Doors | Sizes Vary | 0.90 | lb/gsf | 0 | 0.00 | lb/gsf | 90 | 0.81 | lb/gsf | 10 | 0.09 | lb/gsf |
| Windows | Sizes Vary | 0.40 | lb/gsf | 85 | 0.34 | lb/gsf | 10 | 0.04 | lb/gsf | 5 | 0.02 | lb/gsf |
| Equipment | Typical kitchen equipment | 0.60 | lb/gsf | 85 | 0.51 | lb/gsf | 10 | 0.06 | lb/gsf | 5 | 0.03 | lb/gsf |
| Electrical | Light fixtures, conductors, misc | 0.50 | lb/gsf | 50 | 0.25 | lb/gsf | 25 | 0.12 | lb/gsf | 25 | 0.12 | lb/gsf |
| | | 117.80 | lb/gsf | | 23.50 | lb/gsf | | 76.30 | lb/gsf | | 10.00 | lb/gsf |

Potential Debris
117.80 lb/gsf

Potential Diversion
99.77 lb/gsf

* Asphalt Shingles may not have an outlet for recycling; in this case they become debris.

** Newer components of HVAC systems may be reused. GWB = gypsum wall board

bf/gsf = board foot per gross square foot; lb/gsf = pound per gross square foot; sf/gsf = square foot per gross square foot

| lb/sf | General Summary |
|-------|-----------------|
| 28.76 | Wood |
| 71.00 | Concrete |
| 0.31 | Metals |
| 1.00 | Enclosures |
| 2.39 | MEP* |

*Mechanical, Electrical, Plumbing

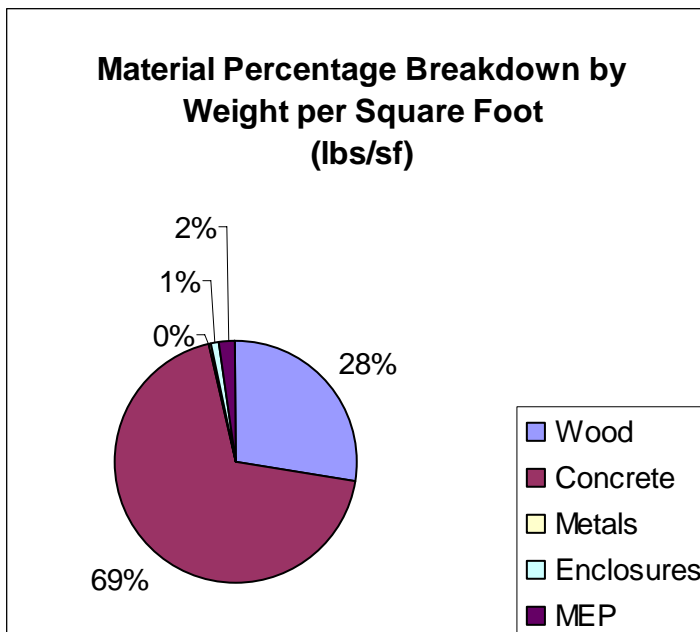


Table B2. Light-Framed, Detached House with Slab-on-Grade

(Quantities are based on per-square-foot per one individual housing unit)

