United States
Environmental Protection
Agency

Office of Emergency and
Remedial Response
Washington, DC 20460

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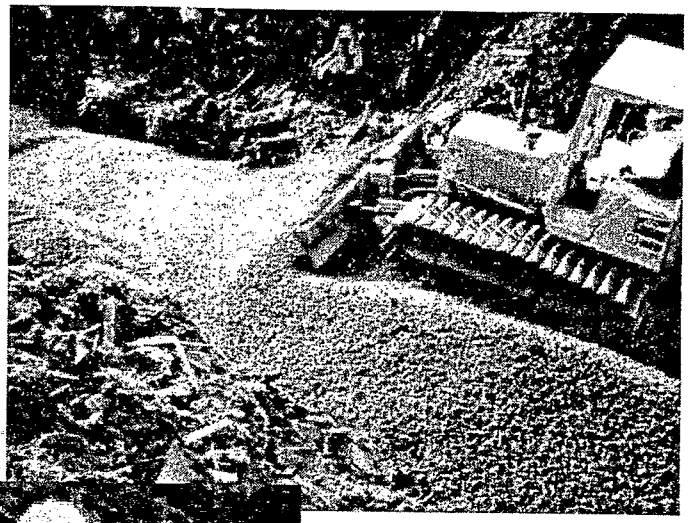
October 1997

EPA

Implementing Presumptive Remedies



A Notebook of Guidance and Resource Materials

WHAT'S IN THIS PRESUMPTIVE REMEDY NOTEBOOK

Superfund's extensive experience in complex toxic waste site cleanup has revealed certain consistencies in site characteristics and remedies. Some categories of sites have similar characteristics, such as types of contaminants present, past industrial use, or environmental media affected. The "presumptive remedy" initiative looks for remedies that are appropriate for specific site types and/or contaminants. Its objective is to use the program's past experience to streamline site investigations and make remedy selection speedier and more predictable. The five types of sites for which there is (or soon will be) presumptive remedy guidance are:

- VOCs in Soils
- Municipal Landfills
- Metals in Soils (scheduled for early FY98 release)
- Wood Treaters
- Contaminated Ground Water

So, what are the advantages of using the presumptive remedies? They offer several advantages over the conventional remedy selection process. Presumptive remedies:

- **Save time and money** — At municipal landfills implementing the containment presumptive remedy, for example, EPA estimates time savings ranging from 36 to 56 percent, and cost savings up to 60 percent resulting from a streamlined remedial investigation/feasibility study process.

- **Help promote consistency in the remedy selection** — Ensures that similar remedies are used for similar types of contamination and allows cross-site comparisons, which ultimately minimizes the time involved in remedy selection decisions.

- **Improve the predictability of the remedy selection process for communities and PRPs** — Allows interested parties to review previous actions taken at similar sites—increasing their comfort level in accepting the selected remedy and hastening the selection process.

- **Take no extra time or effort** — The steps you must follow to implement a presumptive remedy are aspects of your daily job duties. In other words, these savings can be achieved without increasing your workload, and they may even streamline your workload.

- **Are supported by experts** — RPMs can access presumptive remedy experts that will be able to provide support and information to assist you during implementation.

- **Are NCP compliant** — The use of presumptive remedies advances the NCP remedy selection objectives in that they promote consistency in decision-making and carry out the screening step in a generic manner. This approach minimizes the steps needed to perform this analysis at a site-specific level.

Presumptive remedies are also Superfund policy. EPA guidance states that presumptive remedies are expected to be used at all appropriate sites, except under unusual site-specific circumstances. This means that RPMs working at the types of sites represented in this notebook ***should*** investigate the possibility of implementing a presumptive remedy.

This notebook contains the current guidance, users guides, and supplemental information available on specific presumptive remedies, including names and numbers of colleagues you can call for advice. Contents include:

Chapter 1 — Three general fact sheets on presumptive remedies including one that can be used to help explain the benefits to communities, and a presumptive remedies directive from Richard Guimond.

Chapter 2 — VOCs in Soils and related information

Chapter 3 — Municipal Landfills and related information

Chapter 4 — Wood Treaters and related information

Chapter 5 — Contaminated Ground Water and related information

Chapter 6 — Administrative Record Requirements and related information

An annotated table of contents follows this introduction which contains a brief description explaining each of the documents in the notebook. The notebook will be updated periodically as new information or guidance becomes available; new chapters will be added as appropriate.

Presumptive remedies are not new. EPA has been using them since 1993. To date, presumptive remedies have been used or are being used at 48 Superfund sites, and more than 80 operable units, across the country. The chart on the following page provides a list of Regional contacts available to assist EPA staff in implementing presumptive remedies.

In short, EPA expects that the use of presumptive remedies will streamline cleanup actions while improving consistency, reducing costs, and speeding remediation. This notebook will provide you, the RPM, with all the tools necessary to implement a presumptive remedy at your site.

PRESUMPTIVE REMEDIES REGIONAL CONTACTS
(current as of August 1, 1997)

REGION	CONTACT	PHONE NUMBER
I	Mike Nalipinski	(617) 223-5503
II	Mel Hauptman	(212) 637-3952
III	Paul Leonard	(215) 597-3163
IV	Felicia Barnett	(404) 562-8659
V	Dion Novak	(312) 886-4737
VI	Cathy Gilmore	(214) 665-6766
VII	Diana Engemann	(913) 551-7746
VIII	Victor Kettelapper	(303) 312-6578
IX	Sean Hogan	(415) 744-2334
X	Keith Rose	(206) 553-7721

PRESUMPTIVE REMEDIES HEADQUARTERS CONTACTS
(current as of August 1, 1997)

PRESUMPTIVE REMEDY	HEADQUARTERS CONTACT	PHONE NUMBER
Contaminated Ground Water	Ken Lovelace	(703) 603-8787
Municipal Landfills	Andrea McLaughlin	(703) 603-8793
Wood Treaters	Frank Avvisato	(703) 603-8949
Metals in Soils	Richard Jeng	(703) 603-8749
VOCs in Soils	John Blanchard	(703) 603-9031

Annotated Table of Contents

General Material

1. **A Citizen's Guide to Understanding Presumptive Remedies (October 1997).** This fact sheet, written for a public audience, provides answers to general questions regarding presumptive remedies. Assumes basic Superfund knowledge. *EPA 540-F-97-019*

2. **Presumptive Remedies: Policy and Procedures (September 1993).** Written in Q&A format, this fact sheet serves as an overall guide to the presumptive remedies initiative and its effect on site cleanup. It also explains how presumptive remedies will streamline or change the remedial and removal processes and how certain Superfund policies will be affected by the initiative. *EPA 540-F-93-047*

3. **Superfund Accelerated Cleanup Bulletin: Presumptive Remedies (August 1992).** This short bulletin, written at the outset of the presumptive remedies initiative, describes Superfund efforts for developing presumptive remedies for various types of sites including Municipal Landfill Sites, Wood Treatment Sites, Solvent Sites, and Ground Water Sites. *Publication 9203.1-021*

4. **Presumptive Remedies Directives: Memo from Richard Guimond (September 1993).** This four page memo provides a brief history on the development of presumptive remedies, explains the objectives of the presumptive remedy guidance including when they are expected to be used.

VOCs in Soils

1. **Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites With Volatile Organic Compounds in Soils (September 1993).** This fact sheet identifies the presumptive remedies for CERCLA sites with soils contaminated by volatile organic compounds (VOCs). *EPA 540-F-93-048*

2. **User's Guide to the VOCs in Soils Presumptive Remedies (July 1996).** This user's guide is based on the VOCs in soils presumptive remedy guidance, *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites With Volatile Organic Compounds in Soils*, and includes recommendations on the preferred presumptive remedy for sites where VOCs are present in soil and treatment is warranted. *EPA 540-F-96-008*

3. **Presumptive Remedy: Supplemental Bulletin Multi-Phase Extraction (MPE) Technology for VOCs in Soil and Ground Water (April 1997).** This fact sheet serves as an ancillary to the guidance on presumptive remedies for VOCs in soils and provides information on the Multi-Phase Extraction (MPE) technology for extraction of VOCs present in soil and ground water. This fact sheet recommends MPE as a technology option under the VOCs presumptive remedy. *EPA 540-F-97-004*

Municipal Landfills

1. **Presumptive Remedy for CERCLA Municipal Landfill Sites (September 1993).** This fact sheet describes presumptive remedies for municipal landfills and recommends containment as the presumptive remedy for such sites. This directive also highlights the importance of certain streamlining principles related to the scoping (planning) stages of the remedial investigation/feasibility study (RI/FS). *EPA 540-F-93-035*

2. **Landfill Presumptive Remedy Saves Time and Cost (January 1997).** This bulletin summarizes the results of implementing the containment presumptive remedy at three CERCLA municipal landfill sites, including details on the achieved time and cost savings. *EPA 540-F-96-017*

3. **Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (December 1996).** This fact sheet discusses the application of the CERCLA Municipal Landfill presumptive remedy to military landfills. It also highlights a step-by-step approach to determining when a specific military landfill is an appropriate site for application of the containment presumptive remedy. *EPA 540-F-96-020*

4. **Superfund Accelerated Cleanup Bulletin: Presumptive Remedies for Municipal Landfill Sites (Volume 1 Number 1, April 1992).** This bulletin describes the kick-off of Municipal Landfill Pilot Projects to expedite site investigation and remedy selection process for municipal landfills. *Publication 9203.1-021*

5. **Superfund Accelerated Cleanup Bulletin: Presumptive Remedies for Municipal Landfill Sites (Volume 2 Number 1, February 1993).** This bulletin describes the Municipal Landfill Pilot Project and provides key findings from the pilots completed as of the date of publication (four site visits), particularly with respect to the level of detail that was appropriate for establishing risk at two of the sites. *Publication 9203.1-021*

6. **Presumptive Remedies: CERCLA Landfill Caps RI/FS Data Collection Guide (August 1995).** This fact sheet identifies the data pertinent to landfill cap design that will be required for most sites. These data are organized within six categories: (1) waste area delineation; (2) slope stability and settlement; (3) gas generation/migration; (4) existing cover assessment; (5) surface water run-on/run-off management; and (6) clay sources. *EPA 540-F-95-009*

7. **Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites (February 1991).** This streamlining manual presents the framework for the presumptive remedy for CERCLA Municipal Landfill sites and details those principles related to the scoping (planning) stages of the remedial investigation/feasibility study (RI/FS). **This document is not contained in this notebook but is a worthwhile source for more detailed information.** This document is available for a fee at: National Technical Information Center (NTIS) U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161 (703) 603-8919. *OSWER Directive 9355.3-11,Publication 91-921205*

Wood Treaters

1. **Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites (December 1995).** This directive provides guidance on selecting a presumptive remedy or combination of presumptive remedies for wood treater sites with contaminated soils, sediments, and sludges. *EPA 540-R-95-128*

2. **Superfund Accelerated Cleanup Bulletin: Presumptive Remedies for Wood Treatment Facilities (May 1992).** This bulletin describes the presumptive remedy selection initiative as it relates to wood treatment sites and provides a general overview of recommended presumptive remedies for such sites. *Publication 9203.1-021*

3. **Technology Selection Guide for Wood Treater Sites (May 1993).** This fact sheet presents information on technology performance for wood treater sites and is intended for use by a decision-making team experienced with wood treater sites. *EPA 540-F-93-020*

4. **Feasibility Study Analysis and Administrative Record for Wood Treater Presumptive Remedy: Memo from Thomas Sheckells (July 1997).** This memo transmits for Regional use the Administrative Record documents supporting the policy directive entitled "Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites." The actual administrative record is fairly large and is being forwarded to the presumptive remedies administrative records contacts listed in Attachment A. Attachment B provides a list of Presumptive Remedies Workgroup Members, and Attachment C contains a general guide on the presumptive remedies Administrative Record.

