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# Green Remediation Best Management Practices:
# Materials and Waste Management

Office of Superfund Remediation and Technology Innovation — Quick Reference Fact Sheet

The U.S. Environmental Protection Agency (EPA) *Principles for Greener Cleanups* outline the Agency's policy for evaluating and minimizing the environmental "footprint" of activities undertaken when cleaning up a contaminated site.[1] Use of the best management practices (BMPs) identified in EPA's series of green remediation fact sheets can help project managers and other stakeholders apply the principles on a routine basis, while maintaining the cleanup objectives, ensuring protectiveness of a remedy, and improving its environmental outcome.

The use of non-renewable materials such as minerals, metals, and fossil fuel-derived products has significantly increased in the United States over recent decades. In 1900, for example, 41% of the materials used in the United States consisted of renewable resources such as agricultural, fishery, and forestry products. By 1995, renewable resources accounted for only 6%.[2] Much of this increase is due to the rapid growth of manufacturing processes that consume nonfuel minerals. Currently, more than 25,000 pounds per capita of new nonfuel minerals are extracted from the earth each year as input for manufactured products used in the United States.

Increased reliance on non-renewable resources and accelerated consumption of raw, processed, and manufactured materials has led to adverse environmental effects. The effects include habitat destruction, biodiversity loss, over-stressed fisheries, desertification, and greenhouse gas (GHG) emission. In 2006, materials management accounted for 42% of GHG emissions in the United States.[3]

*Materials management refers to the control of material resources throughout their life cycle as they flow through the economy, from extraction or harvest through production and transport of goods, provision of services, reuse of materials, and, if necessary, disposal.*

The process of cleaning up a contaminated site often involves purchasing and consuming large volumes of manufactured items as well as raw or processed resources. Site cleanup can also generate significant volumes of waste such as:

- Industrial materials and products accumulated as debris during onsite demolition of structures and during remedy construction
- Organic materials such as wood and plant matter displaced during excavation
- Metal, glass, plastic, or paper containers and packaging from single-use products, including field supplies such as test kits for soil or water sampling, and
- Expended products such as fabric tarps and metal tooling or chemical solutions used to clean equipment or treat contaminated environmental media.

Much of this waste could be recycled or salvaged for reuse rather than disposed of at landfills.

Techniques for sustainable materials management can help reduce the environmental footprint of a cleanup. EPA's *Methodology for Understanding and Reducing a Project's Environmental Footprint* specifies seven metrics associated with materials and waste, which together constitute a core element of greener cleanups.[4]


| Materials & Waste: Environmental Footprint Metrics & Units of Measure |
|---|
| 1) Refined materials used on site (tons) |
| 2) Refined materials from recycled or waste material (percent) |
| 3) Unrefined materials used on site (tons) |
| 4) Unrefined materials from recycled or waste material (percent) |
| 5) Onsite hazardous waste generated (tons) |
| 6) Onsite non-hazardous waste generated (tons) |
| 7) Total potential onsite waste recycled or reused (percent) |

Industrial materials salvaged from demolition activities, for example, can be reused to construct new buildings and transportation systems, enhance infrastructure for water storage or drainage, or provide supplies for local agriculture, while remaining consistent with state regulations and appropriate environmental considerations.[5] Similarly, organic matter can be reused as remediation material or site restoration components, and other solid or liquid wastes can be recycled.

EPA's suite of green remediation BMPs describes specific techniques or tools to achieve a greener cleanup.[6] Opportunities to reduce the environmental footprint associated with materials and waste focus on:

- ***Purchase of greener products***, and
- ***Material reuse or recycling versus disposal***.

## Purchase of Greener Products

Implementation of green remediation BMPs should begin during planning stages of a cleanup, to facilitate sustainable materials management throughout remedy construction and maintenance. Key BMPs to reduce purchasing of virgin resources include:

- Survey onsite buildings and infrastructures to determine the potential to reuse existing structures and equipment or their components as a substitute for virgin materials
- Investigate potential offsite sources such as nearby facilities that may have surplus inventory or are undergoing decommissioning, for additional substitutes
- Check for availability of needed products at local non-profit or retail centers that facilitate product reuse
- Select products that are environmentally preferable (when compared to other products serving the same purpose) with respect to raw materials consumption, manufacturing processes and locations, packaging, distribution, recycled content and recycling capability, maintenance needs, and disposal procedures
- Choose vendors with production and distribution centers near the site, to minimize fuel consumption associated with delivery
- Choose suppliers that will take back scraps or unused materials
- Design new construction to utilize standard material sizes, which minimizes excess purchasing volumes and avoids waste from custom sizing, and
- Plan new construction with future deconstruction or material reuse in mind.