| Building Component Categories | Description | Average Quantity per Gross SF of | Units | Potential Diversion | | | | | | | | | |
|--------------------------------|--|----------------------------------|--------|---------------------|----------|--------|---------|----------|--------|---------|----------|--------|--------|
| | | | | Salvage for Reuse | | | Recycle | | | Debris | | | |
| | | | | Percent | Quantity | Units | Percent | Quantity | Units | Percent | Quantity | Units | |
| Dim. Lumber | Framing lumber greater than 6 ft in length | 4.30 | bf/gsf | 75 | 3.23 | bf/gsf | 20 | 0.86 | bf/gsf | 5 | 0.20 | bf/gsf | |
| | | 10.30 | lb/gsf | | 7.74 | lb/gsf | | 2.06 | lb/gsf | | 0.52 | lb/gsf | |
| Scrap Lumber | Framing lumber less than 6 ft in length | 0.60 | bf/gsf | 0 | 0.00 | bf/gsf | 90 | 0.54 | bf/gsf | 10 | 0.10 | bf/gsf | |
| | | 1.40 | lb/gsf | | 0.00 | b/gsf | | 1.30 | lb/gsf | | 0.14 | lb/gsf | |
| Siding | Metal siding | 1.00 | lb/gsf | 75 | 0.76 | lb/gsf | 20 | 0.20 | lb/gsf | 5 | 0.10 | lb/gsf | |
| Sheathing | Plywood | 3.70 | bf/gsf | 75 | 2.78 | bf/gsf | 20 | 0.74 | bf/gsf | 5 | 0.20 | bf/gsf | |
| | | 8.90 | lb/gsf | | 6.66 | lb/gsf | | 0.00 | lb/gsf | | 0.44 | lb/gsf | |
| Plywood | 1/4 in. plywood sheathing | 5.30 | lb/gsf | 90 | 4.79 | lb/gsf | 5 | 0.27 | lb/gsf | | 0.00 | lb/gsf | |
| T&G Flooring | 1x T&G flooring | 0.20 | bf/gsf | 90 | 0.15 | bf/gsf | 5 | 0.01 | bf/gsf | 5 | 0.00 | bf/gsf | |
| | | 0.40 | lb/gsf | | 0.36 | lb/gsf | | 0.00 | lb/gsf | | 0.02 | lb/gsf | |
| Drywall | 1/2 in. GWB | 3.70 | sf/gsf | 0 | 0.00 | sf/gsf | 0 | 0.00 | sf/gsf | 100 | 3.70 | sf/gsf | |
| | | 7.80 | lb/gsf | | 0.00 | lb/gsf | | 0.00 | lb/gsf | | 7.81 | lb/gsf | |
| Asphalt Shingles & Felt Paper* | 235 lb Shingles | 2.50 | sf/gsf | 0 | 0.00 | sf/gsf | 99 | 2.48 | sf/gsf | 1 | 0.03 | sf/gsf | |
| | | 6.00 | lb/gsf | | 0.00 | lb/gsf | | 0.00 | lb/gsf | | 0.06 | lb/gsf | |
| Concrete | RC foundation slabs & piers | 92.40 | lb/gsf | 0 | 0.00 | lb/gsf | 99 | 91.48 | lb/gsf | 1 | 0.92 | lb/gsf | |
| Reinforcing Steel | Typical steel reinforcement | 0.40 | lb/gsf | 0 | 0.00 | lb/gsf | 99 | 0.40 | lb/gsf | 1 | 0.00 | lb/gsf | |
| Masonry | Brick chimney | 0.00 | lb/gsf | 50 | 0.00 | lb/gsf | 50 | 0.00 | lb/gsf | 0 | 0.00 | lb/gsf | |
| Plumbing | Fixtures, Piping, misc. | 1.00 | lb/gsf | 50 | 0.50 | lb/gsf | 50 | 0.50 | lb/gsf | 0 | 0.00 | lb/gsf | |
| HVAC** | Equipment, Ductwork, misc. | 0.90 | lb/gsf | 0 | 0.00 | lb/gsf | 90 | 0.81 | lb/gsf | 10 | 0.09 | lb/gsf | |
| Doors | Sizes Vary | 0.40 | lb/gsf | 85 | 0.34 | lb/gsf | 10 | 0.04 | lb/gsf | 5 | 0.02 | lb/gsf | |
| Windows | Sizes Vary | 0.60 | lb/gsf | 85 | 0.51 | lb/gsf | 10 | 0.06 | lb/gsf | 5 | 0.03 | lb/gsf | |
| Equipment | Typical kitchen equipment | 0.60 | lb/gsf | 85 | 0.51 | lb/gsf | 10 | 0.06 | lb/gsf | 5 | 0.03 | lb/gsf | |
| Electrical | Light fixtures, conductors, misc. | 0.50 | lb/gsf | 50 | 0.25 | lb/gsf | 25 | 0.12 | lb/gsf | 25 | 0.12 | lb/gsf | |
| | | 136.90 | lb/gsf | | | 21.7 | lb/gsf | | | 97.10 | lb/gsf | 10.10 | lb/gsf |

Potential Debris
136.90 lb/gsf

Potential Diversion
118.77 lb/gsf

* Asphalt Shingles may not have outlet for recycling, in this case they become debris.

** Newer components of HVAC systems may be reused. GWB = gypsum wall board

bf/gsf = board foot per gross square foot; lb/gsf = pound per gross square foot; sf/gsf = square foot per gross square foot

| lb/sf | General Summary |
|-------|-----------------|
| 26.36 | Wood |
| 92.40 | Concrete |
| 0.40 | Metals |
| 1.00 | Enclosures |
| 2.39 | MEP* |

*Mechanical, Electrical, Plumbing

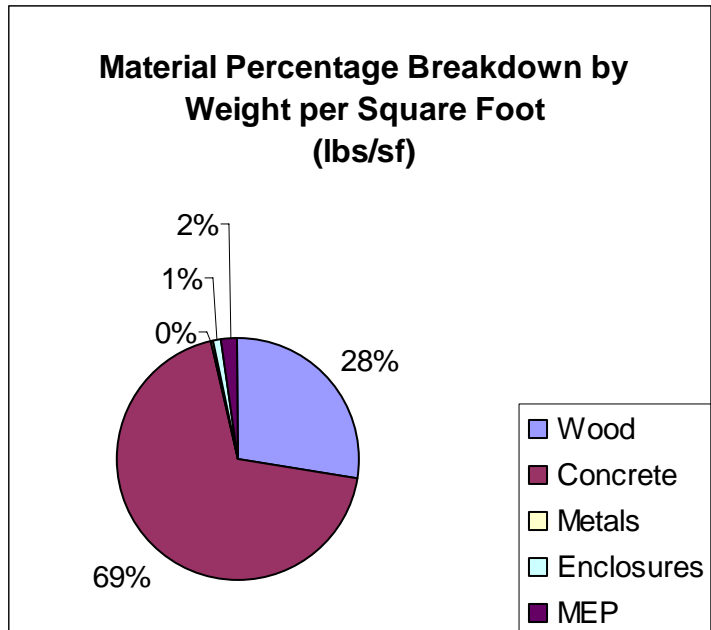


Table B3. Light-Framed, Housing Units, Two Stories, Slab-on-Grade

(Quantities are based on per-square-foot per one individual housing unit)