Contaminated Ground Water

1. **Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites (October 1996).** This guidance emphasizes the importance of using site-specific remedial objectives as the focus of the remedy selection for contaminated ground water and recommends a presumptive response strategy for all sites with contaminated ground water. This guidance is available on the Internet at: http://www.epa.gov/superfund/index.htm#products. *EPA 540-R-96-023*

Administrative Record Requirements

1. **Presumptive Remedies and NCP Compliance: Memo from James Costello (June 1995).** This memorandum explains the relationship of EPA's presumptive remedies initiative for CERCLA site remediation to the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. In addition, this document suggests methods for meeting the NCP administrative record requirements for Superfund sites where presumptive remedies are considered.

2. **Feasibility Study Analysis and Administrative Record for Presumptive Remedies: Memo from David Bennett (September 1994).** This memo provides a general guide on the presumptive remedies Administrative Record and is intended to assist Regional staff in understanding the administrative record documents and site-type directives for supporting presumptive remedies at individual sites.

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

Directive No. 9378.0-11FS
EPA 540-F-97-019
PB97-963303
October 1997

EPA

A Citizen's Guide to Understanding Presumptive Remedies

Office of Emergency and Remedial Response
5202G

Cleaning up abandoned hazardous waste sites has been the charge of EPA's Superfund program since 1980. Over the past 17 years, Superfund has gained considerable experience on hazardous waste cleanup approaches and technologies. As we gained experience, we found that certain sites have similar characteristics that we could use to our advantage to improve the cleanup process. The "presumptive remedy" initiative is one of the results. Essentially, we said: "Here's a site similar in all key ways to many other sites we've cleaned up. Wouldn't it make sense to use that cleanup approach here, too?"

Presumptive remedies benefit both Superfund and you—the community members affected by a Superfund site. Keep reading to find the answers to questions you may have about presumptive remedies, how they work, and why we use them.

1. What are presumptive remedies?

As Superfund worked through hundreds of cleanups, we discovered similarities. Certain types of sites, like wood treater sites, have similar chemical contaminants. Other sites, like municipal landfills, share similar characteristics. At similar sites, standard remedies (called "presumptive") can be applied. Presumptive remedies are based on historical patterns of remedy selection and our scientific and engineering evaluation of how well cleanup technologies perform. EPA now expects presumptive remedies to be considered at all applicable sites. And they should—those applicable sites make up more than 60% of sites on the National Priorities List!

2. Why use presumptive remedies?

Presumptive remedies have helped us streamline the cleanup process. This approach has led to many advantages, for you and for Superfund. When we first investigate a site, we try to decide whether it is a candidate for a presumptive remedy. If it is, then we can narrow down the cleanup choices. This could save us a lot of time in site investigation and data collection efforts. More importantly, it means that we spend less time in your community, so there are fewer disruptions. And, since the presumptive remedies have been successfully implemented at other sites, you can be confident that it will fully protect your health and your community's environment.

One of the most important advantages is that, the sooner your community knows the remedy, the sooner you can plan for how you may want to use the site once it's cleaned up. We can work with your local land planning group to help determine how the community would like to use the cleaned up site. Finally, some sites that have used presumptive remedies have shown significant time and cost savings. The more time and money we save at a site, the more resources we have available to clean up other sites.

3. What are the different types of presumptive remedies?

Presumptive remedies have been developed for four kinds of sites: municipal landfills, volatile organic chemicals (VOCs) in soils, wood treater sites, and contaminated ground water. Presumptive remedies can be grouped by the type of cleanup plan: containment, treatment, and response strategy. "Containment" holds the waste and prevents the spread of contaminants. "Treatment" uses a single technology or group of technologies to get rid of the contaminants. A "response strategy" is a long-term approach with several steps and options to decide among treatment and containment options for different sections of a site.

4. What is the presumptive remedy for municipal landfills?

The presumptive remedy for municipal landfills is containment, which can include some or all of the following components, as appropriate, on a site-specific basis: landfill cap, to minimize infiltration of rain water through the buried waste and to ground water below; leachate collection and treatment; source area ground water control to contain plume; landfill gas collection and/or treatment; and institutional controls to ensure that the integrity of the landfill cap is preserved.

5. What is the presumptive remedy for a site with VOCs in the soils?

We have three presumptive remedy technologies to treat a site with soils contaminated with VOCs. The preferred remedy is *soil vapor extraction*. With this method, we can leave the soil in place and remove contaminants with a process that forces air through the soil. The other choices are *thermal desorption* and *incineration*. Both of these technologies require us to excavate the soil and treat it with a process using heat. Once the soil is treated, cleaned, and tested, we can return it to the site.

6. What is the presumptive remedy for a wood treater site?

The presumptive remedy for a wood treater site depends on the types of contaminants located at the site. If the contaminants are organic, we use *bioremediation*, *thermal desorption*, or *incineration*. If they are inorganic, we use *immobilization*. Bioremediation is a natural process that uses microorganisms, such as bacteria, fungi, or yeast, that "eat" harmful contaminants and transform them into nonhazardous products. Thermal desorption and incineration are the same technologies described above to treat VOCs in soils. Immobilization does not treat the contaminants, but rather prevents them from spreading. This process mixes the hazardous substances with chemicals and cement-like materials to bind them and makes them immobile and inactive.

7. What is the presumptive remedy for a site with contaminated ground water?

We use a response strategy to address sites with contaminated ground water. This means we take a phased approach to characterize and clean the site. Information from each sequence of steps, or phase, helps us to improve future investigations or actions. Basically, this presumptive remedy helps us with the *process* of selecting a remedy rather than choosing a particular remedy.

8. Couldn't this "cookie cutter" approach overlook special problems at my site?

No. Presumptive remedies are meant to improve the remedy selection process, not undermine it. Our site investigation professionals use their expertise to examine every site carefully. EPA is committed to the best and the safest cleanup for every community. And Superfund understands your community's need to find a unique solution to your unique problems. You can rest assured that when a full-length investigation of the remedy alternatives is considered necessary, we will do it.

9. Can the community ask EPA to consider other cleanup alternatives?

Your voice will be heard! Communities are full partners in the remedy selection process. If residents request it, we will consider investigating other cleanup approaches even if a presumptive remedy exists, or give you a full explanation of why the presumptive remedy was selected. We will assess each suggested alternative on its own merits, and may proceed with further studies.

Presumptive remedies still add value even if we include other approaches. Presumptive remedies provide a baseline for protecting human health and the environment; if we consider other specific cleanup alternatives, they add additional layers of protection.

For more information about each presumptive remedy, see the box titled "For Further Reading."

For Further Reading

The following documents are available at:

National Technical Information Service (NTIS)
(703) 487-4650 (800) 553-NTIS (*rush service only*)

- VOCs in Soil, EPA 540F-93-048/PB93-963346
- Municipal Landfills, EPA 540-F-93-035/PB93-963339
- Wood Treater Sites, EPA 540/R-95/128 PB-963410
- Ground Water Strategy, EPA 540/R-96/023 PB96-963508

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

Directive: 9355.0-47FS
EPA 540-F-93-047
PB 93-963345
September 1993

EPA

Presumptive Remedies: Policy and Procedures

Office of Emergency and Remedial Response
Hazardous Site Control Division 5203G

Quick Reference Fact Sheet

Since Superfund's inception in 1980, the remedial and removal programs have found that certain categories of sites have similar characteristics, such as types of contaminants present, types of disposal practices, or how environmental media are affected. Based on information acquired from evaluating and cleaning up these sites, Superfund is undertaking an initiative to develop presumptive remedies to accelerate future cleanups at these sites. The presumptive remedy approach is one tool of acceleration within the **Superfund Accelerated Cleanup Model (SACM).**

The objective of the presumptive remedies initiative is to use the program's past experience to streamline site investigations and speed up selection of cleanup actions. Over time presumptive remedies are expected to ensure consistency in remedy selection and reduce the cost and time required to clean up similar types of sites. Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances. EPA plans to develop a series of directives on presumptive remedies for various types of sites.

This directive serves as an overall guide to the presumptive remedies initiative and its effect on site cleanup. Through a question and answer format, it explains, in general terms, ways in which presumptive remedies will streamline or change the remedial and removal processes from the conventional processes and how certain Superfund policies will be affected by the initiative. This directive also unites the series of directives, due to come out over the next year, on presumptive remedies for specific site types (e.g., Volatile Organic Compounds (VOCs), wood treaters, ground water). This general directive, together with the site type-specific directives, will provide readers with a comprehensive knowledge of the procedural as well as policy considerations of the presumptive remedies initiative. The directive is designed for use by staff involved in managing site cleanups (e.g., Remedial Project Managers (RPMs), On-Scene Coordinators (OSCs), Site Assessment Managers (SAMs)). Site managers in other programs, such as RCRA Corrective Action, the Underground Storage Tank program, State Project Managers, or private sector parties, may also use this directive, as appropriate.

Provided below are several common questions and answers regarding general issues associated with presumptive remedies.

Q1. What Are Presumptive Remedies and How Should They Be Used?

A. Presumptive Remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. EPA has evaluated technologies that have been consistently selected at past sites using the remedy selection criteria set out in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); reviewed currently available performance data on the application of these technologies; and has determined that a particular remedy, or set of remedies, is **presumptively** the most appropriate for addressing specific types of sites.

Presumptive remedies are expected to be used at all appropriate sites. The approaches described in each presumptive remedies directive are designed to accommodate a wide range of site-specific circumstances. In some cases, multiple technologies are included (e.g., VOCs); in others, various

components of the presumptive remedy are optional, depending on site situation (e.g., municipal landfills). Further, these directives recognize that at some sites, there may be unusual circumstances (such as complex contaminant mixtures, soil conditions, or extraordinary State and community concerns) that may require the site manager to look beyond the presumptive remedies for additional (perhaps more innovative) technologies or remedial approaches.

These tools will help site managers to focus data collection efforts during site investigations (e.g., remedial investigations, removal site evaluation) and significantly reduce the technology evaluation phase (e.g., Engineering Evaluation/Cost Analysis (EE/CA) and/or Feasibility Studies (FS)) for certain categories of sites. The specific impacts on the various stages of the remedy selection process are highlighted in questions 7 and 8 of this guidance. It is advised that presumptive remedies be used with the assistance of the expert teams[1] for the various categories of sites.

Q2. Why Should Presumptive Remedies Be Used?

Presumptive remedies are expected to have several benefits. Limiting the number of technologies considered should promote focused data collection, resulting in streamlined site assessments and accelerated remedy selection decisions which achieve time and cost savings. Additional time savings could be realized during the remedial design since early knowledge of the remedy may allow technology-specific data to be collected upfront during the remedial investigation (RI). Presumptive remedies will also produce the added benefit of promoting consistency in remedy selection, and improving the predictability of the remedy selection process for communities and potentially responsible parties (PRPs).

Presumptive remedies may be used as part of a wide variety of response actions. These actions include non-time-critical removal and early remedial actions, actions at sites with different leads (e.g., Fund-lead, State-lead, PRP-lead), actions addressing one or more contaminated media, actions with several operable units, and actions involving treatment trains.

Q3. Can Presumptive Remedies be Implemented Within the Existing NCP Process?

Yes. The presumptive remedy approach is consistent with all of the requirements of the NCP, and in particular the site management principle of streamlining (see section 300.430(a)(1)(ii)(C)). The presumptive remedy approach simply consolidates what have become the common, expected results of site-specific decision making at Superfund sites over the past decade. The various presumptive remedies directives and supporting documentation (e.g., "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils") provide the basis for an administrative record which justifies consideration of a very limited number of cleanup options. These materials summarize the findings of EPA's research and analysis, and the reasons that were found for generally considering certain technologies more or less appropriate.

The availability of presumptive remedies does not preclude a Region from expanding the FS (either on its own initiative or at the suggestion of outside parties) to consider other technologies under unusual site-specific circumstances. The site type directives will define the kind of circumstances (e.g., soil conditions, heterogeneous and complicated contamination mixtures, field tests demonstrating significant advantages of alternate or innovative technologies, etc.) that may make presumptive remedies less clearly suited for particular sites. Most of these directives also provide references to additional technologies if the presumptive remedies are found not to apply at a particular site.

Q4. How Did the Presumptive Remedies Initiative Evolve?

