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Green Remediation: Best Management Practices for Excavation and Surface Restoration

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

This fact sheet is one of a series describing best management practices (BMPs) for green remediation, which holistically addresses a cleanup project's (1) energy requirements, (2) air emissions, (3) impacts on water, (4) impacts on land and ecosystems, (5) material consumption and waste generation, and (6) long-term stewardship actions. BMPs can be used for sustainable removal or cleanup activities at contaminated sites under Superfund, corrective action, underground storage tank, and brownfield cleanup programs.

Some green remediation strategies stem from environmentally progressive practices of business market sectors such as construction. Others build new elements such as green purchasing into traditional practices of the remediation sector. Yet more evolving BMPs incorporate innovative technologies that can be readily adapted to increase cleanup sustainability.

Overview

Excavation in varying degrees is often required at contaminated sites to:

- Address immediate risk to human health and/or the environment as part of immediate or long-term removal actions
- Prepare for implementation of in situ or ex situ remediation technologies, which often involves building or structural demolition, or
- Treat soil or sediment hot spots for which other remedies may be infeasible due to extremely high cost, long duration, or technical constraints

Many opportunities exist to reduce the negative impacts of excavation, which commonly include soil erosion, high rates of fuel consumption, transport of air-borne contaminants, uncontrolled stormwater runoff, offsite disposal of excavated material, and ecosystem disturbance. Decisions regarding excavation processes and targets affect follow-up land and surface water restoration strategies as well as ultimate land use.

Planning for Excavation and Surface

Early and integrated project planning allows the (typically early) excavation period to set the stage for sharing of resources, infrastructures, and processes throughout site cleanup and reuse. Early BMPs include:

- Incorporation of green requirements into product and service procurements
- Installation of a modular renewable energy system to meet low energy demands of field equipment, other remedies, and construction or operational activities associated with site reuse
- Dynamic work planning; for example, treated excavation material found unnecessary as backfill can be put to beneficial use at onsite or offsite locations
- Consideration of environmental and economic tradeoffs involved in onsite versus offsite treatment of excavated soil or sediment
- Balance of trade-offs associated with onsite versus offsite disposal of contaminated soil or other material
- Early and continuous scouting for onsite or nearby sources of backfill material for excavated areas
- Establishment of decision points that could trigger in situ treatment instead of excavation in subareas
- Integrated schedules allowing for resource sharing and fewer days of field mobilization

Profile: RE-SOLVE, Inc. Waste Chemical Reclamation Facility, North Dartmouth, MA

- *Excavated 22,500 yd^3 of polychlorinated biphenyl (PCB)-contaminated soil above the water table, treated soil onsite through dechlorination, backfilled with cleaned soil, and covered with 18 inches of gravel*
- *Excavated 3,000 yd^3 of PCB-contaminated sediments from wetland areas, treated excavated sediments through dechlorination, and restored the wetlands*
- *Excavated 36,000 yd^3 of soil, treated soil with low-temperature thermal desorption, and backfilled*
- *Replaced the gravel cap with a four-acre native upland meadow cover to reestablish onsite native species and enhance environmental habitat*
- *Avoided significant fossil fuel consumption for offsite transportation of contaminated soils and replacement with clean fill*

Energy Requirements

Determining the optimum extent of excavation relies on accurate delineation of the contaminant plume(s). Use of the Triad approach for site investigations can reduce field mobilizations and associated fuel consumption through systematic planning, dynamic work activities, and real-time measurements.

BMPs that can help reduce fuel consumption (as well as waste generation) during site investigations include:

- Direct-push technology instead of rotary drilling rigs to reduce drilling duration by as much as 50-60%, avoid drilling fluids, and eliminate drill cuttings; this technique may be infeasible in applications limiting the depth, type, weight, or volume of target samples or installation of new ground water wells
- Reuse of wells and subsurface bore holes throughout investigations, remediation, and long-term monitoring
- Field test kits whenever possible and selection of the nearest qualified laboratory for confirmatory analyses or contaminants outside the scope of field kits

Procurement of goods and services offers other opportunities for reducing fuel consumption.