| Building Component Categories | Description | Average Quantity per Gross SF of Building | Units | Potential Diversion | | | | | | | | |
|--------------------------------|--|---|--------|---------------------|--------------|--------|---------|--------------|--------|---------|-------------|--------|
| | | | | Salvage for Reuse | | | Recycle | | | Debris | | |
| | | | | Percent | Quantity | Units | Percent | Quantity | Units | Percent | Quantity | Units |
| Dim. Lumber | Framing lumber greater than 6 ft in length | 7.40 | bf/gsf | 75 | 5.55 | bf/gsf | 20 | 1.48 | bf/gsf | 5 | 0.40 | bf/gsf |
| | | 17.80 | lb/gsf | | 13.32 | lb/gsf | | 3.55 | lb/gsf | | 0.89 | lb/gsf |
| Scrap Lumber | Less than 6 ft in length | 0.80 | bf/gsf | 0 | 0.00 | bf/gsf | 90 | 0.72 | bf/gsf | 10 | 0.10 | bf/gsf |
| | | 1.90 | lb/gsf | | 0.00 | lb/gsf | | 1.73 | lb/gsf | | 0.19 | lb/gsf |
| Siding | Metal siding | 0.80 | lb/gsf | 75 | 0.62 | lb/gsf | 20 | 0.17 | lb/gsf | 5 | 0.00 | lb/gsf |
| Sheathing | Plywood | 0.60 | bf/gsf | 75 | 0.47 | bf/gsf | 20 | 0.13 | bf/gsf | 5 | 0.00 | bf/gsf |
| | | 1.50 | lb/gsf | | 1.13 | lb/gsf | | 0.00 | lb/gsf | | 0.08 | lb/gsf |
| Plywood | 1/4 in. plywood sheathing | 2.70 | lb/gsf | 90 | 2.39 | lb/gsf | 5 | 0.13 | lb/gsf | | 0.00 | lb/gsf |
| T&G Flooring | 1x T&G flooring | 0.10 | bf/gsf | 90 | 0.13 | bf/gsf | 5 | 0.01 | bf/gsf | 5 | 0.00 | bf/gsf |
| | | 0.30 | lb/gsf | | 0.30 | lb/gsf | | 0.00 | lb/gsf | | 0.02 | lb/gsf |
| | | 0.90 | sf/gsf | 0 | 0.00 | sf/gsf | 0 | 0.00 | sf/gsf | 100 | 0.90 | sf/gsf |
| Drywall | 1/2 in. GWB | 1.80 | lb/gsf | | 0.00 | lb/gsf | | 0.00 | lb/gsf | | 1.83 | lb/gsf |
| Asphalt Shingles & Felt Paper* | 235 lb Shingles | 0.70 | sf/gsf | 0 | 0.00 | sf/gsf | 99 | 0.68 | sf/gsf | 1 | 0.01 | sf/gsf |
| | | 1.70 | lb/gsf | | 0.00 | lb/gsf | | 0.00 | lb/gsf | | 0.02 | lb/gsf |
| Concrete | RC foundation slabs & piers | 54.90 | lb/gsf | 0 | 0.00 | lb/gsf | 99 | 54.39 | lb/gsf | 1 | 0.55 | lb/gsf |
| Reinforcing Steel | Typical steel reinforcement | 0.50 | lb/gsf | 0 | 0.00 | lb/gsf | 99 | 0.52 | lb/gsf | 1 | 0.01 | lb/gsf |
| Masonry | Brick chimney | 0.80 | lb/gsf | 50 | 0.40 | lb/gsf | 50 | 0.40 | lb/gsf | 0 | 0.00 | lb/gsf |
| Plumbing | Fixtures, Piping, misc. | 1.00 | lb/gsf | 50 | 0.49 | lb/gsf | 50 | 0.49 | lb/gsf | 0 | 0.00 | lb/gsf |
| HVAC** | Equipment, Ductwork, misc. | 0.40 | lb/gsf | 0 | 0.00 | lb/gsf | 90 | 0.32 | lb/gsf | 10 | 0.04 | lb/gsf |
| Doors | Sizes Vary | 0.50 | lb/gsf | 85 | 0.38 | lb/gsf | 10 | 0.05 | lb/gsf | 5 | 0.02 | lb/gsf |
| Windows | Sizes Vary | 0.90 | lb/gsf | 85 | 0.73 | lb/gsf | 10 | 0.09 | lb/gsf | 5 | 0.04 | lb/gsf |
| Equipment | Typical kitchen equipment | 0.40 | lb/gsf | 85 | 0.34 | lb/gsf | 10 | 0.04 | lb/gsf | 5 | .02 | lb/gsf |
| Electrical | Light fixtures, conductors, misc. | 0.90 | lb/gsf | 50 | 0.45 | lb/gsf | 25 | 0.23 | lb/gsf | 25 | 0.23 | lb/gsf |
| | | 87.40 | lb/gsf | | 19.80 | lb/gsf | | 61.80 | lb/gsf | | 3.70 | lb/gsf |

Potential Debris
87.40 lb/gsf

Potential Diversion
81.59 lb/gsf

* Asphalt Shingles may not have outlet for recycling; in this case they become debris.