EPA recommends taking advantage of existing resources to help select and purchase environmentally preferred products. The U.S. General Services Administration (GSA), for example, offers the Sustainable Facilities Tool (SF Tool), a comprehensive, online source of information and electronic links on materials for constructing and operating buildings or conducting facility activities in a sustainable way.[7] Product categories in the SF Tool's "green production compilation" area cover a range of topics, including construction materials, landscaping elements such as compost and fertilizers, cleaning products, HVAC/mechanical equipment, and non-paper office products. The tool includes a search function to identify specific items such as fencing, signage, and bioremediation materials.

Environmental programs and standards captured within the tool include the:

- Design for the Environment (DfE) Program safety screening for lower hazard products
- Biopreferred® Program for products with biobased content
- WaterSense® performance testing for water-efficient products
- Federal Energy Management Program (FEMP) for water- and energy-efficient products
- ENERGY STAR verified ratings for energy-efficient products
- Significant New Alternatives Policy (SNAP) Program for ozone-depleting chemical substitutes, and
- American National Standards Institute (ANSI), Green Seal, and other independent certification programs.

*A pump-and-treat (P&T) system to treat contaminated groundwater at the* ***Lawrence Aviation Site*** *on Long Island, New York, consists of equipment previously used elsewhere in the community:*

- *An air stripper salvaged from a local dry cleaning facility; the unit is equipped with two 3,000-pound filtration vessels containing reactivated (instead of virgin) carbon to treat air prior to its emission from the plant, and*
- *Two aqueous-phase carbon vessels, a vapor-phase carbon vessel, bag filters, a blower, piping, valves, connectors, pumps, and electrical wiring reclaimed from a nearby manufacturing facility undergoing upgrades.*

*Construction of a building to house the P&T system involved use of greener products and salvaged construction materials:*

- *Lumber from a Certified Green Dealer™ lumberyard and wood certified under the Sustainable Forestry Initiative® or Program for Endorsement of Forest Certification*
- *Low-maintenance, insect- and weather-resistant composite siding made of sustainable materials with low toxicity, such as wood pulp, cement, and sand*
- *Spray-foam insulation made of renewable resources (soybeans) and through processes involving no formaldehyde, petroleum, asbestos, fiberglass, or volatile organic compounds*
- *Common-area flooring made of rapidly renewable cork, with an underlayment of post-consumer recycled granulated rubber from tires*
- *Light-reflective ceiling tiles comprising 45% rapidly renewable resources and 23% recycled content*
- *Cabinetry, hurricane shutters, and exterior doors made of remnant framing lumber instead of virgin wood, and*
- *Landscape mulch containing chipped wood from selected onsite trees requiring removal before remedy construction.*

*During construction, 240 tons of soil requiring excavation was transferred and stockpiled at a nearby municipal property for use by the Port Jefferson Highway Department. Prior to transfer, analytical tests were conducted on the soil to assure no residual contamination.*

## Material Reuse or Recycling Versus Disposal

Green remediation BMPs to facilitate sound planning for material reuse or recycling include:

- Check with applicable state agencies and local authorities to assure acceptable reuse of non-routine waste material or of industrial materials salvaged during construction and demolition (C&D)
- Screen local recyclers and waste haulers to identify organizations that will handle materials in an environmentally responsible manner, including suitable transportation methods and waste destinations, and
- Evaluate environmental or other trade-offs involved in onsite reuse of materials versus shipment offsite for reuse and/or recycling; evaluations can range in level of effort from qualitative comparisons of options to more rigorous quantification of alternative outcomes.[4]

Sustainable materials management can be facilitated through specific procurement practices for cleanup services, including subcontracts; for example:

- Include a requirement for reuse and recycling of all uncontaminated C&D material in documents such as requests for proposals and bid specifications
- Specify materials management goals in documentation such as construction waste management plans
- Develop a plan and reporting format to routinely track materials reuse/recycling and disposal, and
- Consider performance-based service contracts that can additionally motivate cleanup contractors and subcontractors to maximize material reuse/recycling.