A. The general concept of presumptive remedies was first proposed in 1990 during the Superfund 90-Day Study and subsequently in 1991 during the 30-Day Study as a method of accelerating the remedial process. These management studies were efforts to generate options for accelerating the overall Superfund clean-up process. The presumptive remedies initiative is also consistent with, and supports, a larger program initiative known as the Superfund Accelerated Cleanup

[1] It is envisioned that for most categories of sites, teams of experts (technical, legal, policy, etc.) who have developed the presumptive remedies guidance and Regional site managers conducting field demonstrations, will be available to assist site managers in implementing presumptive remedies on a site-specific basis.

Table 1
Current Presumptive Remedies and Contacts

Site Type/Schedule	Presumptive Remedy(ies)	Anticipated Products	EPA Contact
General Policy and Procedures (9/93)	NA	*Presumptive Remedies: Policy and Procedures*	Shahid Mahmud Headquarters, HSCD (703) 603-8789
Volatile Organic Compounds (VOCs) in Soils (9/93)	Soil Vapor Extraction, Thermal Desorption, Incineration	*Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with VOCs in Soils*	Shahid Mahmud Headquarters, HSCD (703) 603-8789
Wood Treaters (6/94)	For Organics - Incineration, Bioremediation, Dechlorination For Inorganics - Immobilization	*Presumptive Remedy: Wood Treating Sites* *Technology Selection Guide for Wood Treater Sites (5/93)*	Lisa Boynton Headquarters, ERD (703) 603-9052 Harry Allen Emergency Response Division (908) 321-6747
Municipal Landfills (9/93)	Containment (could include capping, leachate collection and treatment, LF gas treatment, institutional controls, etc.)	*Presumptive Remedy for CERCLA Municipal Landfill Sites*	Andrea McLaughlin Headquarters, HSCD (703) 603-8793
Contaminated Ground Water (1/94)	Pump and Treat (Will specify preferred treatment technologies & describe overall approach)	*TBD*	Ken Lovelace Headquarters, HSCD (703) 603-8787
Region 7 Pilots - PCB Sites, Coal Gas Sites, Grain Storage Sites (6/94)	TBD	*TBD*	Diana Engeman Region 7 (913) 551-7746

KEY:
TBD - To Be Determined
NA - Not Applicable

Model (SACM). SACM incorporates the experience gained from past Superfund actions into an integrated approach to site cleanup aimed at getting response action decisions made and implemented more quickly. The presumptive remedies initiative is one mechanism for accomplishing the broad streamlining goal set forth by SACM. The presumptive remedies initiative was also identified as one of the Administrative Improvements to Superfund in June of 1993.

Q5. What Other Presumptive Remedy Initiatives Are Underway or Planned?

A. There are a variety of presumptive remedy activities currently planned or underway. Table 1 lists the site types with the anticipated schedule of associated presumptive remedy products that are currently underway along with the Headquarters and Regional contacts. There are four site types for which presumptive remedies are being developed in EPA Headquarters: VOCs, wood treaters, municipal landfills, and contaminated ground-water sites. Concurrently, Region 7 is preparing presumptive remedy guidances for PCB, coal gasification, and grain storage sites.

Q6. How Will Presumptive Remedies Affect the Remedy Selection Process?

A. Presumptive remedies are anticipated to affect several phases of the current remedy selection process. A diagram depicting the generic impacts on the overall process is provided in Table 2.

Data collection during the initial site assessment (Preliminary Assessment/Site Inspection (PA/SI)

Table 2
Generic Effect of Presumptive Remedies

Phases of Cleanup Process	Effect on Cleanup Process
PA/SI or Removal Site Evaluation	X
Scoping	
• Collect and analyze existing data	○
• Identify initial project/OUs and remedial action objectives	⊘
• Identify range of likely alternatives	⊘
• Identify potential ARARs	○
• Identify initial DQOs	○
• Prepare project plans	⊘
Remedial Investigation	
• Conduct field investigation	X (1)
• Define nature and extent of contamination	○ (1)
• Identify ARARs	○
• Conduct baseline risk assessment	○ (1)
Remedy Selection	
• Identify potential treatment technologies and containment/disposal requirements	●
• Screen technologies	●
• Assemble technologies into alternatives	●
• Screen alternatives as necessary to reduce number subject to detailed analysis	●
• Further refine alternatives as necessary	⊘
• Analyze alternatives against the nine criteria and each other	⊘
Proposed Plan	⊘
Record of Decision	⊘
Remedial Design	⊘

) = Not impacted ⊘ = Streamlined

x Focused ● = Eliminated

Streamlined for Municipal Landfills

or Removal Site Evaluation) can be used to help define the specific site type and to determine whether presumptive remedies may be potentially applicable.

Assuming the site warrants further attention (i.e., it is listed on the National Priorities List (NPL) or determined by the Regional Decision Team (RDT) to be an NPL-caliber site or to merit a removal action), further confirmation of the site type should take place as either an RI/FS or EE/CA is scoped to determine whether the site is a potential candidate for presumptive remedies. For a detailed discussion of how to make this determination, refer to the appropriate site type-specific directive. If it is determined that the site falls into a certain category, the presumptive remedies associated with that site type should be included in the list of likely remedial alternatives (e.g., no action, presumptive remedies, etc.) for the site. Other aspects of scoping that may be affected by presumptive remedies are the designation of appropriate operable units (OUs) and identification of data needed to support the evaluation and selection of a presumptive remedy.

Presumptive remedies are expected to help focus data collection efforts. Specifically, initial data collection would focus on confirming the site type. If the site is of the type for which presumptive remedies have been developed, the streamlined steps for site characterization outlined in the site type-specific directive for the particular site type should be followed. These steps outline data collection to determine the extent of contamination and to support selection of the presumptive remedy and Remedial Design (RD).

Presumptive remedies will streamline the FS and the alternatives analysis in the EE/CA more than any other phase of the remedy selection process. In most cases, after a site is confirmed as being a type for which presumptive remedies exist, a focused FS or EE/CA which eliminates the technology identification and screening step would be prepared. The study would limit its consideration to the no action alternative and the presumptive remedy technologies. This is possible because EPA has conducted an analysis of potentially available technologies for most of the presumptive remedies site categories and has determined that certain technologies are routinely and appropriately screened out either on the basis of effectiveness, implementability, or excessive cost (NCP Section 300.430 (e)(3) and (7)), or have not been selected under the nine criteria analysis identified in NCP Section 300.430 (e) (9). This detailed analysis will serve to substitute for the development and screening of alternatives phases of the FS (and will allow the

remaining alternatives to be limited to variations of the presumptive remedy). The site-specific directive and supporting documentation (e.g., "Feasibility Study Analysis for CERCLA Municipal Landfill Sites") along with this directive then can be placed in the administrative record for the site to support the elimination of the screening step identified in section 300.430 (e) (1) of the NCP. Further supporting materials can be provided by Headquarters (e.g., FS reports included in the analysis, technical reports), as needed. The specific presumptive remedy directives address the process of eliminating the alternatives development and screening step of the RI/FS or EE/CA in further detail. The directives also provide generic discussion of a partial nine criteria analysis (excluding state ARARs and community and state acceptance) and may help streamline the detailed analysis of alternatives within the FS and EE/CA reports. However, the user is cautioned that the criteria are discussed on a general basis and the nine criteria analysis should be supplemented to reflect the site-specific conditions.

The Proposed Plan (PP) and subsequent ROD would be similarly streamlined by focusing only on the presumptive remedy(ies). The remedial design (RD) may be streamlined since some RD data will likely have been collected previously during the site assessment and RI.

Q7. How Will Presumptive Remedies Affect the Removal Process?

A. Non-time critical removal actions are anticipated to be used more often to accomplish early actions at Superfund sites under SACM. The presumptive remedies approach will focus the data collection during the removal site evaluation and reduce the number of technologies identified and analyzed in the EE/CA. Presumptive remedies are not expected to have an impact on emergency and time-critical actions under the removal program.

Q8. What are the Implications of Presumptive Remedies for Innovative Technologies?

The NCP in section 300.430 (a) (1) (iii) (E) states that "EPA expects to consider using innovative technology when such technology offers the potential for comparable or superior treatment performance and implementability, fewer or lesser adverse impacts than other available approaches, or lower costs for similar levels of performance than demonstrated technologies." The use of the presumptive remedies may tend to reduce the frequency of the full evaluation of innovative technologies. However, as indicated previously, the presumptive remedies provide a tool for streamlining the remedy selection process. They do not preclude the consideration of innovative technologies should the technologies be demonstrated to be as effective or superior to the presumptive remedies. Innovative technologies may be evaluated and recommended in addition to the presumptive remedies where these criteria are met.

EPA encourages review of the latest Innovative Technologies Semi-Annual Reports or Engineering Bulletins for the up-to-date information on the potential effectiveness and applicability of various innovative technologies. Site managers are strongly encouraged to involve the site-type expert team (see Question 13) to determine whether unusual circumstances exist to consider a non-presumptive remedy based on site-specific conditions and/or community, state, and PRP concerns, or the availability of a potentially promising innovative technology.

Q9. How Will Presumptive Remedies Affect Risk Assessments?

A. Generally, the role of baseline risk assessments under the presumptive remedy approach would be unaffected with Municipal Landfill sites being a notable exception. It is anticipated that risk assessments would still be needed on a site-specific basis to assist site managers in determining the need for a response action. EPA managers have indicated the value of the risk assessment in communicating with states, PRPs, and local communities about the nature and extent of health and environmental threats. Therefore, it is recommended that the current risk assessment process be continued on an individual site basis except for Municipal Landfills. The site manager should refer to the EPA Directive entitled "Presumptive Remedy for CERCLA Municipal Landfill Sites," Directive No. 9355.0-49FS to identify streamlining opportunities at Municipal Landfill sites.

Guidance on developing risk-based preliminary remediation goals (PRGs) would be unaffected under this initiative. These goals are needed for individual sites especially in the absence of ARARs to assist in determining which remedial options

will result in medium-specific chemical concentrations that are protective of human health. For example, there may be several candidate presumptive remedies identified in the site-type directives. But it is the extent and degree of contamination across a given site that will determine whether a technology, which is predicted to reduce a chemical's concentration to some specified level, will be adequate by itself to produce protective concentrations following remedial action. For some sites or site locations, because of the magnitude of contamination or co-occurrence of contaminants, it may be necessary to assemble several technologies into a treatment train to adequately reduce levels of all chemicals of concern in a medium to protective levels. In other cases, it may be necessary to evaluate the use of institutional and/or engineering controls on an area following remediation to ensure protection during subsequent land use. In other words, it is not reasonable to assume that because a specific technology resulted in "protection" at one site, it will result in protective levels at all sites. A determination that the selected remedy will result in protection of human health and the environment must be made for each site. Both ARARs and risk-based PRGs are important tools in this exercise.

Generally, presumptive remedy directives will specify those technologies that have been determined to achieve levels protective of human health and the environment under a variety of site conditions. However, because all sites differ to some extent, especially in their relation to surrounding communities and sensitive ecosystems, a determination must still be made on a site-specific basis as to how a given remedy design is expected to achieve "protectiveness" during remedy construction and following remedial action. Overall protection of human health and the environment is one of two threshold considerations (the other being compliance with ARARs) that must be met in order for an alternative to be eligible for selection as the remedy for a given site.

Q10. What if Outside Parties such as PRPs or the Community Want Other Alternatives Considered?

A. The identification of a presumptive remedy does not relieve EPA of the obligation to propose the remedy for public comment, or to respond to comments suggesting that other alternatives should have been considered. In some cases, the information in the site-type directive and supporting documentation may be sufficient to address such comments; in others, additional analysis may be required to assess the relative merits of an alternative technology proposed by a commenter.

To reduce the risk of delay due to the need to respond to such comments, it is generally desirable to publicize the planned use of presumptive remedies early on, and give States, communities, PRPs, and others an early opportunity to express any concerns they may have about focusing the FS or EE/CA in this way. The agency may then decide whether to include additional alternatives in the FS or EE/CA so that those concerns can be addressed before the remedy is proposed.

In general, it is expected that the directive and supporting documents will provide substantial justification for preferring the presumptive remedy over alternative technologies. Therefore, the submission of comments advocating other approaches does not necessarily require broadening of the FS or EE/CA, or conducting additional analysis after the plan has been proposed. Whether additional documentation is required will depend upon how substantial or persuasive the comments are (e.g., whether a comment identifies unusual site circumstances that seriously call into question the applicability of the presumptive remedy). The Region will have to assess this by evaluating each comment on its own merits.