** Newer components of HVAC systems may be reused. GWB = gypsum wall board

bf/gsf = board foot per gross square foot; lb/gsf = pound per gross square foot; sf/gsf = square foot per gross square foot

| lb/sf | General Summary |
|-------|-----------------|
| 24.19 | Wood |
| 55.73 | Concrete |
| 0.53 | Metals |
| 1.31 | Enclosures |
| 2.63 | MEP* |

*Mechanical, Electrical, Plumbing

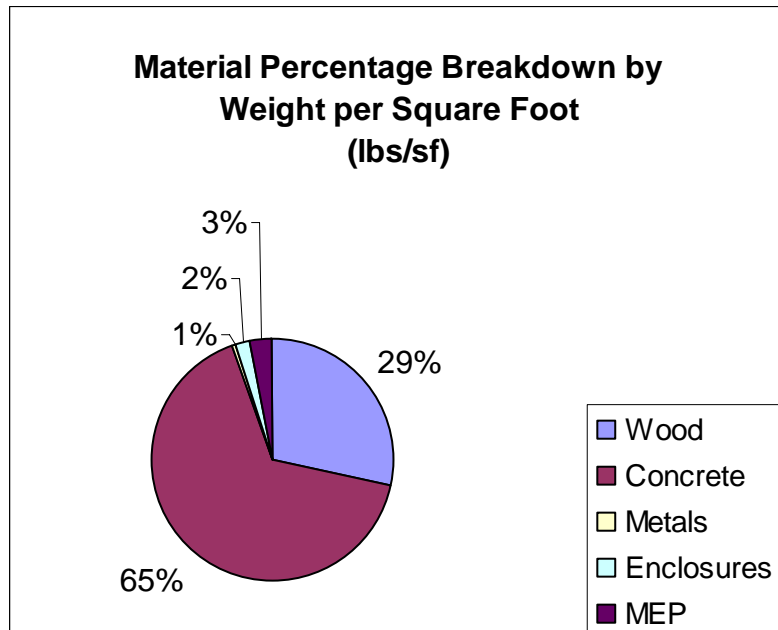


Table B4. Light-Framed, Housing Units, Two Stories, Basement

(Quantities are based on per-square-foot per one individual housing unit)

| Building Component Categories | Description | Average Quantity per Gross SF of Building | Units | Potential Diversion | | | | | | Debris | | |
|--------------------------------|--|---|--------|---------------------|--------------|--------|---------|--------------|--------|---------|-------------|--------|
| | | | | Salvage for Reuse | | | Recycle | | | Percent | Quantity | Units |
| | | | | Percent | Quantity | Units | Percent | Quantity | Units | | | |
| Dim. Lumber | Framing lumber greater than 6 ft in length | 7.40 | bf/gsf | 75 | 5.55 | bf/gsf | 20 | 1.48 | bf/gsf | 5 | 0.40 | bf/gsf |
| | | 17.80 | lb/gsf | | 13.32 | lb/gsf | | 3.55 | lb/gsf | | 0.89 | lb/gsf |
| Scrap Lumber | Framing lumber less than 6 ft in length | 0.80 | bf/gsf | 0 | 0.00 | bf/gsf | 90 | 0.72 | bf/gsf | 10 | 0.10 | bf/gsf |
| | | 1.90 | lb/gsf | | 0.00 | lb/gsf | | 1.73 | lb/gsf | | 0.19 | lb/gsf |
| Siding | Metal siding | 0.80 | lb/gsf | 75 | 0.62 | lb/gsf | 20 | 0.17 | lb/gsf | 5 | 0.00 | lb/gsf |
| Sheathing | Plywood | 0.60 | bf/gsf | 75 | 0.47 | bf/gsf | 20 | 0.13 | bf/gsf | 5 | 0.00 | bf/gsf |
| | | 1.50 | lb/gsf | | 1.13 | lb/gsf | | 0.00 | lb/gsf | | 0.08 | lb/gsf |
| Plywood | 1/4 in. plywood sheathing | 2.70 | lb/gsf | 90 | 2.39 | lb/gsf | 5 | 0.13 | lb/gsf | | 0.00 | lb/gsf |
| T&G Flooring | 1x T&G flooring | 0.10 | bf/gsf | 90 | 0.13 | bf/gsf | 5 | 0.01 | bf/gsf | 5 | 0.00 | bf/gsf |
| | | 0.30 | lb/gsf | | 0.30 | lb/gsf | | 0.00 | lb/gsf | | 0.02 | lb/gsf |
| Drywall | 1/2 in. GWB | 0.90 | sf/gsf | 0 | 0.00 | sf/gsf | 0 | 0.00 | sf/gsf | 100 | 0.90 | sf/gsf |
| | | 1.80 | lb/gsf | | 0.00 | lb/gsf | | 0.00 | lb/gsf | | 1.83 | lb/gsf |
| Asphalt Shingles & Felt Paper* | 235 lb Shingles | 0.70 | sf/gsf | 0 | 0.00 | sf/gsf | 99 | 0.68 | sf/gsf | 1 | 0.01 | sf/gsf |
| | | 1.70 | lb/gsf | | 0.00 | lb/gsf | | 0.00 | lb/gsf | | 0.02 | lb/gsf |
| Concrete | RC foundation slabs & piers | 54.90 | lb/gsf | 0 | 0.00 | lb/gsf | 99 | 54.39 | lb/gsf | 1 | 0.55 | lb/gsf |
| Reinforcing Steel | Typical steel reinforcement | 0.50 | lb/gsf | 0 | 0.00 | lb/gsf | 99 | 0.52 | lb/gsf | 1 | 0.01 | lb/gsf |
| Masonry | Brick chimney | 0.80 | lb/gsf | 50 | 0.40 | lb/gsf | 50 | 0.40 | lb/gsf | 0 | 0.00 | lb/gsf |
| Plumbing | Fixtures, Piping, misc. | 1.00 | lb/gsf | 50 | 0.49 | lb/gsf | 50 | 0.49 | lb/gsf | 0 | 0.00 | lb/gsf |
| HVAC** | Equipment, Ductwork, misc. | 0.40 | lb/gsf | 0 | 0.00 | lb/gsf | 90 | 0.32 | lb/gsf | 10 | 0.04 | lb/gsf |
| Doors | Sizes Vary | 0.50 | lb/gsf | 85 | 0.38 | lb/gsf | 10 | 0.05 | lb/gsf | 5 | 0.02 | lb/gsf |
| Windows | Sizes Vary | 0.90 | lb/gsf | 85 | 0.73 | lb/gsf | 10 | 0.09 | lb/gsf | 5 | 0.04 | lb/gsf |
| Equipment | Typical kitchen equipment | 0.40 | lb/gsf | 85 | 0.34 | lb/gsf | 10 | 0.31 | 0.04 | 5 | 0.02 | lb/gsf |
| Electrical | Light fixtures, conductors, misc. | 0.90 | lb/gsf | 50 | 0.45 | lb/gsf | 25 | 0.23 | lb/gsf | 25 | 0.23 | lb/gsf |
| | | 87.40 | lb/gsf | | 19.80 | lb/gsf | | 61.80 | lb/gsf | | 3.70 | lb/gsf |

