

BROWNFIELD REMEDIAL DESIGN AND ACTION WORK PLAN GUIDANCE

Adopted January 2008

After the Final Plan of Remedial Action (Final Plan) has been completed, a Brownfields Remedial Design and Action Work Plan or Brownfields Remedial Work Plan (BRWP) is completed. The BRWP combines remedial design (i.e. technical or engineering drawings for a vapor barrier) with a remedial action work plan (how the design will be implemented) into one document. In some cases, remedial design may not be necessary. The work plan must be consistent with the Final Plan of Remedial Action (Final Plan). The primary objectives are as follows:

1. Provide a complete engineered design of the selected remedial action(s) and evaluate the effectiveness prior to implementation
2. Discuss how design will be implemented
3. Identify and obtain required construction and other permits
4. Quality Control and Quality Assurance

Note: It is important to keep the public informed of design aspects which can potentially impact them.

Workplan Format

The BRWP should include the details of the technical requirements of the remedial actions to be implemented. It should indicate the size, scope, and nature of a site's remediation. It translates information from the Remedial Investigation and Feasibility Study, the Record of Decision, and additional data gathered prior to design preparation into clear, precise facts, numbers and a schedule.

The Remedial Design format is located in Appendix D of the Hazardous Substance Cleanup Act Guidance Manual. Sections of the BRWP may include, but are not limited to the following:

1. Executive Summary
2. Introduction
3. Site Description
4. Summary of Final Plan Remedial Actions:
 - a. Soil Removal/treatment
 - b. Soil/ Vegetative Cap
 - c. Asphalt Cap
 - d. Vapor Barrier
 - e. Groundwater Pump and Treat
 - f. Environmental Covenants (ie.GMZ restrictions/acknowledgement, digging restrictions, land use restrictions)
 - g. Other as appropriate

Note: Refer to Appendix A for complete list

5. Remedial Design Documents
6. Remedial Action Scope of Work
This section should describe how the remedial action will be implemented.
7. Potential Permit or Approval Requirements (All items listed below require approval prior to implementation):
 - a. Sediment and Erosion Control (Refer to DNREC Division of Soil and Water)
 - b. Well Permits
 - c. Dewatering Permits
 - d. Underground Injection Control Permits
 - e. Discharge Permits (National Pollutant Discharge Elimination System (NPDES), etc.)
 - f. Dredging Permit- Refer to Division of Water Resources
 - g. Off-site Soil Disposal
 - h. Air permits for asbestos removal
 - i. Air permits for air stripper
 - j. Subaqueous lands permit
 - k. Other Permits as required
8. Remedial Action Requirements, Considerations and Provisions
 - a. Sampling and Analysis Plan
 - b. *Contaminated Materials Management Plan
Refer to Appendix B
 - c. *Sediment Management Plan
Refer to Appendix B
 - d. Vapor Barrier Design
Refer to Appendix C
 - e. Other plans, as required
9. Construction Activities
10. Documentation of Construction Quality Assurance/Quality Control

* These documents are typically completed prior to the Final Plan as part of interim action requirements. Permanent structures such as concrete slabs, etc. can't be placed prior to the Final Plan. These plans must be in place and approved by DNREC-SIRB before any soil disturbing activities take place on the Site. These documents, when completed before the Final Plan, are typically stand-alone documents. They need to be included as an appendix in the work plan or referred to in the work plan with a DNREC-SIRB approval date.

The following activities should be evaluated for their applicability:

PILOT STUDIES

It may be necessary to conduct a pilot study of the selected RD in order to identify problematic areas. This study may involve the analysis of contaminated media samples of contaminated media before and after a small-scale laboratory version of the remedial

action process. Ultimately, a pilot study is used to predict and identify conditions that may either contribute to the success or failure of the design. If a pilot study applies to your project, a scope of work for the pilot study will need to be completed.