It should be noted that even if the FS is broadened to consider alternatives other than the presumptive remedy, much of the benefit of the presumptive remedy approach can still be achieved. In such cases, it is not necessary to address the full array of possible technologies, rather only the presumptive remedy and the specific alternative(s) that genuinely warrant detailed study. Therefore, the FS can still be narrowed and data gathering can still be focused.

Q11. How do State ARARs Affect the Use of Presumptive Remedies?

A. Any remedy, including presumptive remedies, must be selected in accordance with Section 121(d)(2)(A)(ii) of the Comprehensive Environmental Response, Compensation and Liability Act

(CERCLA), which specifies that selected remedial actions comply with promulgated standards under Federal and more stringent State environmental laws (i.e., State ARARs). At this time it is difficult to predict situations where presumptive remedies will not comply with State ARARs, and such issues must necessarily be addressed on a site-specific basis. However, as the presumptive remedies have been widely selected, they are likely to be capable of meeting State ARARs.

Q12. What Are the Implications of Presumptive Remedies on Community, PRP, and State Relations?

A. It will generally be desirable to notify the community, State, and PRP(s) as early in the clean-up process as possible that presumptive remedies are being considered for the site. This notification can take the form of a fact sheet, a notice in the newspaper, and/or a public meeting in which the site manager (with assistance from the expert team, as desired) explains the rationale for taking such actions and distributes the appropriate directives of the site type in question. Additionally, the site manager should explain the potential benefits associated with the use of presumptive remedies such as time and cost savings, and consistency. Early discussions about the rationale for presumptive remedies should help instill confidence in both the technologies and remedy selection processes.

Q13. How Will EPA Communicate Progress on Current Presumptive Remedies, Newly Developed Presumptive Remedies, and Future Issues Related to Presumptive Remedies?

A. Information about presumptive remedies will be communicated in several ways. First, it is anticipated that an orientation will be provided to communicate the key elements of presumptive remedies to Regional site managers as appropriate. This may be followed by periodic meetings with expert teams, if necessary, to scope out the applications of presumptive remedies on a site-specific basis. The expert team may also be used to convey any new developments on technology or policies and procedures for general or specific applications. A quarterly conference call is also anticipated between site managers and the expert teams to allow for the exchange of ideas and to identify and resolve technical issues. Technology selection directives, SACM Bulletins, and Q&A directives will be published periodically to disseminate information on presumptive remedies and related issues as they arise. Finally, the presumptive remedies directives on the various site categories will be updated every several years to reflect new technology development and up-to-date performance data, as appropriate.

Notice:

The policies set out in this document are intended solely as guidance to the U.S. Environmental Protection Agency (EPA) personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change the guidance at any time without public notice.

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

Publication 9203.1-02I
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EPA

Superfund Accelerated Cleanup Bulletin

Presumptive Remedies

Superfund Revitalization Activity
Office of Emergency and Remedial Response
Hazardous Site Control Division OS-220W

Intermittent Bulletin
Volume 1 Number 3

Since Superfund's inception in 1980, the removal and remedial programs have found that certain site categories have similar characteristics, such as types of contaminants present, past industrial use, or environmental media affected. Based on a wealth of information acquired from evaluating and cleaning up these sites, Superfund is undertaking an initiative to develop presumptive remedies that are appropriate for specific site types and/or contaminants. This initiative is part of a larger program, known as the Superfund Accelerated Cleanup Model (SACM), which is designed to speed all aspects of the Superfund clean-up process.

The objective of the presumptive remedies initiative is to use clean-up techniques shown to be effective in the past at similar sites in the future. The use of presumptive remedies will streamline removal actions, site studies, and clean-up actions, thereby improving consistency, reducing costs, and increasing the speed with which hazardous waste sites are remediated.

This bulletin outlines the Superfund efforts underway for developing presumptive remedies for various types of sites.

Presumptive Remedy Selection Initiatives

Superfund has selected four site type categories to test the presumptive remedy selection approach. Each category was selected based on the number of potential sites, the amount of historical information available, the type of contaminants, and the technologies selected in the past for remediating these types of sites.

Superfund Accelerated Clean-up

Faster...Cleaner...Safer

Several approaches are being evaluated for determining the most effective method(s) for implementing the presumptive remedy selection process. The approaches consist of Regional training on the implementation of a streamlining guidance document for landfill sites, developing new guidance or policy to streamline remedy selection at other categories of sites, and establishing expert teams to help evaluate sites and make decisions on appropriate clean-up methods.

Municipal Landfill, Wood Treater, Solvent, and Contaminated Ground Water Sites will be the first types of sites where the presumptive remedy approach is tried at a national level. Additional pilot efforts are being tried at the Regional level on PCB, Coal Gasification, and Grain Storage sites. It is anticipated that the number of site types that lend themselves to the presumptive remedy selection process will be expanded as more information becomes available and more experience is gained on the approach.

The following is a brief description of the efforts to be carried out under each site-type category.

Municipal Landfill Sites

The goal of this initiative is to assist the Regions in implementing the recently developed guidance on *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*. The focus of the guidance is to streamline site characterization, baseline risk assessment, and selection of remedial alternatives for Municipal Landfill (MLF) sites.

A team of experienced Remedial Project Managers (RPMs) and experts on landfill construction have worked with RPMs for municipal landfill sites in Regions 1, 4, and 5. The team provided assistance in scoping a streamlined Remedial Investigation and Feasibility Study (RI/FS). These RPMs will become a resource for their Regions, and will assist other RPMs in streamlining their MLF sites.

Two additional pilots are planned for this summer. The purpose of these pilots is to bring the remaining Regions into the pilot project, so that every Region will have at

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least one individual who is knowledgeable about the streamlining methods identified in the manual. It is intended that RPMs who participate in the pilot projects will become members of an "Expert Team" for Municipal Landfills and will be available to assist other RPMs in designing streamlined processes for their sites. (Contact: Andrea McLaughlin 703-603-8793)

Wood Treatment Sites

The goal of this initiative is to speed up response actions at wood treatment sites. This acceleration will be accomplished by narrowing the list of potential technologies from which to choose a remedy, early in the remedy selection process. Program experience, guidance and an expert team will be used in concert to identify technologies that may be applied to specific situations. This approach will provide the flexibility required to accommodate site-specific characteristics, while shortening the time required to identify, select, and implement a remedy.

This initiative includes establishment of an expert team; development of a presumptive remedy selection process, using a selection outline and matrix; development of a series of fact sheets; and performance of pilot studies and ad hoc site support to implement the presumptive remedy initiative at wood treatment sites. The expert team consists of representatives from the Environmental Response Team (ERT), the Office of Research and Development (ORD), On-Scene Coordinators (OSCs) and Remedial Project Managers (RPMs) with extensive experience at wood treatment sites. The presumptive remedy selection process will follow a generic outline of site activities and rely upon a technology selection matrix to determine appropriate remedies according to technical criteria. The fact sheets will be used to report on the progress of this initiative and to distribute information on the presumptive remedy process. Pilot studies and ad hoc site support will be used to implement the initiative in the field as it is refined by the expert team. (Contact: David Ouderkirk 202-260-5614)

Solvent Sites

The goal of this initiative is to expedite response actions at sites contaminated with solvents by focusing on a limited number of effective technologies early in the remedial process. This initiative will develop guidance on standardizing remedy selection and will issue a series of fact sheets on technology selection and site characterization strategies, and clean-up criteria for solvent-contaminated soils and sediments.

As with the other site types, this initiative will include the establishment of an expert team of representatives from ERT, ORD, and experienced OSCs and RPMs to he' evaluate sites and streamline the remedy selection proce The initiative will involve conducting pilot studies to test implementation of the presumptive remedy approaches at sites contaminated with solvents. Finally, the initiative will develop a technical and policy directive on streamlining the RI/FS process at these types of sites. (Contact: Shahid Mahmud 703-630-8789)

Ground Water Sites

This initiative will consist of developing a Quick Reference Fact Sheet that discusses the selection of a presumptive remedy for sites with contaminated ground water. This is especially relevant in light of the fact that over 75 percent of sites currently listed on the National Priorities List (NPL) exhibit ground-water contamination. The development of presumptive remedies for ground-water contamination sites will include the Agency's most recent policies pertaining to sites that contain non-aqueous phase liquids (NAPLs), both dense phase (DNAPLs) and light phase (LNAPLs). In addition, EPA will evaluate publishing a notice in the Federal Register that will contain a generic evaluation of six of the nine evaluation criteria set forth for the selection of remedial alternatives in the National Contingency Plan (NCP) (excluding ARARs, and community and state acceptance). The Federal Register Notice would allow for public review and comment on the application of the six generic analysis criteria for ground-water conta nated sites. (Contact: Ken Lovelace 703-630-8787).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

SEP 0 0 1993

MEMORANDUM

SUBJECT: Presumptive Remedies Directives

FROM: Richard J. Guimond
Assistant Surgeon General, USPHS
Acting Assistant Administrator

Walter W. Kovalick, Jr.
for

TO: Director, Waste Management Division
Regions I, IV, V, VII
Director, Emergency and Remedial Response Division
Region II
Director, Hazardous Waste Management Division
Regions III, VI, VIII, IX
Director, Hazardous Waste Division
Region X
Director, Environmental Services Division
Regions I, VI, VII

PURPOSE

The purpose of this memorandum is to transmit for Regional use the three directives entitled "Presumptive Remedies: Policy and Procedures," "Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils," and "Presumptive Remedy for CERCLA Municipal Landfill Sites." These directives are a part of a continuing series of directives being developed under the recent Superfund Administrative Improvements initiative to accelerate site cleanups.

This memorandum also transmits a list of Presumptive Remedies Regional Contacts available to assist Regional staff in implementing these directives.

BACKGROUND

In January of 1992, a workgroup was formed in response to the Superfund 30-Day Study to develop "presumptive remedies" for specific types of sites and contaminants. Presumptive remedy guidance was to be based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation for common categories of sites. It was determined that the use of presumptive remedies would improve the efficiency of the Superfund process by building on past program experience and that this guidance would provide practical tools to the Regions for

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accomplishing the broad streamlining and acceleration goal set forth by the Superfund Accelerated Cleanup Model (SACM).

Through this effort, seven site categories have been identified for presumptive remedy guidance development. Two of these site types are addressed in the attached directives. Additional directives addressing woodtreater, polychlorinated biphenyls (PCBs), coal gasification, grain storage, and groundwater sites will be issued in FY 94.

OBJECTIVE

Use of the attached and subsequent directives by the Regional Decision Teams, Site Assessment Managers (SAMs), On-Scene Coordinators (OSCs), and Remedial Project Managers (RPMs) should streamline the Superfund site evaluation and cleanup process, thereby improving consistency, reducing costs, and increasing the speed at which sites are cleaned up. Generally, these benefits will be realized by eliminating the need for initial identification and screening of alternatives during the Feasibility Study (FS) or Engineering Evaluation/Cost Analysis (EE/CA), streamlining the detailed analysis step of the FS, and focusing data collection during site investigations which in turn may streamline remedial design. Additionally, it is anticipated that both the RI and the baseline risk assessment may be streamlined for municipal landfill sites.

Specifically, the "Policy and Procedures" directive discusses a number of common issues encountered in using presumptive remedies directives (e.g., impact of presumptive remedy directives on risk assessment; selection of innovative technologies). By doing so, this directive provides a broad policy and procedural framework for the full series of category-specific directives.

The "Volatile Organic Compounds (VOCs) in Soils" directive identifies Soil Vapor Extraction (SVE), Thermal Desorption, and Incineration as the presumptive remedies for Superfund sites with VOC contaminated wastes. Through use of a decision tree, this directive provides a streamlined process for site characterization and remedy selection at these types of sites. Additionally, the directive identifies both policy and practical considerations for implementing this directive.

