

SITE RECYCLING PLAN

GOAL

Minimize the amount of construction-related waste destined for landfill and promote environmental stewardship through good housekeeping practices at the work site.

CREDIT REQUIREMENTS

Establish, implement, and maintain a formal Site Recycling Plan as part of the Construction and Demolition Waste Management Plan (CWMP) during construction.

The Site Recycling Plan must clearly describe the plan for implementing, communicating, monitoring and maintaining appropriate recycling and diversion practices on site. The following topics must be specifically addressed.

- Expected types, quantities, processing or disposal facilities, locations of receptacles and proper handling for recyclable (or reusable) roadway materials generated from roadway construction processes such as (but not limited to):
 - Paving process waste (e.g. hot mix asphalt, concrete)
 - Milling waste, concrete slough and grindings, cobble
 - Excess steel rebar and other metal products or scraps
 - Excess plastic pipes and packaging
 - Excavated soil cuttings and boulders
 - Land clearing debris and topsoil
 - Wood and paper products (e.g. packaging materials, cardboard and pallets)
- Expected types, quantities, processing or disposal facilities, locations of receptacles and proper handling for recyclable (or reusable) materials generated from mobile office (e.g. job trailer, site office) activities and personal worker (household) waste such as (but not limited to):
 - Paper, copier paper, paper products
 - Plastic
 - Aluminum and various household metals
 - Glass
 - Household trash or compostables
- Communication expectations for jobsite housekeeping practices for the general contractor (also intended for any subcontractors) regarding:
 - Litter control
 - Expected types of site- and worker-generated recyclables.
 - Collection practices for site- and worker-generated recyclables.
 - Locations of recycling receptacles.
 - Training requirements for all site employees and means of corrective action.

DOCUMENTATION

- Copy of the Site Recycling Plan.


CA-3
1 POINT

RELATED CREDITS

- ✓ PR-6 Waste Management Plan
- ✓ PR-10 Site Maintenance Plan
- ✓ EW-1 Environmental Management System
- ✓ MR-4 Recycled Materials
- ✓ CA-2 Environmental Training

SUSTAINABILITY COMPONENTS

- ✓ Ecology
- ✓ Expectations
- ✓ Exposure

BENEFITS

- ✓ Reduces Air Emissions
- ✓ Reduces Solid Waste
- ✓ Reduces Manmade Footprint
- ✓ Reduces Lifecycle Costs
- ✓ Improves Accountability
- ✓ Increases Awareness

APPROACHES & STRATEGIES

- Include the Site Recycling Plan in agency contract documents, bid packages, and/or specifications.
- Set waste reduction goals and explicitly state them in the Site Recycling Plan.
- Locate receptacles in easily accessible or highly frequented locations on the jobsite. Receptacles should not be placed in areas where they may cause harm to workers or the local environment. See PR-7 Pollution Prevention Plan for more information.
- Clearly label receptacles and recycling locations. Large color photos of what is recyclable and what is not are often very helpful, especially, for multi-lingual work environments.
- Provide waste receptacles that are smaller than the recycling receptacles, slightly more difficult to open, or slightly more difficult to access. This provides a visual or behavioral cue indicating that the trash is supposed to be limited and there are ample recycling alternatives.
- Include instructions or warnings on the waste bin such as: “Are You Sure This Is Not Recyclable?”
- Many recycling facilities can accept co-mingled recyclables, which means that less sorting and fewer receptacles are required. However, quantities of these co-mingled materials are often harder to track and require detailed receipts from the waste transport agency to assess the composition of co-mingled streams.
- Designate a particular person or a few people to be the site monitor for helping workers recycle properly.
- Review local environmental maintenance plans used for litter control and roadway cleanup activities. These plans may be helpful references when developing the Site Recycling Plan, or at minimum, reduce potential for conflict between existing policy and practice. See also PR-10 Site Maintenance Plan.
- Hire a contractor with an Environmental Management System (EMS) in place. (See Credit EW-1 Environmental Management System). These employers already have internal office procedures established to reduce office-related pollution and may be familiar with local agency recovery efforts and recycling or salvage facilities.
- Develop and deliver training to workers to educate them on waste recovery efforts being implemented onsite and compliance with the general CWMP and the Site Recycling Plan. This step will be critical to all projects. See Credit CA-2 Environmental Training for more approaches and strategies for education programs.
- Create an incentive or recognition plan for workers to engage actively in recycling efforts of personal trash that rewards positive and successful behavior.
- Hire an experienced waste transport company to manage site waste and monitor waste streams for unacceptable materials.
- Identify local facilities that accept recyclables or salvaged materials. This is important in designating type of waste to separate, and in making arrangements for drop-off or delivery of materials.
- Identify existing recycling collection facilities that may be decentralized (i.e. recycle bins along a city street). Many urbanized areas will have access or provisions for local recycling programs and may have resources available for use.
- The 2007 Contractor’s Guide by the King County Solid Waste Division and Seattle Public Utilities provides many helpful waste management and reduction strategies for the entire project. A sample waste management plan adapted from this guide is provided in the examples below.