*EPA's* **Greener Cleanups: Contracting and Administrative Toolkit** *provides sample contract language and criteria for sustainable materials management in EPA regions.*[8]

EPA recommends implementing additional BMPs during remedy construction, which may include demolition of existing structures:

- Divert at least 50% (by weight) of the uncontaminated C&D materials generated at the site, and include this goal in the site waste management plan
- Implement deconstruction techniques that involve preserving useable portions of existing structures, dismantling unusable parts for optimized transport, and recovering clean materials
- Salvage and sort clean materials with potential value for onsite reuse, recycling, resale, or donation
- Link a deconstruction project with a current construction or renovation project to facilitate material reuse
- Use crushed concrete as a construction aggregate for road base, pipe bedding, or landscaping
- Use concrete containing secondary cementitious materials to displace a portion of traditional Portland cement
- Use reclaimed asphalt pavement as a granular base for new roads
- Use shredded scrap tires, crushed concrete, and other onsite clean hard materials in place of borrow for fills
- Salvage uncontaminated and pest- or disease-free organic debris for use as infill or mulch as needed
- Optimize product ordering, to prevent purchase and delivery of excess materials, and
- Post onsite signage to designate collection points for routine recycling of single-use items such as metal, plastic, and glass containers, paper and cardboard, and other items that may be locally recyclable.

*A comprehensive list of tools and resources for sustainable materials management decision-making is available in EPA's* **Sustainable Materials Management in Site Cleanup** *engineering issue paper.*[9] *The information focuses on materials reuse and recycling and addresses topics such as:*

- *Locating C&D recyclers and material exchange networks*
- *State program requirements and beneficial use of materials*
- *Environmental benefits of diverting materials from landfills.*

Sustainable materials management, whether focused on greener product selection or waste reduction techniques, also applies to methods for treating contaminated soil, sediment, or groundwater. For example, the following BMPs may be used for remedy operation and maintenance:

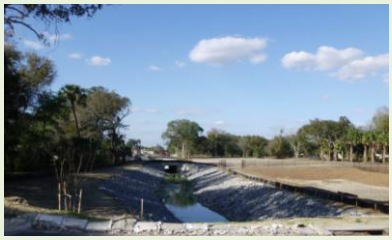
- Use reconstituted reactive media whenever feasible; for example, regenerated rather than virgin granular activated carbon (GAC) can be used in carbon treatment beds or canisters
- Consider non fossil fuel-based substitutes as reactive media, such as locally available coconut shell-derived GAC rather than coal-based GAC
- Explore innovative technology enabling recycling or resale of extracted chemicals; for example, cryogenic compression and condensation processes can enable recovery of hydrocarbon from air stripping condensate[10]
- Maximize use of industrial materials (in ways consistent with agronomic and environmental constraints) such as iron and steel foundry sands, dry wall, flue gas desulfurization (FGD) gypsum, and non-synthetic compost for soil amendments and manufactured soils; FGD gypsum can also serve effectively in flow-through curtains to mitigate phosphorous transport to surface and groundwater
- Use periodic optimization evaluations as opportunities to incorporate industrial material recycling practices and to switch to newer green products, and
- Use continuous process monitoring techniques to maximize capacity of a treatment medium and minimize frequency of treatment media replacement or replenishment.