The "Municipal Landfill" directive establishes containment as the presumptive remedy for CERCLA municipal landfills. The directive also highlights and emphasizes the importance of certain streamlining principles related to the scoping (planning) stage of the RI/FS, provides guidance concerning the level of detail that is appropriate when assessing risk associated with the municipal landfill source area, and discusses factors to consider when making the site-specific decision concerning whether characterization and treatment of hot spots is warranted.

"Demonstration" projects implementing these presumptive remedies approaches are currently underway at four municipal landfill sites and at one VOCs-in-soils site. Other demonstration sites are being sought in the above-mentioned categories to assist headquarters in evaluating the costs and benefits of implementing these directives, as well as practical lessons learned.

IMPLEMENTATION

These directives and their respective presumptive remedies are **expected to be used** at all appropriate sites. The approaches described in each directive are designed to accommodate a wide range of site-specific circumstances. In some cases, multiple technologies are included (e.g., VOCs); in others, various components of the presumptive remedy are optional, depending on site situation (e.g., municipal landfills). Further, these directives recognize that at some sites, there may be unusual circumstances (such as complex contaminant mixtures, soil conditions, or extraordinary State and community concerns) that may require the site manager to look beyond the presumptive remedies for additional (perhaps more innovative) technologies or remedial approaches.

Regional staff are encouraged to contact their Regional Presumptive Remedies Contacts with questions related to these directives (See Attachment 1). Further, quarterly conference calls will be arranged by headquarters to establish a forum for discussion of additional concerns or program experiences. The results of demonstration projects (as available) will also be discussed during these conference calls. Finally, site-type expert teams will be available to provide detailed site-specific technical assistance to Regional staff on an as-needed basis.

These directives along with detailed supporting documentation (e.g., "Feasibility Study Analysis for CERCLA sites with Volatile Organic Compounds in Soils," "Feasibility Study Analysis for CERCLA Municipal Landfill Sites") should be placed in the Administrative record to justify the presumptive remedy approach for a particular site. The above-mentioned documentation will be forwarded to the Regional Presumptive Remedies contacts this fall. Additional documentation (e.g., feasibility study reports included in the analysis, other technical reports) supporting this initiative will be available through Superfund headquarters.

Attachments

cc: Superfund Removal Managers, Regions I-X
Superfund Branch Chiefs, Regions I-X
Superfund Section Chiefs, Regions I-X
Regional Counsel Branch Chiefs, Regions I-X
OSWER Division Directors

ATTACHMENT I

PRESUMPTIVE REMEDIES REGIONAL CONTACTS

REGION	CONTACT	PHONE NUMBER
I	Mike Nalipinski	617-223-5503
II	Mel Hauptman	212-264-7681
III	Paul Leonard	215-597-3163
IV	Felicia Barnett	404-347-7791
V	Brad Bradley	312-886-4742
VI	Cathy Gilmore	214-655-6720
VII	Diana Engemann	913-551-7728
VIII	Victor Kettelapper	303-294-7146
IX	Craig Cooper	415-744-2370
X	Kevin Rochlin	206-553-2106

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

Directive: 9355.0-48FS
EPA 540-F-93-048
PB 93-963346
September 1993

EPA

Presumptive Remedies: Site Characterization and Technology Selection For CERCLA Sites With Volatile Organic Compounds In Soils

Office of Emergency and Remedial Response
Hazardous Site Control Division 5203G

Quick Reference Fact Sheet

Since Superfund's inception in 1980, the remedial and removal programs have found that certain categories of sites have similar characteristics, such as types of contaminants present, types of disposal practices, or how environmental media are affected. Based on information acquired from evaluating and cleaning up these sites, the Superfund program is undertaking an initiative to develop presumptive remedies to accelerate future cleanups at these types of sites. The presumptive remedy approach is one tool of acceleration within the **Superfund Accelerated Cleanup Model (SACM).**

Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The objective of the presumptive remedies initiative is to use the program's past experience to streamline site investigation and speed up selection of cleanup actions. Over time presumptive remedies are expected to ensure consistency in remedy selection and reduce the cost and time required to clean up similar types of sites. Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances.

This directive identifies the presumptive remedies for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites with soils contaminated by ***volatile organic compounds (VOCs).*** In addition, EPA is developing guidance on presumptive remedies for wood treatment, municipal landfill, PCB, grain storage, coal gasification, and contaminated ground-water sites. EPA has also developed a directive entitled *Presumptive Remedies: Policy and Procedures*, (Directive 9355.0-47FS) which outlines and addresses the issues common to all presumptive remedies (e.g., role of *innovative technologies*, consistency with the NCP, State, community involvement).

PURPOSE

The purpose of this directive is to provide guidance on selecting a presumptive remedy at sites with soils contaminated with VOCs. Specifically this guidance:

- Presents the presumptive remedies for this site type;
- Describes the presumptive remedy process in terms of site characterization and technology screening steps; and
- Outlines the data required to select these presumptive remedies.

Since a presumptive remedy is a technology that EPA believes, based upon its past experience, generally will be the most appropriate remedy for a specified type of site, the presumptive remedy approach will accelerate site-specific analysis of remedies by focusing the feasibility study efforts. Where several presumptive remedies are identified, EPA believes that all deserve substantial consideration before utilizing the presumptive remedy approach. EPA personnel should review the directive entitled *Presumptive Remedies: Policy and Procedures* (Directive 9355.0-47FS) for general information on the presumptive remedy process.

Soil vapor extraction (SVE), thermal desorption, and **incineration** are the presumptive remedies for Superfund sites with VOC-contaminated soil assuming the site characteristics meet certain criteria. Table 1 provides a brief description of each of these presumptive remedies.

The decision to establish these technologies as presumptive remedies for this site type is based on EPA's collective knowledge about site investigation and remedy selection for VOC-contaminated soils,

TABLE 1
Presumptive Remedies for VOCs in Soil

Soil Vapor Extraction - Soil vapor extraction (SVE) is an in-situ or ex-situ process which physically removes contaminants from ***vadose zone*** soils by inducing air flow through the soil matrix. The flowing air strips volatile compounds from the solids and carries them to extraction wells. The recovered vapors may require further treatment. In-situ SVE is the primary focus of this document.

Thermal Desorption - Thermal desorption is an ex- situ process that uses direct or indirect heat exchange to vaporize organic contaminants from soil, sediment, sludge or other solid and semisolid matrices. The vapors are then condensed or otherwise collected for further treatment.

Incineration - Incineration is an ex-situ engineered process that employs thermal decomposition via oxidation at temperatures usually greater than 900 °C to destroy the organic fraction of the waste.

The major difference between thermal desorption and incineration is that incineration oxidizes organic compounds, thereby destroying the hazardous material. Thermal desorption volatilizes contaminants, then concentrates them. Thermal desorption reduces the volume of contamination, but the concentrated waste stream still requires treatment. Disposal or treatment of residual waste stream, ash, and concentrated VOC effluent is not covered by this directive. Options such as off-site disposal/regeneration or reuse should be considered.

including field experience from the Superfund, Resource Conservation and Recovery Act (RCRA), and Underground Storage Tank (UST) programs. In addition, EPA conducted an analysis of FY86 to FY91 Records of Decision (RODs) for sites where VOC contamination drove remedy selection. The results of this analysis, which are provided in Appendix A, demonstrate that these three technologies represent over 90% of the remedies selected in the RODs analyzed.

USE OF DOCUMENT

This directive is primarily intended for use by Superfund site managers. However, site managers in other programs (such as RCRA corrective action, the UST program, States), and the private sector, may also use this directive.

This directive is not a "stand alone" document. To ensure a full understanding of VOC site characterization and remedy selection, site managers should refer to all documents cited in the directive. For assistance in understanding complex site conditions, an experienced site manager, the presumptive remedy expert team, the Superfund Technical Assistance and Response Team (START) team, or the Environmental Response Team should be consulted.

ANTICIPATED BENEFITS OF PRESUMPTIVE REMEDIES

Use of this directive will reduce cost and time in remedy selection at VOC sites in the following ways:

1. The directive facilitates identification of the presumed or likely remedial options early in the investigation process, hence allowing for a more focused collection of data during the remedial investigation (RI) or removal site evaluation. In addition, knowledge of the presumptive remedy may facilitate collection of some remedial design data before the ROD or action memo, thereby allowing the action to proceed more quickly after signature of the decision document.

2. This directive eliminates the need for the initial step of identifying and screening a variety of alternatives during the Feasibility Study. Additionally, it will reduce the number of technologies identified and analyzed in the EE/CA. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Section 300.430(e)(1)) states that "the lead agency shall include an alternatives screening step, when needed, (emphasis added) to select a reasonable number of alternatives for detailed analysis." EPA's analysis of feasibility studies for VOC-contaminated soil sites (see Appendix A) found that certain technologies are routinely screened out based on effectiveness, implementability, or excessive costs, consistent with NCP Section 300.430(e)(7). Accordingly, EPA has determined that, when using presumptive remedies at VOC-contaminated sites, site-specific identification and screening of alternatives is not necessary. However, this directive and supporting documentation (see "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils") should be included in the Administrative Record for all sites that use the presumptive remedy(ies) to document the basis for eliminating the "site-specific identification and

TABLE 2
Typical VOCs Addressed by this Directive

Halogenated Volatile Organics

Carbon Tetrachloride
Chlorobenzene
Chloroethane
Chloroform
1,1-Dichloroethane
1,1-Dichloroethylene
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloroethylene
1,2-Dichloropropane
1,4-Dichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
Ethylene Dibromide
Methylene Chloride
Tetrachloroethylene
Trichloroethylene
Vinyl Chloride

Non-Halogenated Volatile Organics

Ketones/Furans
Acetone
Methyl Ethyl Ketone
Methyl Isobutyl Ketone

Aromatics
Benzene
Ethyl Benzene
Styrene
Toluene
m-Xylene
o-Xylene
p-Xylene

Note: Other compounds that have physical/chemical characteristics similar to the compounds listed may also be addressed by the presumptive remedy process.

screening of technologies" section. In addition, other supporting materials (e.g., FS reports included in the analysis, technical reports) will be made available at EPA Headquarters and are available for inclusion in the Administrative Record if needed.

3. This directive streamlines the detailed analysis portion of the FS. Remedial alternatives developed for a site must be evaluated against the nine criteria (required under NCP Section 300.430(e)(9)). Under this presumptive remedy approach, the detailed analysis can be limited to the three presumptive remedies (in addition to the no-action alternative), thereby streamlining that portion of the FS. Appendix B provides a generic evaluation of the presumptive remedies for seven of the nine criteria. This evaluation may serve as a basis for each detailed analysis conducted under the presumptive remedy process and should be augmented, as needed, to address site-specific conditions.

One of these presumptive remedies is expected to be used for all VOC sites except under unusual circumstances. Such circumstances may include unusual site soil characteristics, demonstration of significant advantages of alternate (or other innovative) technologies over the presumptive remedies, or extraordinary community and state concerns. If such circumstances are encountered, additional analyses may be necessary or a more conventional detailed RI/FS may be performed.