Potential Debris
87.40 lb/gsf

Potential Diversion
81.59 lb/gsf

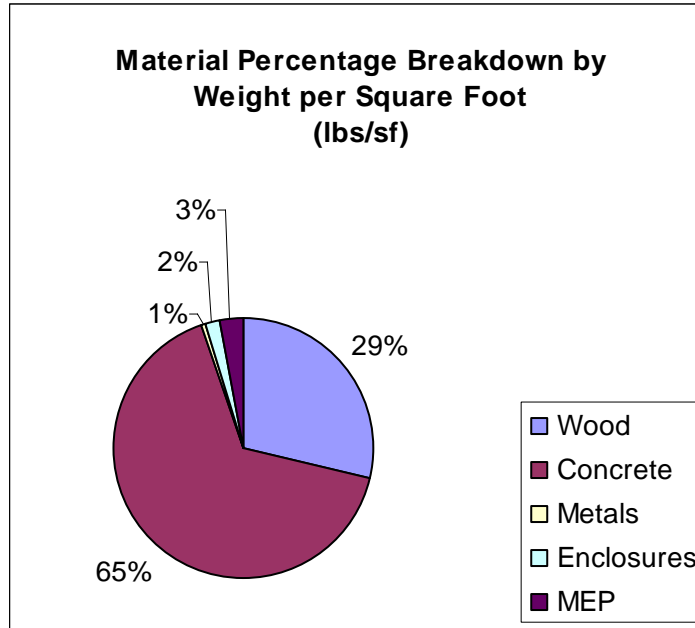
* Asphalt Shingles may not have outlet for recycling; in this case they become debris.

** Newer components of HVAC systems may be reused. GWB = gypsum wall board

bf/gsf = board foot per gross square foot; lb/gsf = pound per gross square foot; sf/gsf = square foot per gross square foot

| lb/sf | General Summary |
|-------|-----------------|
| 24.19 | Wood |
| 55.73 | Concrete |
| 0.53 | Metals |
| 1.31 | Enclosures |
| 2.63 | MEP* |

*Mechanical, Electrical, Plumbing



Appendix C

Developing a Waste Management Strategy

C&D Waste Management Planning

The RCI Partners are ultimately responsible for their own C&D waste management and disposal. Beyond encouraging them to reduce and divert C&D waste, the installation can support the RCI Partner in a number of ways. As a minimum, the installation should assemble and provide information on installation and local waste reduction programs, local waste management agencies and their resources, or salvaged and recycled materials services and outlets. Installation personnel can collaborate with the RCI Partner in identifying salvage and recycling resources, assessing market values for recyclable materials, and identifying opportunities for waste diversion. Installation personnel may also contact parties who may perform deconstruction, salvage, and recycling services, or materials outlets, assess interest, obtain general price information, and refer interested parties to the RCI Partner for further discussions. Note that the installation ought not to develop a waste management plan or make arrangements on behalf of the RCI Partner. However, developing options and promoting feasible alternatives with the appropriate supporting information is entirely appropriate. If the installation can illustrate to the RCI Partner the benefits of waste diversion to both parties, the likelihood is greater that the RCI Partner will participate.

Reuse/Recycle Options

Many materials have a variety of reuse or recycle options, and it is important to understand the potential value in these materials. Some possible material diversion potentials are:

- Concrete and concrete masonry can be crushed (Figure C1) and used as base, fill, erosion control, or other applications of aggregate. Brick can be crushed with concrete rubble, or can be crushed separately as a landscaping material. When this is the case, it is usually more efficient to bring a crusher on site and avoid shipping the materials.