APPENDIX A

Currently, the types of remedial technologies can be categorized into two; conventional and innovative. Conventional types are most widely used, though they are being replaced with state-of-the-art, typically more cost-effective and innovative technologies. Below are some examples of each:

1. REMEDIAION TECHNOLOGIES (NOT LIMITED TO THE FOLLOWING)

a. SOIL/SEDIMENTS

1. SOIL WASHING: contaminants that are absorbed onto fine soil particle surfaces are separated from bulk soil in a water-based system based on particle size. The wash water may be augmented with a basic leaching agent, surfactant, or chelating agent or by adjustment of pH to help remove organics and heavy metals. Soils and wash water are mixed ex situ in a tank or other treatment unit. The wash water and various soil fractions are usually separated using gravity settling.
2. INCINERATION: This involves the ex situ destruction of contaminated soil, sludge, and sediment in high temperature (1,800 - 2,200°F) combustion devices. A typical hazardous waste incinerator, diagrammed below, consists of a rotary kiln (primary combustion chamber), an afterburner (secondary combustion chamber), connected to an air pollution control system, all of which are controlled and monitored.
3. BIOREMEDIATION uses microorganisms to degrade organic contaminants in either excavated or in situ soil, sludge, or solids. The microorganisms break down contaminants by using them as a food source or co-metabolizing them with a food source. Land farming, biopiles, composting, and slurry-phase bioremediation are examples of ex situ applications. Bioventing is a common form of in situ bioremediation which uses extraction wells to circulate air through the ground, sometimes also pumping air into the ground.
4. IN SITU SOIL FLUSHING: large volumes of water, at times supplemented with surfactants, cosolvents, or treatment compounds, are applied to the soil or injected into the groundwater to raise the water table into the contaminated soil zone. Injected water and treatment agents are isolated within the underlying aquifer and recovered together with flushed contaminants.

5. PHYTOREMEDIATION is a process that uses plants (roots, shoots, tissues, and leaves) to remove, transfer, stabilize, or destroy contaminants in soil, sediment, and groundwater. Phytoremediation applies to all biological, chemical, and physical processes that are influenced by plants and that aid in cleanup of contaminated substances. Plants can be used in site remediation, both through the mineralization of toxic organic compounds and through the accumulation and concentration of heavy metals and other inorganic compounds from soil into the aboveground shoots. Phytoremediation may be applied in situ or ex situ, to soils, sludge's, sediments, groundwater or other solids.
6. SOIL VAPOR EXTRACTION (SVE) is used to remediate the zone of soil which is unsaturated with contaminated groundwater. A vacuum is applied to the soil to control the flow of air and remove volatile and some semi-volatile organic contaminants from the soil.
7. SOLIDIFICATION/STABILIZATION (S/S) reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. The S/S process physically binds or encloses contaminants within a stabilized mass. S/S is performed both ex situ and in situ. Ex situ S/S requires excavation of the material to be treated, and the resultant material must be disposed. In situ S/S uses auger/caisson systems and injector head systems to add binders to the in-situ contaminated soil.
8. SOLVENT EXTRACTION uses an organic solvent as an extractant to separate organic and metal contaminants from soil. The organic solvent is mixed with contaminated soil in an extraction unit. The extracted solution is then passed through a separator, where the contaminants and extractant are separated from the soil. Organically bound metals may be extracted along with the target organic contaminants.
9. THERMALLY ENHANCED RECOVERY uses heat to increase the volatilization rate of organics and facilitate extraction. Volatilized contaminants are typically removed from the vadose zone using soil vapor extraction. Specific types of these thermally enhanced recovery techniques include Contained Recovery of Oily Waste (CROW™), radio frequency heating, conductive heating, steam heating, in situ steam stripping, hot air injection, dynamic underground stripping, in situ thermal desorption, and electrical resistance heating. Thermally enhanced

recovery is usually applied to contaminated soil, but may also be applied to groundwater.

10. VITRIFICATION uses an electric current to melt contaminated soil at elevated temperatures (1,600 to 2,000°C or 2,900 to 3,650°F). Upon cooling, the vitrification product is a chemically stable, leach-resistant, glass and crystalline material similar to obsidian or basalt rock. The high temperature component of the process destroys or removes organic materials. Radio-nuclides and heavy metals are retained within the vitrified product. Vitrification may be conducted in situ or ex situ.
11. THERMAL DESORPTION is treatment where wastes are heated so that organic contaminants and water volatilize. Typically, a carrier gas or vacuum system transports the volatilized water and organics to a gas treatment system.