PRESUMPTIVE REMEDIES PROCESS

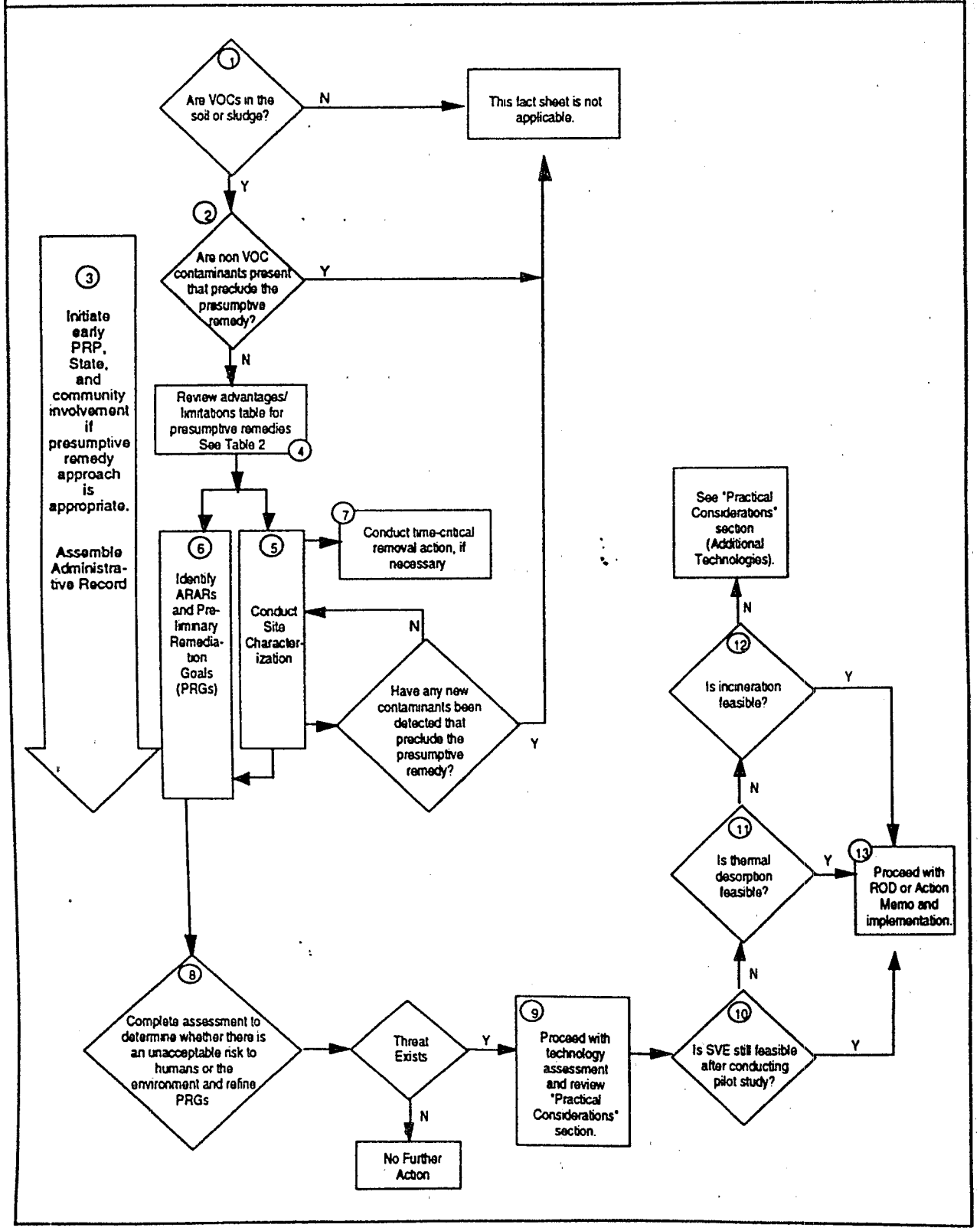
This section and the accompanying diagram (Figure 1) describe the sequence of steps involved in the presumptive remedy process (site characterization and technology selection) for sites containing soil contaminated with VOCs. While the process is not mandatory, EPA believes that following the steps outlined below will expedite the clean-up process for this category of sites.

SVE is the primary presumptive remedy. SVE has been selected most frequently to address VOC contamination at Superfund sites and initial performance data indicate that it effectively treats waste in place at a relatively low cost. In cases where SVE will not work or where there is very highly concentrated contamination, thermal desorption may be the more appropriate response technology. In a limited number of situations, incineration may be more appropriate.

The numbered paragraphs below correspond to the numbered steps in Figure 1 and provide a detailed discussion of each step.

1. *Are VOCs Present in the Soil?* The first step is to determine whether VOCs are the major contaminant present in soil at the site. Table 2 lists the VOCs that are amenable to the presumptive remedies outlined in this directive. If VOCs are present at levels of concern (see forthcoming guidance on soil screening levels), then the presumptive remedies outlined in this directive may be applicable. However, if it is confirmed (at this point or at any later point during the presumptive remedy process) that there are no VOCs present in the soil, then this directive is not applicable for use in technology selection at the site.

FIGURE 1
Decision Tree for Investigating and Selecting a Remedy at Solvent Sites



Most likely, this analysis will occur during scoping of the RI/FS or EE/CA. However, there may be only limited information available at that time about the site. Therefore, whatever information is available should be used to determine whether VOCs are present or suspected in the soil based on prior use. Chemical use at a site can be ascertained from a number of sources such as facility records, previous sampling efforts by local or State agencies or through Information Request letters.

2. *Are Non-VOC Contaminants Present That Preclude the Use of Presumptive Remedies?* In addition to determining whether VOCs are present in the soil, it is also necessary to identify other non-VOC contaminants, if any, present in the soil.

   The site characterization and technology selection procedures outlined in this directive are recommended for use primarily on soil containing VOCs only. See Table 2 for VOCs that are amenable to the presumptive remedies.

   For sites containing a mixture of VOCs and other contaminants in soil, the presumptive remedies should be considered only if they can also be effective in removing the non-VOC contaminants or combined with other, non-presumptive remedies in a treatment train, assuming the presumptive remedies do not exacerbate the problems presented by the non-VOCs. For example, sites with VOCs and metals commingled in soil may be effectively remediated by employing SVE to remove VOCs followed by fixation or solidification to address the metal contamination. In contrast, a VOC and polyaromatic hydrocarbons (PAHs) contaminant combination may be treated more appropriately with a single biological treatment scheme that would be effective for both the VOCs and PAHs. Note that sites containing mixtures of VOCs and non-VOCs are varied, and, for this reason, remedy selection may be more complicated than the framework presented in this directive; therefore, the presumptive remedy analysis may need to be supplemented or modified on a site-specific basis.

3. *Initiate Early Community, State, and Potentially Responsible Party (PRP) Involvement.* As early in the clean-up process as possible, EPA should notify the community, State, and any PRPs that a presumptive remedy is being considered for the site. It is important for all stakeholders to understand completely how the presumptive remedy process varies from the usual clean-up process and the benefits of using the presumptive remedies process.

   Early identification of State applicable or relevant and appropriate requirements (ARARs) also is a critical part of this process. Because the presumption set forth in this directive is national in scope, it does not take into account State ARARs. For this reason, State ARARs relating to the presumptive remedies should be considered on a site-specific basis. Regions may want to supplement this directive by compiling the requirements of the States in their Regions that are likely to be associated with the use of the presumptive remedies and placing them in the administrative record for a site where presumptive remedies are being considered. This directive along with the "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils" should be included in the administrative record for the site if one of the presumptive remedies is proposed for a particular VOC-contaminated site.

4. *Review Advantages/Limitations of the Presumptive Remedies.* During initial site characterization, Table 3 should be reviewed to consider the advantages and limitations of the presumptive remedies. This information may be useful in preparing for and/or modifying the site characterization or alternatives analysis process. The "Practical Considerations" section of this directive should also be reviewed at this time to ensure a comprehensive site characterization and remedy evaluation.

5. *Conduct Site Characterization.* Site characterization for sites using VOC presumptive remedies should be designed to:

   - Positively identify the site type (i.e., VOC site);
   - Obtain data to determine whether the presumptive remedy is feasible for the site;
   - Focus (and possibly streamline) site characterization by collecting data to support the selection of presumptive remedy(ies) only (e.g., volume and cost information); and,
   - Collect some design data (i.e., pilot studies to determine radius of influence and flow rates of SVE), thereby streamlining data collection during the remedial design stage.

   Table 4 lists the data that are required for characterization of sites with soil contaminated with VOCs. This table also includes the rationale for collecting these data and references for established collection methods. Note that bench-scale and pilot/treatability studies should be performed whenever possible concurrent with site characterization to define the parameters that will be important to designing the system.

   In areas with low organic content soil (e.g., alluvial basins), or where there are impediments to obtaining soil samples (e.g., under buildings), soil gas sampling

is highly recommended as a site characterization technique. In addition, the use of soil gas sampling during implementation of SVE and confirmatory soil sampling afterward is less expensive than constantly installing new soil borings, especially for deep contamination.

If incineration or thermal desorption is under serious consideration, bench-scale treatability studies may be conducted, especially if metals or other inorganic compounds are present. Thermal desorption generally should be considered if concentrations of VOCs are less than 5 to 10 percent; incineration may be appropriate if VOC concentrations exceed 5 to 10 percent. Note that excavation and mixing of soil can produce a desorber input of less than 10 percent contaminant concentration and allow thermal desorption to be chosen.

Additionally, the feasibility of excavation should be determined by evaluating surface conditions and depth of contaminants as well as the potential for any air emissions associated with the excavation. Test digs should be monitored closely to assure protection of the public and the environment.

It is important to note that during the site characterization, the volume and concentration of waste constituting the principal threats at the site should be identified. The NCP (Section 300.430(a)(1)(iii)(A) and *A Guide to Principal Threat and Low Level Threat Wastes*, Superfund Publication: 9380.3-06FS, November 1991, define principal threats as source materials, including liquids, that are highly toxic or highly mobile wastes which generally cannot be reliably contained or would present a significant risk to human health and or environment should exposure occur. In accordance with NCP expectations, waste constituting "principal threats" posed by a site generally are expected to be treated. The site manager is encouraged to characterize the site in terms of principal and low-level threat areas to determine materials to be targeted for treatment and containment.

6. *Identify Potential ARARs, To Be Considered (TBCs), and Preliminary Remediation Goals (PRGs).* Potential Federal and State ARARs and pertinent TBCs information should be identified on a chemical-, location-, and action-specific basis concurrent with site characterization. For a more detailed ARARs discussion, refer to the various ARARs fact sheets. (See *Compendium of CERCLA ARARs Factsheets and Directives*, EPA Publication 9347.3-15, October 1991).

   At this step, PRGs should also be identified (NCP Section 300.430(e)(2)(c)). Note that different health risk-based PRGs are often set for soils, depending on depth. Shallow soil levels are usually based both on direct contact exposure and protection of ground water, while levels for deeper soils are generally based only on mass transport modeling of effects on ground water. Ecological effects may also be important to consider in setting PRGs.

7. *Conduct Time-Critical Removal Action (if necessary).* During initial site characterization, data will be gathered to determine whether a time-critical removal action will be needed and to determine whether the contaminants present are amenable to the presumptive remedies. Time-critical removal actions, such as drum removal or actions addressing highly contaminated (typically small volumes) of soil, should be conducted in accordance with current guidance and regulations. The decision to take a time-critical removal action may be made by the Regional Decision Team (RDT) or if time does not permit, by an On-Scene Coordinator (OSC) or a Remedial Project Manager (RPM) in consultation with an OSC.

8. *Is There a Threat Posed by the Site?* A risk assessment must be conducted to determine if a sufficient health or environmental threat exists to warrant a removal or remedial action. (Refer to *Risk Assessment Guidance for Superfund, Volumes I and II*, EPA/540/1-89/002 and EPA/540/1-89/001). Where it is determined that such a threat exists, site-specific exposure data can be used to modify the PRGs identified in Step 6 (NCP Section 300.430(e)(2)(i)). If it is determined that such a threat does not exist, no further action at the site will be required.

9. *Proceed With Technology Assessment and Review "Practical Considerations" section.* If the analysis described in step 8 confirms that the contaminants are a threat to human health and/or the environment, a proposed remedy should then be identified.

   If this project is a remedial action, a detailed analysis using the nine criteria will be required under NCP Section 300.430(e)(9)) to justify the selection of remedy decision. Appendix B provides an analysis of SVE, thermal desorption, and incineration against seven of the nine selection criteria. In addition to the seven criteria discussed in Appendix B, community, and State acceptance must also be evaluated. If a non-time critical removal action is planned, the streamlined analysis described in the EE/CA guidance will be required that uses the three criteria of effectiveness, implementability, and cost. During the technology assessment, the factors listed in the "Practical Considerations" section of this directive should be reviewed to ensure a comprehensive evaluation of alternatives.

10. *Does the Pilot /Treatability Study Indicate that SVE is Feasible?* SVE is the primary presumptive remedy. Pilot/treatability study testing of SVE should be conducted prior to final remedy selection. Such testing will provide information on the rate of removal of contaminants. EPA/540/2-91/091A cited in the References section of this directive provides guidance on conducting the pilot/treatability study. Removal efficiencies and treatment effectiveness must be carefully considered alongside the PRGs identified in the FS to estimate the potential for successful remedial action using SVE.