Example: Sample Specification Language for Site Recycling Plan

- The King County Solid Waste Division (King County, 2009) provides some helpful tools for writing clear and manageable recycling and diversion expectations into contract documents at <http://www.greentools.us>. A sample of “Section 01505 (or 1524) – Construction Waste Management” is provided at the link below in Construction Specifications Institute (CSI) MasterFormat (King County, 2008): http://your.kingcounty.gov/solidwaste/greenbuilding/documents/Sect01505_const_waste-mgmt.pdf
- Communicating the plan expectations with subcontractors is equally important. Following is a sample clause for subcontractor agreements:

“The subcontractor will make a good-faith effort to reduce the amount of waste generated on the jobsite and recycle material as per the contractor’s waste management plan. The subcontractor will follow the designated handling procedures for each type of waste generated on site and provide documentation to verify material reuse, recycling and disposal as indicated in the waste management plan.” (King County, 2008)

Example: Sample Construction Waste Management Plan with Materials Recovery

The following example content has been adapted from the 2007 Seattle/King County Contractor’s Guide, which is available here: <http://your.kingcounty.gov/solidwaste/greenbuilding/documents/ConGuide.pdf>. Projects teams should consider customizing the Site Recycling Plan information based on project goals and agency or client expectations.



SITE RECYCLING PLAN

General Contractor:
Project Name:
Site Recycling Coordinator:
Phone:
Debris Collection Agency:

Site Recycling/Diversion Goals:

Steps to inform contractors/subcontractors of Site Recycling Plan policies.

- 1.
- 2.
- 3.
- 4.
- 5.

C&D Materials Expected to be Generated and Proposed Diversion Method

The following charts identify materials expected to be generated by this project and the planned method for diverting these materials from disposal as a waste.

DECONSTRUCTION & DEMOLITION PHASE			
<i>Material</i>	<i>Quantity (units)</i>	<i>Diversion Method & Location</i>	<i>Handling Procedure</i>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

CONSTRUCTION PHASE			
<i>Material</i>	<i>Quantity (units)</i>	<i>Diversion Method & Location</i>	<i>Handling Procedure</i>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
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_____	_____	_____	_____

Figure CA-3.1: Sample site recycling plan format.