Figure C1. Concrete recycling.

- Asphalt has a variety of potential as a recycled material, ranging from: hot mix asphalt, cold patch, dust control on rural roads, temporary roads or driveways, aggregate road base, new shingles, or even fuel.
- Scrap metals (Figure C2) currently have a high recycling value. Covering a large range of materials, this tends to be a large market and a local company should be easy to find. A company should be found that will pay for the metal by weight. Some companies may charge for pickup or may charge to have a container left on site and picked up when full. Over the past 50 years, approximately 50 percent of the steel produced in America has been recycled and used in every application from food cans to new cars and structural steel.
- Lumber can be salvaged and reused in other buildings. With careful deconstruction techniques, 75 percent or more of the lumber in a residential building can be salvaged for reuse (Figure C3). If deconstruction is not an option, the wood should be separated from the rubble for recycling. Lumber, along with scrap wood can be recycled as simply as chipping to make mulch or can be processed as fuel for waste-to-energy plants.



Figure C2. Scrap metal rebar separated for recycling.



Figure C3. A worker loads salvaged lumber for recycling.

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- In some areas, gypsum wall board (GWB) can be returned to the GWB factory and recycled into new GWB products. Recycled gypsum can also be applied as a agricultural soil amendment product.
- Doors, windows, kitchen cabinets and appliances, hardwood flooring, plumbing fixtures and equipment, electrical fixtures, and other detachable items can be removed intact and taken by a local salvage group such as a Habitat for Humanity ReStore. HfH ReStores may be able to provide "soft-stripping" or "cherry-picking" services themselves.

C&D Waste Management Plan Checklist

A C&D waste management plan typically includes the following information:

- List of building materials and components in place. These can be described simply as wood, metals, plastics, concrete and rubble, shingles, and other major material categories. Further definition can also be useful, especially if various services and outlets may be involved with salvage or recycling efforts.
- Estimated total quantity of each material in place for the project.
- The quantity of each material that can be salvaged for reuse, recycled, or disposed of as debris.
- Methods that can be applied for reducing waste or salvaging/recycling each material.
- Destinations for each material to be recycled, salvaged for reuse, or disposed of as debris. Include any on-post agencies that can use recycled materials.
- How each material will be handled, processed, and transported to be recycled, salvaged for reuse, or disposed of as debris.
- Method for calculating the estimated diversion.

Costs

The cost of landfilling all materials is compared with the cost and savings of salvage and recycling. These costs can vary greatly depending on the tipping fees at area landfills, the

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availability of diversion outlets, and values for recyclable materials. Once all costs and savings are known, the net savings or cost can be determined. A waste management analysis or plan should, therefore, include the following information.

- Estimated total cost for hauling and landfilling all materials.
- Cost or revenue associated with salvaging and recycling each identified material.
- Cost for hauling and landfilling remaining debris materials.
- Cost avoidance by using recycled materials in the project in lieu of purchasing new materials.

Once overall net costs can be estimated, the RCI Partner can identify the most economical and efficient waste diversion options available to them, and conclude arrangements with the appropriate salvage, recycling, and waste hauling services.

Waste Diversion

The following is a summary of methods commonly used on construction sites, and which will contribute to C&D waste management planning:

- Reduce packaging and packing. The RCI Partner can instruct (or require) their contractors and suppliers to reduce packaging and packing in several ways. Purchase materials in bulk where possible. Avoid individual packaging for volume purchases. Utilize returnable containers and packing materials. Reuse nonreturnable containers on the jobsite. Collect and distribute these resources to subcontractors and tradespersons. Give away nonreturnable containers where possible. Contact local and community organizations (schools, youth groups, community service groups, HfH, other similar).
- Maximize the use of materials. Use scrap in lieu of cutting full new materials. The RCI Partner can encourage (or require) their contractors and trades to set up cutting and fabricating locations, and sort scrap by size for easy access by tradespersons. Alternatively, tradespersons can collect scrap and deposit it in dedicated scrap centers. Collect paints and similar liquid materials from almost-empty containers.

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- For materials that are heated, mixed, exposed to environmental conditions, or otherwise prepared and have a limited time for application or installation, limit quantities to those that can reasonably be installed within their expiration times. Ensure volatile materials and materials that degrade when exposed to heat, cold, or moisture are protected from spoilage.
- When components, products, or materials are damaged and unsuitable for the work, recycle them, or disassemble them into their constituent materials for recycling.
- Return, sell, or donate unused materials. The contractor and/or subcontractors should establish a return or buy-back arrangement with suppliers. Alternatively, used but serviceable, or unused materials and products can be sold or donated to building materials reuse or architectural salvage retail outlets. A donation to a nonprofit outlet, such as a HfH ReStore, is usually tax-deductible. Proceeds from ReStore sales support HfH homebuilding programs. Proceeds from other similar nonprofit organizations also support community programs.
- Recycle commingled waste off-site. The RCI Partner, or their subcontractor, may contract with a C&D recycling firm who accepts commingled debris. The debris is collected at the jobsite in common receptacles and hauled off-site to the recycling facility. At the recycling site, concrete and masonry rubble are separated out of the debris for crushing into aggregate products. The remaining debris is typically crushed or shredded, then conveyed along a pick line (Figure C4) for sorting and separating. Recycling commingled debris and waste off-site requires virtually no adjustment in practice on the contractor's part. This method typically achieves a very high diversion rate. However, clean wood is frequently sold for boiler fuel, and some agencies (including EPA) do not include waste-to-energy as debris diversion.