*A range of industrial materials may exist as waste at sites undergoing cleanup. Conversely, industrial materials can effectively contribute to site cleanup. EPA's* ***Industrial Materials Recycling*** *website provides more information on recycling and beneficial use of industrial materials such as C&D materials, coal combustion products, foundry sand, and iron and steel slag.*[5]

*Cleanup at the* ***Sanford Gasification Plant*** *in Seminole County, Florida, incorporated a sustainable materials management plan involving extensive reuse or recycling of onsite materials; minimized offsite disposal of excavated materials; and overall reductions in consumption of water and fossil fuels. The implemented BMPs and associated results included:*

- *Screened clean versus contaminated soil through a "cut line" investigative approach and segregated soils accordingly, which minimized the soil treatment load while averting import of 1,600 cubic yards of non-native soils for site restoration*
- *Used granulated blast furnace slag in lieu of a portion of the cement specified in the typical formula used to stabilize coal tar-contaminated soil, avoiding 13,700 tons of carbon dioxide ($CO_2$) otherwise emitted by thermal reactions during mixing of cement with other reagents*
- *Chipped and sent 5,000 cubic yards of extracted trees and stumps to local landscapers for use as mulch, avoiding shipment of 800 tons of material to landfills*
- *Installed a solar-powered backup energy system for perimeter air monitoring during remedy construction*
- *Reused 3.7 million gallons of water from onsite dewatering operations in the soil stabilization process*
- *Used B20 (20% biodiesel) to operate diesel vehicles and machinery, averting 177 tons of $CO_2$ emissions, and*
- *Procured 75% of the remedial labor and supplies (valued at $8 million) from local sources within 50 miles of the site.*

*A gravity drain network overlaying recycled concrete was used to divert 500 feet of an onsite creek during remedy construction, which reduced use of diesel pumps.*



*The stabilization project involved extensive use of recycled concrete serving as riprap to armor the creek bed and limit erosion.*

## Materials and Waste Management: Recommended Checklist

### Purchase of Greener Products

- ✓ Explore options for reusing materials onsite or available from local sources
- ✓ Purchase from local vendors who accept unused materials upon project completion
- ✓ Design for optimized product sizing and product ordering and for future reuse or repurposing
- ✓ Choose environmentally preferable products

### Material Reuse or Recycling Versus Disposal

- ✓ Verify acceptable reuse of C&D materials with regulators
- ✓ Screen recyclers and waste haulers
- ✓ Evaluate environmental trade-offs
- ✓ Specify requirements and goals in service contracts
- ✓ Salvage uncontaminated demolition and other materials with value for reuse/recycling, resale, or donation
- ✓ Use onsite or offsite industrial materials such as crushed concrete and shredded scrap tires for remedy construction
- ✓ Recycle routine single-use items regularly
- ✓ Minimize direct or indirect use of fossil fuels during activities such as product purchasing or waste transfer
- ✓ Plan treatment process optimization and monitoring that includes sustainable materials management

## References [Web accessed: December 2013]


1 U.S. EPA; *Principles for Greener Cleanups;* August 27, 2009; http://www.epa.gov/oswer/greenercleanups

2 U.S. EPA; *Sustainable Materials Management: The Road Ahead*; EPA 530-R-09-009; June 2009

3 U.S. EPA; *Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices*; EPA 530-R-09-017; September 2009

4 U.S. EPA; *EPA's Methodology for Understanding and Reducing a Project's Environmental Footprint*; EPA 542-R-12-002; February 2012; http://www.cluin.org/greenremediation/methodology/docs/GC_Footprint_Methodology_Feb2012.pdf

5 U.S. EPA; Industrial Materials Recycling; http://www.epa.gov/osw/conserve/imr/

6 U.S. EPA; *Green Remediation Best Management Practices: Fact Sheets on Specific Remedies and Other Key Issues;* http://www.cluin.org/greenremediation/docs/GR_factsheet_topics.pdf

7 GSA; Sustainable Facilities Tool; http://www.sftool.gov/learn

8 U.S. EPA; *Greener Cleanups Contracting and Administrative Toolkit*; http://www.cluin.org/greenremediation/docs/Greener_Cleanups_Contracting_and_Administrative_Toolkit.pdf

9 U.S. EPA; *Sustainable Materials Management in Site Cleanup*; EPA 542-F-13-001; March 2013; http://www.clu-in.org/greenremediation/docs/materials_management_issue%20paper.pdf

10 U.S. EPA; *Technology News and Trends*; Cryogenic Compression and Condensation Process Used for Hydrocarbon Recovery; EPA 542-N-10-004; August 2010


*The Agency is publishing this fact sheet as a means of disseminating information regarding the BMPs of green remediation; mention of specific products or vendors does not constitute EPA endorsement.*

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