POTENTIAL ISSUES

1. A central location for collecting recyclables on a roadway project may not be feasible for jobsites that consistently change starting locations on a daily basis (i.e. several miles down the roadway away from the collection area). This may result in unnecessary vehicle or worker trips to and from a particular location just to deposit something in a correct recycling receptacle. The authors are unaware of any practices that have been used on roadway construction projects that could solve or avoid this problem.
2. There is a trade-off between transport costs (including environmental costs from emissions) and the overall utility or value of the recycled or salvaged materials. Some locations, especially many rural areas, may have difficulty finding recovery facilities that are located near enough to the project to be financially or environmentally cost-effective.
3. Technology is quickly developing for recycling of materials into reconstituted building materials (See credit MR-4). However, new technologies may not be available locally or in rural areas.
4. Careless behavior or lack of stewardship may be an issue that can result in recyclables being disposed of in waste-only receptacles, or vice versa, especially if objectives of a Site Recycling Plan are not meaningful or communicated well to workers. This behavior can contaminate the recyclables stream and make an entire receptacle unsuitable for reprocessing or salvage, or accidentally send recyclables to a landfill.
5. Proper handling of recyclable materials is a key safety issue for new and unfamiliar recycling activities. Communication and training is critical to minimize risk and preserve safety.
6. Safety and security considerations should be taken into account relative to on-site storage of recoverable materials of high value. Opportunities for theft may be increased, especially for some types of metals that are commonly used in infrastructure or electrical utilities like copper wire.
7. Storage areas must comply with relevant regulations and the pollution prevention plan (see Project Requirement PR-7).
8. At this time, points are not available for achieving waste reduction based on percentage of total waste. This is due to lack of data regarding waste management for roadway construction activities.

RESEARCH

This section describes known challenges about implementing a recycling and recovery plan at roadway construction sites and explores the potential environmental benefits of such plans. For detailed background information on what is known about construction and demolition (C&D) waste management for roadways, the reader is referred to Project Requirement PR-6 Waste Management Plan. Similarly, for detailed information on planning for bulk roadway materials recycling, recovery or reuse (the first requirement for the Site Recovery Plan), the reader is directed toward the Materials & Resources Credits MR-2 Pavement Reuse, MR-3 Earthwork Balance, and MR-4 Recycled Materials. These credits contain many approaches and strategies that may be synergistic when pursuing this credit.

This section addresses two key points which are not addressed in the requirements or credits noted above: what is known about the state of recycling housekeeping practices and municipal solid waste (MSW, also known as household or personal waste) generation on construction sites and the benefits and costs of applicable construction materials recovery activities. Helpful resources are also listed at the end for more information.

State of the Road Industry Recycling Practice

While several agencies and authors promote recycling material waste products used in roadway construction, information on the recyclable material wastes generated by roadway construction and demolition projects is hard to locate. The following list identifies areas of construction activities for which there is currently little or no relevant data:

- Waste management plans for transportation contractors
- Sorting, segregation and processing activities for roadway construction waste, and where these activities occur (i.e. on-site, off-site)
- Behaviors and stewardship practices of road construction employees

- Generation rates and quantities of personal trash
- Generation rates and quantities of office-related trash for construction site offices
- Costs associated with C&D and MSW management from construction worksites

Existing regulatory requirements focus mainly on stormwater, sediment and dust control and other standard pollution prevention activities, such as the National Pollution Discharge and Elimination System (see also Project requirement PR-7 Pollution Prevention Plan). Some agencies may also have Environmental Management Systems (EMS) in place (see Credit EW-1 Environmental Management System) which often institute personal and office waste management policies, but no information is available relative to whether these EMS plans are implemented and followed at the construction site.

The lack of information is likely partly because recycling activities represent a materials feedback loop at many levels of the roadway system, from design and construction to start and end of the supply chain. Waste management and recovery of resources fit near the end of the pollution prevention scheme, but these activities themselves can inject materials into various lifecycle phases of the overall project (EPA, 2009b). This makes environmental costs and benefits of recycling difficult to quantify, characterize and compare between different projects. Some environmental costs of materials and products due to extraction and initial production are effectively extended into a second service life through downcycling recovery activities (where some original value is lost), general recycling or upcycling (value is gained) practices. (McDonough & Braungart, 2002) It also means long-range and upstream planning and reduction strategies can often provide more evident reduction benefits later in the lifecycle (EPA, 2009b).

Rajendran and Gambetese (2007) estimated waste rates for C&D material types based on literature review and quantitative modeling. Their estimates, however, do not include MSW materials generated from personal or office activities or behaviors of site staff (their estimated rates are itemized in Table PR-6.1). Solid waste recovery for construction and demolition debris is addressed in PR-6 and MR-4.