Figure C4. C&D recycling pick line.

- Segregate waste materials on-site. The RCI Partner, or their contractor, may contract with individual recycling firms who deal in specific materials, or selected materials, and a general waste hauler. The construction process lends itself to on-site segregation. As the recyclable materials are segregated, the recycling firms will generally offer a higher price for the material (if the contractor hauls it), or a lower hauling rate if the recycler performs this task. Alternatively, the contractor can subcontract with a waste hauler who provides receptacles for recyclable materials and debris, and hauls all materials as a single service. Hauling costs for segregated materials are frequently much less than for commingled debris.
- The waste diversion potential with demolition is considerable. Develop the project schedule with consideration of tasks involved in materials salvage, reuse, or recycling. Prior to demolition, salvage as much useable components and materials as the schedule will allow.

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If none of the alternative salvage, reuse, or recycling options are possible, mixed demolition debris can be hauled to a C&D debris recycling facility, as described above.

Design for Waste Reduction

The RCI Partner's design team can also contribute to waste reduction in several ways. These include:

- Balance cut and fill in site design to reduce borrow and spoil requirements.
- Utilize natural topography for storm water management to reduce artificial drainage construction requirements.
- Use indigenous vegetation on-site to reduce land clearing debris.
- Design buildings to optimize systems' and components' use. Avoid extraneous materials that do not contribute to function. Publications on Optimum Value Engineering (OVE) and efficient framing techniques provide details.
- Be efficient in area and volume. The more materials that are required by the design, the more waste is generated on the jobsite.
- Observe standard material and product dimensions. Locate features "on module" to reduce cutting and special fitting, which creates scrap.
- Select construction systems that do not require construction aids, or other materials that are not part of the finished product, and will not be disposed of as debris during the project. Reuse construction aids to the maximum extent possible. Use scrap material in lieu of purchasing or using new materials.
- Select materials that do not rely on adhesives, which require containers and create residue and packaging waste.
- Select materials with integral finishes. Reduce requirements for applied finishes, laminates, coatings, adhesives, and the associated scrap, packaging, and waste.

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- Prevent damage and spoilage: Avoid materials sensitive to damage, contamination, environmental exposure, or spoilage on-site, which increase the potential for jobsite waste.

One option to consider is reusing materials on-post. Inform the RCI Partner of installation requirements for aggregate products, wood mulch or compost, or other common C&D materials. Use the on-post recycling infrastructure to the extent possible for cardboard packaging, office paper, beverage containers, and other recyclable waste materials.

Recent Army deconstruction experience has revealed a requirement for construction materials by troop units. The most common request has been for lumber, doors, windows, and concrete components such as piers. These materials were used on ranges and Military Operations on Urbanized Terrain (MOUT) facilities for exercises. Ordinarily, the units would have to purchase new construction materials, only to demolish them in training. DPW personnel should survey the installation and identify uses for C&D materials to use in lieu of purchasing new materials. One request of salvaged materials at Fort Lewis, WA, involved construction of decks and landscape features by soldiers suffering combat wounds and undergoing rehabilitation. DPW should exploit these types of opportunities to the greatest extent possible to reduce the C&D waste stream, as well as provide a resource to other activities on-post.

APPENDIX D

C&D WASTE REDUCTION AND DIVERSION RESOURCES

One of the greatest challenges to diverting C&D debris in some regions is to identify construction-related services to perform salvage or deconstruction activities, and outlets for the salvaged and recycled materials. While the installation's environmental personnel may be well-versed in municipal solid waste recycling resources, salvaging and recycling building materials may be an area with which they are not familiar. Furthermore, the RCI Partner's primary business does not deal with waste management, but in development and construction. The salvage and recycling industry and infrastructure in the region may not be well known.

The following compendium provides resources that could contribute to C&D waste diversion on RCI sites. States in which RCI programs are currently active, or are planned, are included. These resources include public agencies and authorities with recycling and waste reduction missions (federal, state, and local), industry associations, materials exchanges, professional associations, and other contacts that can provide assistance in C&D waste diversion. This Appendix does not provide a directory of specific service providers and businesses. Rather, it provides references whereby specific services and businesses can be identified for each RCI site.

NATIONAL RECYCLING RESOURCES

<http://www.habitat.org/env/restores.aspx>

<http://www.redo.org/FindReuse.html>

<http://www.ubma.org/directory/>

<http://www.thebluebook.com/cl/all3455.htm>

<http://www.recyclingmarkets.net/markets/index.html?us=>

<http://www.shinglerecycling.org/links.asp>

<http://www.epa.gov/epaoswer/non-hw/recycle/jtr/comm/exchstat.htm>

<http://www.epa.gov/jtr/state/index.htm>

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<http://www.buildingreuse.org/>

<http://www.astswmo.org/State%20Links.htm>

<http://www.nrc-recycle.org/default.htm>

<http://www.cdrecycling.org/>

<http://www.deconstructioninstitute.com/>

REGIONAL RECYCLING RESOURCES

<http://permanent.access.gpo.gov/websites/epagov/www.epa.gov/epaoswer/non-hw/recycle/jtr/state/macro.htm>