11. *Is Thermal Desorption Feasible?* If SVE will not be sufficiently effective in achieving PRGs due to low permeability, lithology or insufficient removal of contamination during the pilot study, thermal desorption should be considered as the primary ex-situ presumptive remedy.

    Thermal desorption technologies cover a variety of vendors and processes. However, ample data are available to substantiate remedy selection of thermal desorption for soil contaminated solely with VOCs.

12. *Is Incineration Feasible?* If contaminant concentrations and bench-scale testing indicate thermal desorption will not achieve desired PRG levels, incineration is the second ex-situ presumptive remedy.

    If incineration is planned, and a substantial number of inorganic contaminants are expected to be present based on site characterization data, materials handling problems, or slagging problems are likely.

    If none of the three presumptive remedies is considered to be feasible at a particular site, it will be necessary to consider other technologies. (For more information, refer to the Practical Considerations section below.)

13. *Select Remedy for Remedial/Removal Action.* At this point, there should be enough data to identify a preferred remedy in the proposed plan and distribute the plan for public comment. Once the remedy has been selected in the ROD, the user can proceed to do a limited design which relies largely on the substantial amount of design-related data collected during the RI. The extent of additional or supplemental data required will be determined on a site-specific basis.

Practical Considerations

The following factors should be considered prior to taking any remedial action.

Enforcement: This directive applies to fund-lead sites as well as to sites where a PRP is conducting the investigation and/or response action. In the event that there is an ongoing PRP-lead RI/FS, the scope of work may be amended to reflect the presumptive remedy approach to site characterization and remedy selection. The potential savings in time and money to be gained by using the presumptive remedy approach are expected to outweigh the burden of modifying the scope of work in many cases.

Initial Site Actions: If the VOC material is still in original, intact containers, it may be returned to the manufacturer (if the manufacturer is willing to accept these containers), assuming this response is a cost-effective and feasible action as opposed to treating the material. Reuse of material (i.e., process liquids and relocation of equipment to other permitted facilities) should also be considered. Further, phase separation should be conducted and recycling considered depending on the purity of the recovered phase or for any existing liquids that are high enough in concentration. Refer to Appendix C for a list of the currently recognized waste exchanges.

Site Characterization: Site characterization should proceed as a single, multi-media activity whenever possible. Field screening methods should be integrated into the sampling and analysis plan in order to accelerate information gathering. Data quality must reflect the ultimate use of the information.

Ground Water: The decision maker should consider the ground-water strategy for the site since soil clean-up levels are often set to protect ground-water quality. Therefore, ground-water clean-up levels may have a direct impact on the selected clean-up levels for soil. (See forthcoming guidance on Soil Screening Levels and the directive entitled *Presumptive Remedies: Remedial Strategy and Treatment Technologies for CERCLA Sites with Contaminated Ground Water.*) It should be noted that, of the VOC-type contaminants, listed in Table 2, the halogenated volatiles are dense nonaqueous phase liquids (dense NAPLs or DNAPLs) and many of the others are light NAPLs (LNAPLs) in their pure liquid form. If LNAPLs are present, it may be possible to address them by lowering the water table, removing free product (if present), and applying SVE. To address DNAPLs contamination, refer to the above mentioned ground-water guidance.

Management of Different Soils: A situation may arise where highly contaminated shallow material cannot be addressed by SVE. The action to address this contamination may differ from the rest of the soil contamination and will most likely involve incineration or thermal desorption. If it is suspected that soil contamination existing at greater depths will also be treated in this manner, then the excavated shallow material should be staged and stored in order to treat it with the deep material.

Another situation may arise where VOCs are mixed with metals, and none of the presumptive remedies can address both sets of contaminants. The action to address this situation may consist of a treatment train where VOCs are

addressed through SVE or thermal desorption and the metals are addressed through fixation.

Finally, the site manager should be aware of situations where a mixture of principal and low-level threat wastes call for the use of treatment (i.e., SVE or thermal treatment) of principal threat waste and containment (capping) of low-level contamination. (See *A Guide to Principal Threat and Low-Level Wastes* in Reference Section).

Off-Site Disposal: In general, it may not be cost-effective to ship quantities of contaminated soil in excess of 5,000 cubic yards for off-site disposal. For this reason, pretreatment of soil and water may be required prior to shipment or discharge to another treatment facility.

Capping: Capping alone is not recommended to control the migration of VOCs. However, capping can improve the effectiveness of SVE by decreasing the rate of infiltration of residual VOCs through the vadose zone into the ground water as well as possibly increasing the radius of influence and preventing "short circuiting" of air pathways in the vicinity of the extraction well. Capping can also be used to address non-principal threat waste unless it is more cost-effective to treat this waste along with more highly contaminated materials.

Patents: SVE is a patented technology. Royalty payments may be required under certain conditions of implementation.

Attainment of Remediation Goals: It should be noted that, like other in-situ technologies, it is difficult to ascertain with confidence whether SVE will attain remediation goals until the action is actually implemented. However, the lower cost and ease of SVE implementation will often weigh heavily in its favor, as long as protection of human health and the environment is ensured.

Additional Technologies: If for some reason none of the presumptive remedies is applicable to a particular site, the site manager is encouraged to refer to EPA's forthcoming document entitled *Contaminants and Remedial Options at Solvent Sites* for a discussion of additional VOC treatment technologies. It should be noted that this comprehensive document, which identifies additional VOCs and technologies, may be appropriate to consider on a site-specific basis.

Thermal Treatment Technologies: The site manager should refer to EPA's Draft Strategy for Combustion of Hazardous Waste (May 18, 1993) when considering any thermal treatment technologies at a particular site.

Conclusion

For sites containing VOC-contaminated soil and appropriate soil characteristics, SVE is a relatively inexpensive and efficient technology. If material needs to be excavated, thermal desorption is preferred. In a few cases, incineration may be the most appropriate remedy -- for example, where SVE and thermal desorption will not meet clean-up criteria based on contaminant concentrations or composition.

As remedies other than SVE, thermal desorption and incineration become more widely used in the future, this directive may be modified to reflect these trends. For further assistance on presumptive remedy related activities consult the Regional Presumptive Remedies contact.

Notice:

The policies set out in this document are intended solely as guidance to the U.S. Environmental Protection Agency (EPA) personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change this guidance at any time without public notice.

TA. E 3
Comparison of Technologies for VOC Sites

	PERFORMANCE[1]	ADVANTAGES	LIMITATIONS	COSTS[1]
Soil Vapor Extraction	Can be as high as 99% removal of VOC contaminants but is typically lower than other technologies with range of 85-99%	• High level of effectiveness in removing VOCs. • Relatively inexpensive. • Little site disturbance; no excavation required. • Effective for waste under buildings or other construction.	• Soil that is tight or has high moisture content (>50%) has a reduced permeability to air, hindering the operation of SVE. • Soil with a high degree of heterogeneity has highly variable permeabilities, resulting in uneven delivery of gas flow to the contaminated regions, which in turn reduces removal rates by SVE. • Soil with high organic content or that is extremely dry has a high sorption capacity for VOCs, which results in reduced removal rates. • SVE may require treating residual soil tailings, liquids, and spent activated carbon. • Air emissions must be controlled to eliminate possible harm to the public and the environment. • SVE is not effective in the saturated zone. However, lowering the aquifer can expose more media to SVE (this may address concerns regarding LNAPLs).	$10 - 150/ton
Thermal Desorption	95-99% removal of VOCs	• All compounds that are listed on Table 2 are readily treated by thermal desorption. • Because of lower treatment temperatures and often lower oxygen levels, thermal desorbers should produce less nitrogen oxides and sulfur dioxide than incinerators. • Process can be performed onsite or offsite. • Lower temperatures produce fewer products of incomplete combustion (PICs).	• Requires excavation. If contamination is very deep or below the water table, excavation may be difficult and expensive. • Mercury, if present, can be removed from soil by thermal desorption and impose additional treatment costs for the offgas. • Soil containing high fractions of clay or silt may result in a high percentage of particulate carry-over from the desorber into downstream treatment devices. • Soil that contains constituents greater than 1 to 2 inches in diameter will require screening or crushing to prevent jamming the mechanical equipment. • Soil with a high moisture content (>30%) can result in low processing rates, high operating costs, and difficulty in materials handling. • High or low pH wastes may corrode the metal components of the system, requiring pretreatment. • Potential process residuals are treated solids, oversized debris, condensed contaminants and water, particulate control system solids, and contaminated activated carbon. • Air pollution control system required.	$200-300/ton
Incineration	>99% removal of VOCs	• Capable of accepting a wide range of media. • Processes can be performed onsite or offsite. • Metals can be concentrated in the residuals.	• Requires excavation. If contamination is very deep or below the water table, excavation may be difficult and expensive. • Soil containing high fractions of clay or silt may result in a high percentage of particulate carry-over from the incinerator into downstream treatment devices. • Air pollution control equipment is required. • High treatment temperatures, as compared to thermal desorption, can produce nitrogen oxides, sulfur dioxides, and PICs. • Solids with volatile metals may require additional treatment or more elaborate air pollution equipment.	$200 - 1700/ton

NOTES:

(1) Actual performance and cost for any remediation technology is highly site specific. Both depend upon the original and target clean-up level concentrations of contaminants, soil quantity to be treated, soil characteristics, and the design and operation of the remediation technology equipment used.

TABLE 4
Information Required for Characterization and Technology Selection at VOC Sites

INFORMATION	RATIONALE FOR COLLECTING INFORMATION	REFERENCE
All Technologies:		
Site Geology	SVE is most effective in porous, permeable, homogeneous soil. Highly heterogeneous soil (i.e., fractured porous rock or sands interspersed with clay lenses) may exhibit air flow channeling through highly permeable soils. Also, desorption kinetics may be slow in some situations (i.e., high organic content or high clay content soil). In these cases, mass transfer kinetics may reduce the rate of removal of SVE below that which is expected by calculations with a local equilibrium model or pilot scale experiments carried out for only a few days. Often diffusion kinetics limitations can be substantially reduced by proper design of the SVE facility.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
USGS Soil Classification	For SVE to be effective, the soil must have sufficient pneumatic permeability ($>10^{-6}$ cm^2) to permit air to move through the medium. Sandy, gravely soils are the most conductive to SVE, while clays and silts are less conductive. However, remediations using SVE in clays and silts have been successful. Soil permeability may need to be measured in the field.	ASTM D 2487 ASTM D 2488
Soil Moisture	High moisture content in soil may drastically decrease its air permeability and, thus, the effectiveness of SVE. The site must be sufficiently well drained to prevent the severe reduction in air permeability, which occurs when the percent water saturation of the soil is greater than 50%. Conversely, organics can be strongly adsorbed onto extremely dry soils, which also impedes SVE. The moisture content of the soil will affect the amount of energy required to heat the soil, the target temperature and the handling properties of fine-grained soil. Thermal desorption requires that the moisture content of the soil be less than 30%.	ASTM D 2216 ASTM D 3017
Depth to Ground Water	SVE is not effective in saturated soil. However, the water table can be lowered by pumping. Thermal desorption and incineration are more expensive for high moisture soil.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Contaminant Identity and Properties	Boiling Point - Thermal desorption target temperature is dependent on contaminant boiling point. Vapor Pressure - SVE is effective for compounds with a vapor pressure greater than 0.5 mm Hg at soil temperatures. Dimensionless Henry's Constant - SVE is effective for compounds with a dimensionless Henry's constant higher than 0.01 at soil temperatures. Water Solubility - SVE is more successful for compounds with lower solubilities. Liquid and Vapor Density - A contaminant with a density greater than water may form a DNAPL. A contaminant with a density less than water may form an LNAPL. The flow characteristics of a compound's vapor for SVE is a function of its vapor density.	CRC Chemical Handbook

TABL
Information Required for Characterization and Technology Selection at VOC Sites (Continued)