b. GROUNDWATER

1. PUMP-AND-TREAT involves the removal of contaminated groundwater from the subsurface and subsequent treatment, and discharge or reinjection. The pump and treat remediation approach is used on approximately three-quarters of the Superfund sites where ground water is contaminated and at the majority of the sites where cleanup is required by the Resource Conservation and Recovery Act and state laws. This approach remains a necessary component of most ground-water remediation efforts and can be appropriate for both restoration and plume containment.
2. VERTICAL ENGINEERED BARRIERS (VEBs) are subsurface barriers made of an impermeable material used to contain contaminated groundwater, divert uncontaminated groundwater from a contaminated area, or divert contaminated groundwater from a drinking water intake or other protected resource.
3. CHEMICAL TREATMENT, also known as chemical reduction/oxidation, typically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, or inert. The oxidizing agents most commonly used for treatment of hazardous contaminants in soil are ozone, hydrogen peroxide, hypochlorites, chlorine, chlorine dioxide, potassium permanganate, and Fentons reagent (hydrogen peroxide and iron). Cyanide oxidation and dechlorination are examples of chemical treatment. This method may be applied in

situ or ex situ, to soils, sludges, sediments, and other solids, and *may also be applied for the in situ treatment of groundwater.*

4. AIR SPARGING involves the injection of air or oxygen through a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column, creating an underground stripper that removes volatile and semi-volatile organic contaminants by volatilization. Soil Vapor Extraction is usually implemented in conjunction with air sparging to remove the generated vapor-phase contamination from the unsaturated zone, Oxygen added to the contaminated groundwater and vadose-zone soils also can enhance biodegradation of contaminants below and above the water table.
5. DUAL-PHASE EXTRACTION, also known as multi-phase extraction, uses a vacuum system to remove various combinations of contaminated groundwater, separate-phase petroleum product, and vapors from the subsurface. The system lowers the water table around the well, exposing more of the formation. Contaminants in the newly exposed unsaturated zone are then accessible to soil vapor extraction. Once above ground, the extracted vapors or liquid-phase organics and ground water are separated and treated.
6. TREATMENT BARRIERS, also known as permeable reactive barriers (PRBs) or passive treatment walls, are installed across the flow path of a contaminated groundwater plume, allowing the water portion of the plume to flow through the wall. These barriers allow the passage of water while prohibiting the movement of contaminants by employing agents within the wall such as zero-valent metals, chelators, sorbents, and microbes. The contaminants are either degraded or retained in a concentrated form by the barrier material, which may need to be replaced periodically.

APPENDIX B

Checklist for Contaminated Material Management Plan (CMMP)

A Contaminated Material Management Plan (CMMP) is used to ensure the proper handling of soil, sediment and groundwater on a Site during redevelopment activities. Proper handling of soil includes safe handling and use of appropriate personal protective equipment by the current construction workers, as well as future construction/utility workers. The CMMP:

- Ensures that the properties adjacent to the Site are not adversely impacted by excessive dust.
- May be referenced during interim actions on the Site that take place prior to issuance of the Proposed and Final Plans of Remedial Action.
- Is necessary when a construction worker risk assessment indicates that disturbance of the soil, groundwater or sediment will present a risk to human health.
- May also be used presumptively.

A CMMP should be a dynamic document. Addendums should be added as new situations arise. All contractor and subcontractors need to be briefed on the plan prior to onsite activities.

Sections of the CMMP

General

- Site Location (include Site Location and Site Map)
- Types of Activities
 - List of the soil, groundwater, and sediment disturbing activities
 - Typical-utility trenches, grade beams, elevator shafts, fence holes, grubbing, installation of piles, pilot holes, dewatering, removal of underground storage tanks, site grading, etc. (Note: E&S controls must be in place and the E&S plan approved prior to any land disturbing activities). If applicable, specify the amount and location of sediment to be disturbed.
- Summary of Contaminants of Concern
 - List contaminants of concern in soil, groundwater and sediment. If possible, it should include concentration maps and planned removal areas.

Soil

- Sample for Disposal. Specified by the disposal facility.