Cost Effectiveness of Construction Recycling Programs

A few authors (Seydel et al., 2002; Kourmpanis et al., 2008; Schultmann & Sunke, 2007) have attempted to quantify costs and perceived benefits associated with construction waste management practices. Those that have done so successfully have only followed construction of buildings and building site infrastructure components. Because building sites are relatively compact compared to the linear nature of roads, and because of the vast difference in the expected types of material quantities (e.g. hot mix asphalt and concrete materials), the relevance of these studies may be minor. However, the recycling activities and methods used for buildings projects vary widely. Many different waste management or waste recovery processes may also be applicable to roadway and bridge demolition and construction. Additionally, no quantitative cost models were based on U.S. data.

Schultmann and Sunke (2007) use a lifecycle energy analysis model to show that recovery of waste construction materials reduces lifecycle costs, mostly due to reduced energy use during extraction of materials. These savings appear to translate well to roadway materials based on the energy analysis for roadway construction completed by Rajendran and Gambetese (2007), which does use relevant U.S. data. Schultmann and Sunke (2007), as well as the Construction Industry Research and Information Association (CIRIA, 2004), also note that closed-loop design and planning for deconstruction activities, also known as complete selective demolition (Kourmpanis et al., 2008), instead of destruction activities presents a valuable route to potential cost savings for many material products. Kourmpanis et al. (2008) also suggest that a combination of conventional demolition and deconstruction activities (partial selective demolition) and complete selective demolition of buildings can lower material handling and transport costs and increased recovered value of materials. However, transport costs and machinery costs for on-site activities must be weighed because they are highly variable between projects, especially by location.

Seydel, Wilson and Skitmore's (2002) study (which tracked only three materials in one building project in Australia) demonstrated that recycling and sorting practices require heightened environmental awareness, more supervision of handling operations and more overall sorting that is perceived to be in addition to normal environmental controls. Their highest effort recovery scenario, including sorting and disposal, reduced transport and disposal

costs of the waste by 18% from traditional practices and 9.5% from minimally controlled waste. However, the bottom line cost was increased due to the more complicated waste plan and more time spent managing and monitoring contractor employee waste activities. The authors state that the overall potential for the waste recovery plan to be successfully cost-effective and environmentally beneficial was not realized due to contractor inexperience with such planning. Additionally, they suggest that added planning and environmental stewardship could increase cost-competitiveness among construction contractors.

Poon et al. (2001) state that source separation, which takes place at the construction site, is heavily dependent on an environmentally-educated work-force, including subcontractors, that has been trained in proper materials handling and sorting procedures. "For most of them, it is usually a long learning process to be familiar and feel comfortable with performing waste separation." (p. 169). Proper training has cost implications which are discussed further in Credit CA-2 Environmental Training. Crude separation, however, lowers the overall value of the recoverable material, because it often reduces the sorting efficiency downstream and requires specialized employees to complete the separation at an off-site location (Poon et al., 2001). Off-site waste sorting is typically the preferred option of most building contractors because it does not require additional labor force, supervised work on site, no additional facilities, or added training costs (Poon et al., 2001). Put simply: out of "site," out of mind. Because this management option avoids on-site stewardship practices entirely, this method is not recommended (Poon et al., 2001).

Notable Recycling Statistics for MSW

None of the studies noted above consider MSW streams originating from any type of construction project. What follows in this section are general statistics that may be useful in identifying and characterizing the MSW portion of the waste stream generated on roadway and bridge construction sites.

Generally, in the U.S. municipal solid waste generation has increased over the last five decades, but recycling and composting rates have also increased (EPA, 2009b; EPA, 2009c). The waste stream for MSW landfills has been well-studied and characterized by the EPA. Data below is from the EPA's *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008* and includes statistics for waste types that may be potential encountered at construction sites.