- Purchase materials from one supplier of locally produced products to reduce need for delivery fuels
- Select local providers for field operations
- Coordinate outside services and service providers to minimize transport of equipment and reduce costs

Fuel consumed during transfer of excavated soil or other materials to landfills can be reduced by:

- Selecting the closest waste receiver
- Investigating alternate shipping methods such as rail lines
- Identifying opportunities for resource sharing with other waste haulers

Diesel fuel consumption by heavy construction machinery and equipment can be conserved by:

- Selecting suitably sized and typed equipment for tasks
- Instructing workers to avoid engine idle and using machinery with automatic idle-shutdown devices
- Employing auxiliary power units to power cab heating and air conditioning when a machine is unengaged
- Performing routine, on-time maintenance such as oil changes to improve fuel efficiency
- Repowering an engine or replacing it with a newer, more efficient one

Auxiliary equipment such as electricity generators or wood chippers can be powered by small photovoltaic (PV) systems. Installations can involve placement of PV panel support poles on small concrete pads for short-term use. Micro-scale solar power can be used for small devices such as flashlights, lamps, and temperature-controlled containers.

New technology for installation of ground-mounted PV systems requires no concrete, reduces subsurface disturbance, and increases options for equipment reuse.

Air Emissions

Field generation of contaminated or uncontaminated dust and mobilization of volatile organic compounds can be reduced by new and traditional BMPs such as:

- Covering excavated areas with biodegradable fabric that also can control erosion and serve as a substrate for favorable ecosystems, or with synthetic material that can be reused for other onsite or offsite purposes
- Spraying water in vulnerable areas, in conjunction with water conservation and runoff management techniques
- Securing and covering material in open trucks while hauling excavated material, and reusing the covers
- Revegetating excavated areas as quickly as possible
- Limiting onsite vehicle speeds to 10 miles per hour

Greenhouse gas (GHG) and particulate matter (PM) emissions from mobile sources can be reduced through use of:

- Equipment retrofits involving low-maintenance multi-stage filters for cleaner engine exhaust
- Cleaner fuel such as ultra-low sulfur diesel, wherever available (and as required by engines with PM traps)
- Biodiesel, particularly if made from recycled byproducts

Impacts on Water

Green remediation strategies help reduce consumption of fresh water, reuse or reclaim uncontaminated water, minimize potential for water-borne contamination, and minimize introduction of toxic processing materials.

- Cover soils with biodegradable tarps and mats, rather than spraying with water, to suppress dust while potentially enhancing soil fertility

- Explore options for reusing operational graywater, capturing rainwater, and returning unused water to surface bodies instead of disposing it in public wastewater utility lines
- Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants)
- Employ rumble grates with a closed-loop graywater washing system (or an advanced, self-contained wheel-washing system) to minimize vehicle tracking of sediment and soil across non-work areas or offsite

BMPs for excavation of contaminated sediments in surface water or wetlands focus on slurry management and disposal.

- Evaluate fuel efficiency and sizing suitability of dredging equipment if multiple options can achieve site-specific cleanup goals
- Overlay synthetic barriers and fluid collection systems on ground surfaces of staging areas and where excavated material is dewatered
- Use dewatering processes that maximize water recycling, and consider automated systems to account for sediment variability
- Investigate the potential for treated slurry water to be beneficially reused in other cleanup activities prior to discharge
- Investigate opportunities to transfer treated slurry water for use in non-remedial applications such as irrigation or wetlands enhancement
- Consider the use of geotextile bags or nets to contain excavated sediment, facilitate sediment drying, and increase ease of sediment placement or transport
- Check for toxic contents in synthetic coagulants used in the field and avoid spillage
- Evaluate potential for excavated areas to serve as retention basins in final stormwater control plans

BMPs for restoration of surface water and adjacent banks after sediment excavation rely on low impact development techniques that reduce impacts of built areas and promote natural movement of water.

- Undercut surface water banks in ways that mirror natural conditions
- Retrieve dead trees during excavation and later reposition them as habitat snags
- Select and place suitably sized and typed stones into water beds and banks

Profile: Paducah Gaseous Diffusion Plant, Paducah, KY

- *Used Triad to integrate site characterization, remedial activities, and cleanup verification in a 7,000 foot^2 area with potential uranium and polychlorinated biphenyl (PCB) contamination*
- *Convened federal and state agencies to develop a conceptual site model and dynamic work plan prior to beginning any field work*
- *Used investigative tools requiring no soil disturbance (*laser-based gamma "walkover" surveys (GWS) and x-ray fluorescence (XRF) with gamma spectroscopy) and techniques requiring few analytical samples and minimal sampling waste (PCB test kits, multi-increment sampling, and adaptive compositing)
- *Integrated field information involving* 24,000 GWS data points, hundreds of XRF measurements, and nearly 400 surface soil increments, which resulted in a need for laboratory confirmation on only 23 samples instead of an estimated 300 using a traditional field approach
- *Surgically excavated 13 meter^3 of uranium-contaminated soil and confirmed PCB concentrations in non-excavated areas were below risk-based cleanup targets*
- *Completed investigatory, removal, and verification activities in a single 10-day field mobilization, resulting in less dust generation, fuel consumption, and site disturbance*
- *Saved significant time and costs in reaching cleanup closure when compared to traditional, static work plans involving reiterative activities*