- Field Screening- Soil should be screened in the field. Soil which is visibly stained has an odor or elevated PID reading (suggested minimum 20-30 ppm) should be segregated and tested for offsite disposal.
- Soil Reuse- A proposed plan may allow for the re-use of soil onsite i.e. typically under a cap, building, sidewalk, etc. If a proposed or final plan exists for the Site, please ensure that the CMMP or for your site conforms with the it. Soil may also be transferred to another HSCA site. Consultant should send in a letter describing the situation for DNREC-SIRB approval. Please refer to the DNREC-SIRB May 2006 Soil Reuse Policy at Hazardous Substance Cleanup Act (HSCA) Sites (Soil Reuse Policy) for additional details. **Prior to moving the soil offsite, the soil must be tested to determine if it could be considered a RCRA hazardous waste. Moving a RCRA Hazardous Waste is illegal.** Please refer to the Soil Reuse Policy or to DNREC Solid and Hazardous Waste Management Branch (SHWMB).
- Soil Handling

Contaminated Soil

- Place hazardous soil on plastic, cover with plastic. Specify Stockpile maintenance.
- Specify how hazardous soil be identified, handled, live loading, stockpiling
- Notify DNREC-SIRB five (5) days prior to soil disturbance
- Detail dust monitoring and procedures to minimize dust generation- i.e. Water, foam, etc.
- Describe how to handle unexpected situations-i.e. tanks, etc.
- Describe how debris will be handled- i.e. concrete, timbers, pipes
DNREC-SIRB has a memorandum of agreement (MOA) with the Delaware Solid Waste Authority (DSWA). DSWA will allow disposal of certain materials that are non-hazardous. Each load that arrives at the landfill from a HSCA site must have the DSWA approval letter.
- In non-aqueous phase liquid (NAPL) areas, describe how these soils are to be handled and specify how to prevent auger from transferring contamination to deeper levels.
- Describe if necessary how equipment will be decontaminated.
- Describe structurally suitable soil.

Utility Corridors

- If the findings of the construction worker risk indicate a risk for future construction worker, then this is typically addressed by requiring the utility corridors with DNREC-SIRB approved clean fill. DNREC requires a marker fabric at the base or lining the corridor. Exceptions have included:
-Under Delaware Department of Transportation (DelDOT) roads (Due to stability)

- Under buildings (not possible for future utility workers to encounter)
- Adjacent to gaslines (pulling the fabric out may cause rupture and explosion).
- utilities encased in concrete (access only through manholes)
- Re-address the future utility construction worker risk. The future construction worker duration may be lowered to 20 days according to EPA risk assessment procedures.

At the end of the project as documented in the construction completion report, DNREC-SIRB requires a clean utility / clean vegetation corridor map for the files.

Clean Fill

- In the event that soil is to be used as a cap or in utility corridors, the soil must be from a DNREC-SIRB approved clean fill soil source.
- If the soil is not from a DNREC-SIRB approved source then the soil has to be tested for full TCL organics and TAL metals. See Soil Re-Use Policy for more details.

Groundwater Treatment

- If in the City of Wilmington, does the Site have a sanitary sewer discharge permit. The permit, requirements and limitations should be listed.
Copies of the permit reports should be sent to DNREC-SIRB as well as the City of Wilmington.
Before discharging to any sanitary sewer, check the requirements of the city, township, etc. for permit requirements.
- If a treatment system is necessary, then specify sampling requirements.
- Please describe how cleanout of sludge and silt be addressed.
- Please describe how NAPL will be addressed during groundwater treatment.
- Please describe the schedule for carbon cleanout.
- Please describe the schedule for checking for carbon breakthrough.
- Please describe disposal of any sludge and/or silt.

Containerized

- Please describe how cleanout of sludge and silt be addressed.
- Please describe how NAPL will be addressed during groundwater treatment.
- Please describe disposal of any sludge and/or silt.

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□ Sediment

- Please discuss disposal or use of the contaminated sediments (Specify in this section how the material is to be handled- i.e. Is the soil to be dewatered, dried, material added, etc.)
- Additional analysis of sediment may be required to determine the suitability of re-use for the sediment. These analyses are typically conducted on sediment during the RI. In this case, please specify the type of analysis. Typical analysis include:

Acid Volatile Sulfide and Sulfur Extractable Metals (AVS & SEM): The purpose of this analysis is to determine the bioavailability of metals in sediments. When the difference between the total SEM and AVS is less than zero, then the metals are not bio-available and thus do not present a risk to human health or the environment. Alternately, if the total SEM and AVS is greater than zero, then there is a risk.