- Out of 250 million tons of MSW disposed, about 83 million tons were recycled or composted in 2008. Of the total waste generated, the EPA estimates that approximately 35% to 45% was from commercial and institutional locations but the majority was residential origin.
- The U.S. waste stream was 31% paper and paper products (before recycling). See Figure CA-3.2.
- Approximately 54% of all MSW is discarded, while 33% is recovered for recycling, and the remainder is burned at landfills for energy production. Figure CA-3.3 shows the trends and distributions of MSW since 1960 to 2008.
- By weight, paper and paper products are the largest source of waste, with the highest overall recovered weight (55.5% recovered), though other materials have higher rates of recovery and less recovered mass. Specifically, 71% percent of office-related paper materials were recovered.
- Figure CA-3.4 shows a table of EPA 2008 statistics that includes all materials characterized in the waste streams monitored. Many could be commonly found in site offices and personal belongings, including food products. In fact, vegetative wastes and debris, containers, and packaging account for 44% of the total MSW stream sent to landfill and 15% of wood packaging was recovered (which was mostly pallets).
- As noted in PR-6 Waste Management Plan, some municipal solid waste landfills also accept construction and demolition debris (EPA, 2008a; EPA, 2008d). Materials such as hot mix asphalt and concrete make up a small percentage of the total MSW waste stream and are categorized in Figures CA-3.2 and CA-3.4 as "Other."

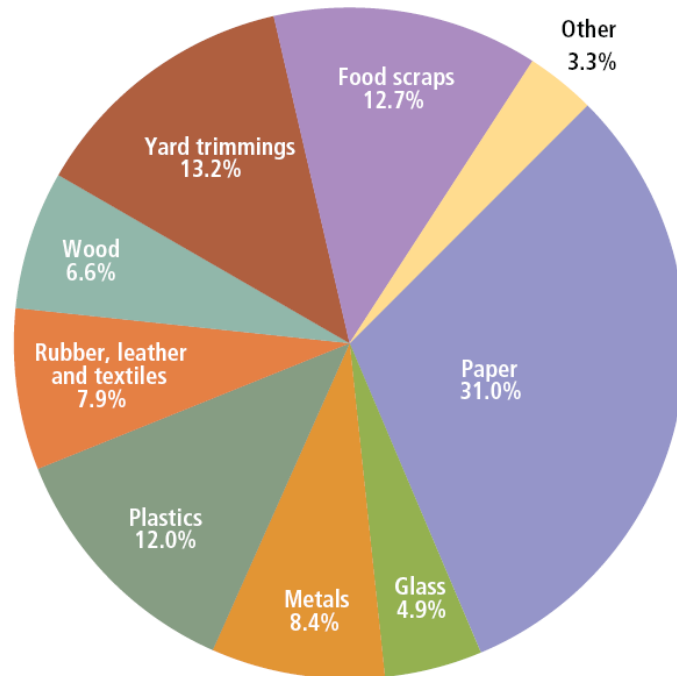


Figure CA-3.2: Composition of 2008 U.S. MSW waste stream, 250 million tons total (before recycling) (EPA, 2009c).