Material Consumption and Waste Generation

Countless and diverse man-made products are purchased and used during excavation, such as personal protective equipment (PPE), synthetic sheeting, and routine business materials. Green purchasing considers product life cycles and gives preference to:

- Products with recycled and bio-based (instead of petroleum-based) contents
- Products, packing material, and disposable equipment with reuse or recycling potential
- Product contents and manufacturing processes involving nontoxic chemical alternatives

To reduce the volume of single-use material such as PPE and sampling materials, activity planning can reflect reduced traffic between hot and clean zones and fewer days in which work is performed. BMPs for waste management include:

- Establishing staging areas prior to any digging
- Salvaging uncontaminated and pest- or disease-free organic debris for use as infill, mulch, or compost
- Reclaiming and stockpiling uncontaminated soil for use as fill or other purposes such as habitat creation
- Salvaging uncontaminated objects with potential recyle, resale, donation, or onsite infrastructure value such as steel, concrete, granite, and storage containers; waste coordinators are available in many states to assist in decisions regarding beneficial reuse or exposure risk

Impacts on Land and Ecosystems

A primary BMP for minimizing the negative impacts on land and ecosystems is to perform an inventory (including detailed photographs and videos) of ecological species, land contours, and drainage patterns prior to digging. Baseline inventories will facilitate restoration that best recreates original conditions. Other BMPs include:

- Establishment of minimally intrusive and well-designed traffic patterns for onsite activities and plans to reduce off-site traffic congestion
- Placement of metal grates over a thick mulch layer in onsite traffic corridors to avoid soil compaction and associated reduction in subsurface water infiltration
- Construction of long-term structural controls such as earth dikes and swales to prevent upgradient surface flow into excavated areas
- Installation of silt fences and basins to capture sediment runoff along sloped areas
- Quick-growth seeding and geotextile placements to stabilize sod in staging areas

When needed, onsite landfills for excavation or other remedies can employ evapotranspiration covers, which promote microbial degradation of waste while providing a substrate for plant growth.

BMPs for preserving ecological systems include:

- Avoiding tree removal in staging areas or intermittent uncontaminated zones, and retrieving and transplanting native, noninvasive plants
- Using non-chemical solarizing techniques for vegetative transplants or new plantings, and non-synthetic fertilizers, herbicides, or pesticides and integrated pest management methods
- Limiting noise and artificial lighting that disturbs sensitive species, and rescuing and relocating sensitive or threatened species

Many environmental, academic, and broad-based community groups offer assistance in ecological inventories as well as rescues.

Long-Term Stewardship Actions

Coordinated planning of remediation and anticipated use of a site is critical to long-term sustainability. Green remediation encourages decision-makers to weigh the environmental and economic tradeoffs of issues such as onsite versus offsite disposal of contaminated soil or sediment. Proper planning will help reduce likelihood of adverse impacts such as soil subsidence, unbalanced soil chemistry, or low microbial populations, and periodic post-excavation field tests will help identify unexpected problems quickly.

Prompt revegetation is critical to restoration of backfilled areas. Installation of native rather than imported plants will increase vegetation viability, avoid immediate- or long-term irrigation needs, and promote rapid ground cover. Plant diversity also will create useful wildlife habitat and more opportunities for future activities or site reuse.

Green Remediation: A Sampling of Success Measures for Excavation and Surface Restoration

- *Reduced fuel consumption and transportation costs as a result of integrated "dig and haul" planning with fewer field mobilizations*
- *Reduced GHG emissions through use of renewable resources to provide electricity for auxiliary equipment or replace natural gas-driven equipment*
- *Increased volumes of graywater recycled or reused in sediment dewatering, in place of clean water*
- *Increased percentage of excavated, clean soil or material that is reused onsite*
- *Higher percentage of ground cover sooner after excavation, with fewer invasive species*
- *Increased utility of "excavation built" erosion and stormwater controls in site reuse*

Visit *Green Remediation* online to obtain more information about BMPs, view site-specific examples, or share new ideas about green cleanups.

http://cluin.org/greenremediation