Gas Chromatography (GC)-Fingerprints: This analysis determines the concentration of total petroleum hydrocarbon (TPH) present in the sediment. It also determines the estimate types of petroleum products.

Total Organic Carbon (TOC): The higher the carbon content, the less available organic compounds are to organisms and thus the lower the risk.

Note: Natural Resource Damage Assessment (NRDA) money for sediment cleanup costs may be available. Contact DNREC-SIRB for more details.

APPENDIX C

Vapor Barrier (Cap) Design

Information on Vapor Intrusion and the need for vapor barrier can be seen in the SIRB Vapor Intrusion Policy Dated March 2007. For an example, please see Justison Landing (DE-1377) vapor barrier design drawings.

Basic Vapor Barrier Design

A barrier consists of a vapor barrier and venting system. The system should be detailed in a drawing from deepest to roof as follows:

- Vent to roof. Vent 5-10 feet above roof or ten feet higher than ground surface if not mounted on the roof.
- Concrete floor
- Protective barrier to perforations caused by walking on the barrier (some barriers don't need a protective cover-see manufacturers requirements)
- Vapor Barrier
- Stone
- Subsurface venting piping
- Stone (base)

Barrier requirements

- Previously approved vendor **or**
- Barrier meets the following:
 - i. Permeability of the barrier or Permanence ASTM E 1745-97 (2004) less than 0.01 perms.
 - ii. Strength of material- puncture resistance (ASTM D1709-04) and tensile strength (ASTM D882-00)
 - iii. Resistance to COC on site- ASTM E154-99, Section 14
 - iv. Test for leaks- Radon Reduction Techniques for Existing Detached Houses, Technical Guidance, Third Edition, EPA/625/R93/011, October 1993.
- Vendor must provide documentation that meets these requirements

Piping requirements

- Under building piping meets Los Angeles County Building Dept. under methane mitigation plans, specifically Table 2 (attached). Please see http://www.ladbs.org/rpt_code_pub/methane.htm and 5 LA Venting Regulations for additional details.
- System designed to be turned on in the event passive system is not sufficient

Air permitting

Generally not required. Air permitting requirements from the DNREC Division of Air and Waste Management Air Quality Management Section are as follows:

- Less than 0.2 lbs/day- No permit
- 0.2 to 10 lbs/day- Self permit
- 10 lbs/day-permit required

- Consultant needs to confirm and provide documentation that DNREC Air Quality Management Section permits are not required.

Design of the Barrier, Subsurface Piping and Venting

- Certified by a Delaware Professional Engineer or certified radon installer.
- Design needs to include a description of how the barrier and piping will meet vapor barrier requirements as well as drawings of the venting and details on the installation of the vapor barrier.

The system needs to include the following, as applicable:

- Vapor barrier under slab seals up to the edge of the wall.
- Vapor barrier overlap of 6 inches of floor sections, taped or according to manufactures details (if sheeting type material).
- All perforations of the barriers (pipes, rebar, etc.) need to be sealed
- Drawing of subsurface piping must account for concrete floor elevations changes
- Vents must have mushroom type caps to avoid water running down the vents
- Passive vents should have empty piping adjacent to the passive vents to run wiring in the future in the event that the system needs to be made into an active system.
- The barrier must seal up to pile caps, footings, walls and grade beams? (A barrier cannot be placed between floor and these types construction)
- Vapor barrier on outside or inside of elevator pits (if contaminated water may enter building-upon DNREC discretion).
- Elevator moved to avoid contaminated groundwater or soil.
- Vents not near any air intakes or any area where air could be sucked back into the building.
- Subsurface venting conform to the Los Angeles Building Codes
- If in a house or other residential structure, the basement slab and any sumps must be sealed

Installation and Documentation

- Prior to installation, hold a pre-construction meeting between DNREC, installer and concrete contractor and go over construction details.
- Document that the vapor barrier is intact prior to installation of concrete floor (ie. Typically through the use of a smoke test)
- Photo document all installation

For other questions or other types of remediation systems, please see January 2007 Interstate Technical and Regulatory Council (ITRC) Vapor Intrusion: A Practical Guideline, Section 4.3. This document is available at <http://www.itrcweb.org/homepage.asp>

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