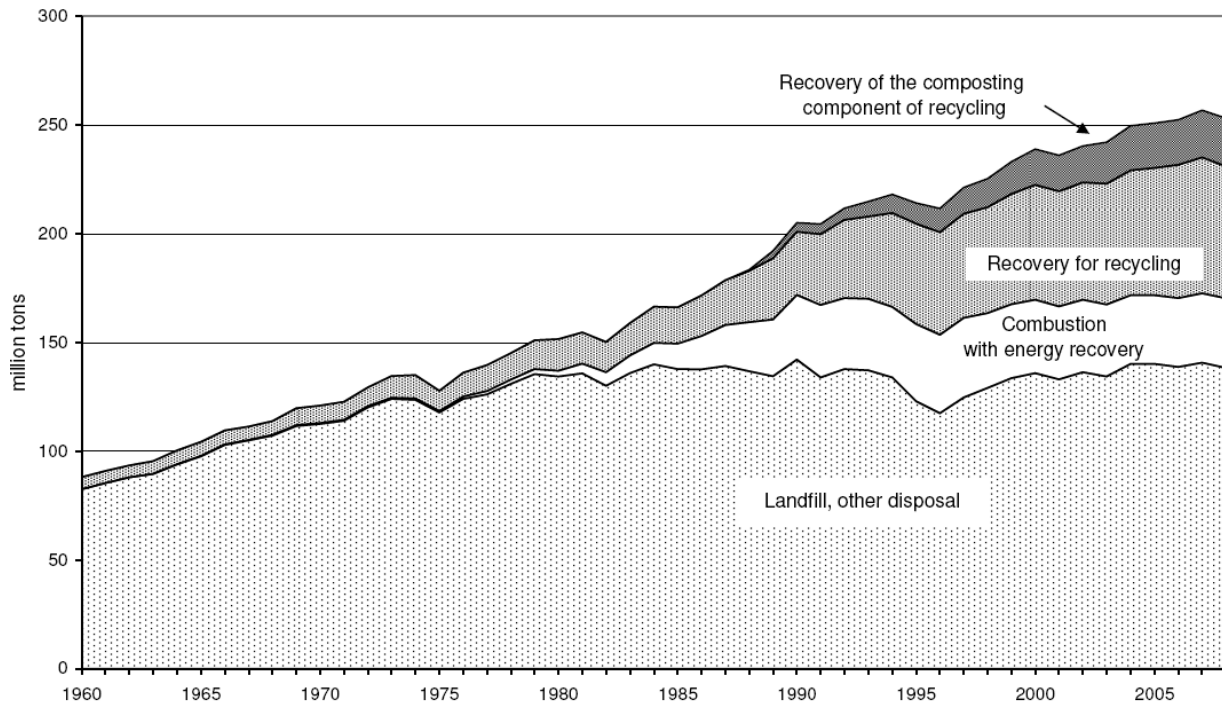


Figure CA-3.3: Disposal trends for MSW in the United States, 1960-2008 (EPA, 2009b).

Material	Weight Generated	Weight Recovered	Recovery as Percent of Generation
Paper and paperboard	77.42	42.94	55.5%
Glass	12.15	2.81	23.1%
Metals			
Steel	15.68	5.29	33.7%
Aluminum	3.41	0.72	21.1%
Other nonferrous metal†	1.76	1.21	68.8%
Total metals	20.85	7.22	34.6%
Plastics	30.05	2.12	7.1%
Rubber and leather	7.41	1.06	14.3%
Textiles	12.37	1.89	15.3%
Wood	16.39	1.58	9.6%
Other materials	4.50	1.15	25.6%
Total materials in products	181.14	60.77	33.5%
Other wastes			
Food, other‡	31.79	0.80	2.5%
Yard trimmings	32.90	21.30	64.7%
Miscellaneous inorganic wastes	3.78	Negligible	Negligible
Total other wastes	68.47	22.10	32.3%
Total municipal solid waste	249.61	82.87	33.2%

* Includes waste from residential, commercial, and institutional sources.

† Includes lead from lead-acid batteries.

‡ Includes recovery of other MSW organics for composting.

Details might not add to totals due to rounding.

Negligible = Less than 5,000 tons or 0.05 percent.

Figure CA-3.4: Generation and Recovery of Materials in MSW, 2008 (in millions of tons and percent of generation of each material) (EPA, 2009c).

Benefits of Recycling MSW

The EPA (2009c) states, “Recycling has environmental benefits at every stage in the life cycle of a consumer product—from the raw material with which it’s made to its final method of disposal. Aside from reducing [greenhouse gas] emissions, which contribute to global warming, recycling also reduces air and water pollution associated with making new products from raw materials.” In 2008, the 83 million tons of MSW that were recovered represent 182 million metric tons of carbon dioxide equivalent emissions saved annually. This is similar to removing the air emissions impact generated by 33 million passenger cars in one year (EPA, 2009c).

For MSW products, paper and wood products (organic materials) are the most common materials in the waste stream that end up in landfills. Diversion of these materials from landfills, as well as other organics such as topsoils and land clearing debris, offers reduced methane emissions due to fewer landfill emissions from decomposition of these organic materials. Methane is a greenhouse gas that contributes 21 times as much to global warming and climate change as carbon dioxide emissions. (Intergovernmental Panel on Climate Change, 2007) Also, paper waste

is easily and commonly recycled, reducing the overall need for forested materials. Therefore, the EPA (2008) states that by not decreasing trees, more carbon dioxide is able to be stored in forest resources, (EPA, 2008) and priceless habitat is preserved.