<http://macredo.org/>

<http://www.nerc.org/recycling/infosrcs.html>

<http://wrrc.p2pays.org/>

STATE RECYCLING RESOURCES

Alabama

<http://www.regionalrecycling.com/geoframe.html>

<http://www.epa.gov/jtr/state/al.htm>

Arizona

<http://www.thebluebook.com/wsnsa.dll/WService=wsbrk1/viewpg.htm?docsstart=0&ncls=3455&keyword=recycling&bkid=21&cache=%5E>

<http://www.epa.gov/jtr/state/az.htm>

Arkansas

http://www.adeq.state.ar.us/solwaste/branch_market_dev/mkt_dev.asp

<http://www.epa.gov/jtr/state/ar.htm>

California

<http://www.sfenvironment.com/directories/yards.htm>

<http://www.ciwmb.ca.gov/ConDemo/Recyclers/>

<http://www.oaklandpw.com/PageFactory.aspx?PageID=39>

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<http://www.thereusepeople.org/Deconstruction/>

<http://www.sjrecycles.org/business/excel/cddd-recovery-reuse.xls>

<http://www.arcatarecycling.org/default.asp>

Colorado

Colorado Materials Exchange - <http://www-ucsu.colorado.edu/comex/>

<http://www.ci.boulder.co.us/buildingservices/codes/greenpoints/constructionrecycling.pdf>

http://www.co.boulder.co.us/recycling/faq/faq_c&d.pdf

Georgia

<http://www.dca.state.ga.us/development/EnvironmentalManagement/programs/recycling/default.asp>

http://www.p2ad.org/Assets/pdf_files/salvage_sites_1.pdf

http://www.p2ad.org/Assets/pdf_files/gacd.pdf

<http://www.co.walker.ga.us/C&D%20Landfill.htm>

<http://www.regionalrecycling.com/geoframe.html>

Hawaii

<http://www.alohashares.org/>

Kansas

<http://www.thebluebook.com/wsnsa.dll/WService=wsbrk1/viewpg.htm?docsstart=0&ncls=3455&keyword=recycling&bkid=28&cache=%5E>

Kentucky

<http://www.kppc.org/about/P2/links/old%20links/generallist.cfm>

<http://www.epa.gov/jtr/state/ky.htm>

Louisiana

<http://www.epa.gov/jtr/state/la.htm>

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<http://www.thebluebook.com/wsnsa.dll/WService=wsbrk1/viewpg.htm?docsstart=0&ncls=3455&keyword=recycling&bkid=32&cache=%5E>

Maryland

<http://www.mdrecycles.org/recyclingDirectory.asp?sec=asphaltShingles>

<http://www.thebluebook.com/wsnsa.dll/WService=wsbrk1/viewpg.htm?docsstart=0&ncls=3455&keyword=&bkid=2&cache=3455>

<http://www.loadingdock.org/>

Missouri

<http://www.mora.org/>

<http://www.thebluebook.com/wsnsa.dll/WService=wsbrk1/viewpg.htm?docsstart=0&ncls=3455&keyword=&bkid=25&cache=3455>

<http://www.epa.gov/jtr/state/mo.htm>

New York

<http://www.nerc.org/recycling/infosrcs.html>

http://www.erie.gov/environment/compliance/recycle_oocwood.asp

<http://www.thebluebook.com/wsnsa.dll/WService=wsbrk1/viewpg.htm?docsstart=0&ncls=3455&keyword=&bkid=1&cache=3455>

North Carolina

<http://www.p2pays.org/DMRM/start.aspx>

<http://www.thebluebook.com/wsnsa.dll/WService=wsbrk1/viewpg.htm?docsstart=0&ncls=3455&keyword=&bkid=29&cache=3455>

<http://www.fac.unc.edu/OWRRGuidelines/?Topic=CDResourcesLinks>

Pennsylvania

<http://www.nerc.org/recycling/infosrcs.html>

http://www.dep.state.pa.us/wm_apps/RecyclingMarkets/default.asp

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South Carolina

<http://www.p2pays.org/DMRM/start.aspx>

<http://www.scommer.com/SearchRecycling.aspx>

Texas

<http://www.recyclecddebris.com/rCDd/Handbook/Chapter10.aspx>

<http://www.recycletx.com/affiliatedcouncils/goldencrescent.htm>

<http://www.thebluebook.com/wsnsa.dll/WService=wsbrk1/viewpg.htm?docsstart=0&ncls=3455&keyword=&bkid=18&cache=3455>

Washington

<http://www.resourceventure.org/rv/issues/waste/get-started/index.php>

<http://www.metrokc.gov/dnrp/swd/exchange/building.asp>

<http://www.metrokc.gov/dnrp/swd/construction-recycling/index.asp>

<http://www.metrokc.gov/dnrp/swd/construction-recycling/documents/ConGuide.pdf>

http://www.metrokc.gov/dnrp/swd/construction-recycling/documents/economics_worksheet.xls

<http://www.co.pierce.wa.us/pc/services/home/environ/waste/recycle/recyclingdirectory/D%20-%20F>

Virginia

<http://www.epa.gov/jtr/state/va.htm>

<http://www.thebluebook.com/wsnsa.dll/WService=wsbrk1/viewpg.htm?docsstart=0&ncls=3455&bkid=20&cache=3455>

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