The EPA promotes solid waste management through prevention (source reduction), recycling and composting (2008c) as three clear ways to reduce climate change impacts due to greenhouse gas emissions and energy consumption. “Less energy is needed to extract, transport, and process raw materials and to manufacture products when people reuse things or when products are made with less material.” (EPA, 2009a). As shown in Schultmann and Sunke (2001), materials that can reduce fossil energy need means fewer associated emissions from the energy sector with the recycled material than for a new material that has been extracted and manufactured from virgin materials (EPA, 2008b). Waste prevention practices (also known as pollution prevention or P2: EPA, 2008e), which are supported by the EPA as the most effective way to reduce environmental impacts, can reduce lifecycle emissions and energy use than construction and demolition and MSW recycling (2008b).

Future of this Credit

Other familiar sustainability rating systems, such as LEED (USGBC, 2009) for buildings and the Sustainable Sites Initiative (2009), award credit for reduction of solid waste and diversion practices for construction and demolition materials. Currently, no minimum recycling standard or data on average waste generated per project is available for common types of roadway construction projects. At this time, Greenroads cannot justify awarding points to one project over another based on waste management practices or goal setting without a known benchmark for this best practice.

Additional Resources

- CIRIA, the Construction Industry Research and Information Association, provides some helpful hints for design and construction best practice for managing waste and resources (2004): http://www.ciria.org.uk/cwr/good_practice_pointers.htm
- The California Integrated Waste Management Board (CIWMB) offers a number of resources and tools, including videos of recycling best practices, (2009) available at: <http://www.ciwmb.ca.gov/Recycle/>
- The EPA’s P2 (Pollution Prevention) Resource Exchange provides contact information for regional agencies that can help connect project leaders to the right resources and opportunities for creating new waste management programs: <http://www.epa.gov/p2/pubs/p2rx.html>
- WasteCap Resource Solutions offers tips and tricks used by the building industry. Of particular interest and applicability to roadway projects are pre-written specifications (free) and additional links and resources. Training videos and receptacle magnetic signs are also available for a small fee. WasteCap also offers an online documentation program for waste management planning called *WasteCapDirect* (price not specified). More information is available here: <http://www.wastecapwi.org/resources/construction-demolition>

GLOSSARY

C&D	Construction and demolition
CIRIA	Construction Industry Research and Information Association
CIWMB	California Integrated Waste Management Board
Closed-loop design	An approach that considers waste management in project planning in order to avoid or eliminate processes that generate waste
Complete selective demolition	See “deconstruction”
CSI	Construction Specifications Institute
CWMP	Construction Waste Management Plan
Deconstruction	The whole or partial disassembly of a product to facilitate component reuse and materials recycling
Demolition	Conventional means of disassembly, or taking apart, a product or facility that is typically destructive and generally un-planned

<i>Diversion</i>	Avoiding placement in a landfill through recovery processes such as recycling or reuse
<i>Downcycling</i>	Recovering a portion of a used product or material in a manner that reduces the original value of the product or material after being reintroduced into the manufacturing or construction process (McDonough & Braungart, 2002)
<i>Partial selective demolition</i>	Engineered areas where waste is placed into the land (EPA, 2008)
<i>Receptacle</i>	A bin or container
<i>Recycling (recyclable)</i>	Recovering a portion of a used product or material from the waste stream and processing such that those same materials can be reintroduced into the manufacturing or construction process (CIWMB, 2009)
<i>Reuse (reusable)</i>	Recovering a portion of a used product or material from the waste stream that requires minimal, if any, processing to be reintroduced into the manufacturing or construction process
<i>ROW</i>	Right-of-way
<i>Upcycling</i>	Recovering a portion of a used product or material in a manner that increases the original value of the product or material after being reintroduced into the manufacturing or construction process
<i>Waste</i>	Any material that must be hauled off-site for disposal or reprocessing, or, if disposed within the project ROW, is not intended for engineered use on-site

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