INFORMATION	RATIONALE FOR COLLECTING INFORMATION	REFERENCE
All Technologies: (continued)		
Contaminant Concentration, Location, Volume, and Depth	These data can be gathered via soil matrix and/or soil gas sampling. Soil gas sampling, both shallow and at depths, may be more appropriate, given depth to ground water and stratigraphy.	Guidance for Conducting Remedial Investigations and Feasiblity Studies Under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Presence of Pipes or Subsurface Material	The presence of water or electrical conduits, soil fracture lines, debris, or any other objects that are more permeable than the surrounding soil will be the preferred pathway for the advecting gases.	Geotechnical Techniques
SVE Only:		
Soil/Air Filled Porosity	Porosity should be less than 40% for SVE to be effective.	Guidance for Conducting Remedial Investigations and Feasiblity Studies Under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Soil/Air Permeability	Soil/air permeability should be greater than 10^{-6} cm^2 for air to move throughout the contaminated soil. SVE is potentially effective in less permeable soil (i.e., between 10^{-6} to 10^{-10} cm^2), but further pilot-scale testing and/or mathematical modeling is recommended to better predict the time for cleanup (which is likely to be prolonged for lower permeability soil).	Guidance for Conducting Remedial Investigations and Feasiblity Studies Under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Soil Temperature	Contaminant vapor pressure, dimensionless Henry's Law constant, water solubility, and phase density are strong functions of temperature.	Guidance for Conducting Remedial Investigations and Feasiblity Studies Under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Soil Humic Content	Solvents adhere strongly to soil with high humic content, which decreases the effectiveness of SVE.	Guidance for Conducting Remedial Investigations and Feasiblity Studies Under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Contaminant Soil Sorption Coefficient Kd (Since Kd is less readily available, Koc, the equilibrium between contaminants sorbed onto organic carbon versus the ground water is used.)	This parameter describes the tendency of the solvent to sorb onto soil or organic matter in the soil. Higher Koc's indicate that a subsurface is more likely to bind to carbon rich media (i.e., soil) than to remain in water.	RREL Treatability Database
Contaminant Adsorption Characteristics on Activated Carbon	This parameter is related to the feasiblity of removing contaminants from residuals by carbon adsorption. This parameter is important since compounds such as MEK become unstable as they are adsorbed onto carbon.	RREL Treatability Database

TABLE 4
Information Required for Characterization and Technology Selection at VOC Sites
(Continued)

INFORMATION	RATIONALE FOR COLLECTING INFORMATION	REFERENCE
Incineration and Thermal Desorption Only:		
Soil Plasticity	Plastic soil, when subjected to compressive forces, can become molded into large particles that are difficult to heat.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Soil BTU Content	The soil BTU content determines the fuel requirements for thermal desorption and incineration.	ASTM D 3286
Contaminant Combustion Characteristics	Information on combustion characteristics of a VOC is required in order to determine the combustion characteristics of the incinerator.	Bench/Pilot Testing
Soil Particle Size Distribution	Thermal desorption usually requires that soil be pretreated to a maximum soil particle size ranging from 1 to 2 inches.	ASTM D 422
Alkaline Metal Salts (e.g., $NaSO_4$, KSO_4)	Alkaline metal salts may cause refractory attack and slagging at high temperatures.	Percentage of Na, K
Volatile Metals Content (e.g., Hg, Pb, Cd, Zn, Sn)	High metal content may cause ash leaching and stack emissions problems.	Heavy Metals Analysis

BTU = British Thermal Units
LNAPL = Light Nonaqueous Phase Liquid
DNAPL = Dense Nonaqueous Phase Liquid
mm Hg = millimeters of mercury pressure
NAPL = Nonaqueous Phase Liquid
PIC = Products of Incomplete Combustion

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES

This Appendix summarizes the analyses that EPA conducted of Record of Decision (ROD) and Feasibility Study (FS) data from VOC-contaminated sites which led to establishing soil vapor extraction (SVE), thermal desorption, and incineration as the presumptive remedies for Superfund sites with VOC-contaminated soil. The analyses consisted of:

- Identifying VOC-contaminated sites
- Determining the frequency of technology selection for VOC sites
- Identifying sites for the feasibility study (FS) analysis
- Conducting the FS analysis.

Results of these analyses, along with the scientific and engineering analysis of the performance data on technology application (Primary Reference document), provide a support for the decision to eliminate the initial alternatives identification and screening step for this site type. These technical reviews found that certain technologies are appropriately screened out based on effectiveness, implementability, or excessive costs. Review of technologies against the nine criteria led to elimination of additional alternatives. Provided below is a discussion of each analysis.

Identification of VOC-Contaminated Sites

The first analysis involved generating a list of signed Records of Decision (RODs) (post-SARA), documenting VOC contamination, from which data could be used for subsequent analyses. The ROD Information Directory database was used for this purpose. Of the 821 signed FY86-FY91 RODs, 418 are identified in the database as containing VOC contamination in source material. This list of RODs was subsequently divided into two lists: RODs where VOCs were the only contaminants of concern identified in the source material and RODs containing VOCs, as well as other contamination, in source material. For those RODs involving VOC plus other contaminants, a review of the ROD document was conducted to identify cases where only VOCs were driving the selection of remedy. To make this determination, the Remedial Response Objectives and Selected Remedy sections of the ROD were reviewed to identify specific language indicating that the remedial action was designed to address only the VOCs at the site. In addition, if cleanup goals were specified only for VOCs, the assumption was made that VOCs were driving the remedy.

As a result of this analysis, 88 RODs were identified as VOC-only RODs or VOCs plus other contaminants RODs where a clear determination could be made that VOCs were driving the selection of remedy.

Frequency of Technology Selection for VOC-Contaminated Sites

Table 1 presents the distribution of the 88 FY86-FY91 RODs among the treatment technologies used to address VOCs in soil. This table demonstrates that the three presumptive remedies (SVE, thermal desorption, and incineration) together were selected more often (over 90% of the RODs analyzed) than the other applicable technologies. Presumptive Remedies were also those remedies where a fair amount of performance data on technology implementation was available. Furthermore, SVE, chosen in over two-thirds of the RODs analyzed, was the primary presumptive remedy selected.

Identification of Sites for Feasibility Study Analysis

The purpose of the FS analysis was to document the technology screening step in FSs of VOC-contaminated soil/sludge sites and identify the principal reasons given for eliminating technologies from further consideration. To achieve a representative sample of FSs for the analysis, sites were selected using ROD data according to the following criteria:

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES
(Continued)

Table 1

Presumptive Remedy VOC Site Treatment Summary Table, FY86-FY91*

TECHNOLOGIES USED TO ADDRESS VOCs IN SOIL	TOTAL
Bioremediation (1)	3
Incineration	11
Soil Flushing/Washing (1)	3
Soil Vapor Extraction	62
Thermal Treatment (2)	9
Total	88

Source: ROD Information Directory (RID), FY86 - FY91

Notes:
(1) Relatively limited amount of performance data available for these technologies versus the presumptive remedies.
(2) Thermal treatment includes RODs employing thermal desorption, thermal aeration, low-temperature thermal desorption, and the generic remedy "thermal treatment".

* A population of 418 RODs was identified for this study based on the parameters: FY 1986-1991, and VOC contamination of source media.

- Sites were chosen, based on the selected remedy, to ensure an even distribution among the five treatment technologies for VOCs in soil (i.e., bioremediation, incineration, SVE, soil flushing, and thermal treatment).
- Whenever possible, both VOC-only sites and VOC and other contamination sites were represented under each technology.
- Sites were selected to ensure an even distribution in geographic location, ROD signature date, and site size.

Feasibility Study Analysis

The FS analysis involves a review of the technology screening phase, including any pre-screening steps, followed by a review of the detailed analysis and comparative analysis phases in each FS and ROD. Information derived from each review was documented on site-specific data collection forms, which are available for evaluation as part of the Administrative Record for this directive. (See "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils", September 1993, available at EPA Headquarters and Regional Offices.)

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES
(Continued)

For the screening phase, the full range of technologies considered was listed on the data collection forms, along with the key reasons given for eliminating technologies from further consideration. These reasons were categorized according to the screening criteria: cost, effectiveness, or implementability. The frequency with which specific reasons were given for eliminating a technology from further consideration was then tallied and compiled into a screening phase summary table (Table 2).

For the detailed analysis and comparative analysis, information on the relative performance of each technology/alternative with respect to the nine NCP criteria was documented on the site-specific data collection forms. The advantages and disadvantages associated with each clean-up option were highlighted. In some cases, a VOC technology was combined with one or more technologies that address minor site contaminants into one or more alternatives. Only the component of the alternative which addressed the VOC contamination was evaluated in this analysis. The disadvantages of a technology/ alternative were then compiled into a detailed analysis/comparative analysis summary table, under the assumption that these disadvantages contributed to non-selection. All summary tables are available for review as part of the Administrative Record.

The FS analysis has been completed for 21 sites (representing approximately 25% of universe studied). The information from these FSs has been compiled and summarized in Table 2. Additional FS analysis is planned and will be added to the Administrative Record, when available. Table 2 demonstrates that technologies, other than the presumptive remedies, are consistently eliminated from further consideration in the screening phase due to effectiveness, implementability, or excessive costs. In addition, the analysis indicates that, although certain technologies routinely passed the screening phase, these technologies were selected infrequently because they did not provide the best overall performance with respect to the nine criteria. Together these analyses (Appendix A to this directive and "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils"), along with the scientific analysis of performance data (USEPA (In Progress) Contaminants and Remedial Options at Solvent Sites) will support the decision of using presumptive remedies and bypassing the technology identification and screening step for a particular site. As previously indicated, this factsheet and accompanying analysis should be part of the Administrative Record for the site. Further supporting materials, not found in the Regional files, can be provided by Headquarters, as needed.

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES[1]

Remedial Technology Or Treatment [2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	# FSs Where Criterion Contributed To Screening Out [3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State [4] Concerns	Community [4] Concerns
Capping	21	8	7	6	1	6	2	0	8	5	3	7	6	6	3	1	--	--
Offsite Nonhazardous Landfill	4	0	2	2	0	2	1	0	0	0	0	0	0	0	0	0	--	--
Offsite RCRA Disposal	18	12	4	2	1	3	3	2	10	3	6	7	3	9	5	7	--	--
Onsite Encapsulation	3	1	2	0	1	1	0	0	1	0	0	1	0	0	0	0	--	--
Onsite Nonhazardous Landfill	2	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	--	--
Onsite RCRA Landfill	14	1	11	2	0	8	7	0	1	0	0	1	0	1	1	0	--	--
Activated Sludge	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	--	--
Composting	4	1	3	0	0	3	0	0	1	0	0	0	0	1	0	1	--	--
Land Farming	3	0	3	0	0	1	1	0	0	0	0	0	0	0	0	0	--	--
Bioremediation (unspecified)	6	0	6	0	0	5	4	0	0	0	0	0	0	0	0	0	--	--
Ex-situ Bioremediation	7	1	6	0	2	5	2	1	0	0	0	0	0	0	0	0	--	--
In-situ Bioremediation	11	1	10	0	2	9	4	0	0	0	0	0	0	0	0	0	--	--
Dechlorination/ APEG	3	0	3	0	0	3	1	0	0	0	0	0	0	0	0	0	--	--

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES (Continued)[1]

Remedial Technology Or Treatment[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out[3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement.			Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State[4] Concerns	Community[4] Concerns
Other Chemical Destruction	3	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	--	--
Reduction	7	0	6	1	0	5	1	0	0	0	0	0	0	0	0	0	--	--
Neutralization	6	0	6	0	0	5	0	0	0	0	0	0	0	0	0	0	--	--
Oxidation	6	1	5	0	0	4	0	0	1	0	0	0	0	1	1	1	--	--
Offsite Incineration (unspecified)	16	7	8	1	5	5	2	0	7	2	0	1	0	7	6	2	--	--
Onsite Incineration (unspecified)	7	1	6	0	2	3	5	0	1	0	0	0	0	1	1	0	--	--
Fluidized Bed	5	0	4	1	3	1	2	0	0	0	0	0	0	0	0	0	--	--
Infrared	5	1	4	0	2	2	1	1	0	0	0	0	0	0	0	0	--	--
Pyrolysis	3	0	3	0	2	1	1	0	0	0	0	0	0	0	0	0	--	--
Multiple Hearth	5	0	4	1	2	4	1	0	0	0	0	0	0	0	0	0	--	--
Rotary Kiln	11	6	3	2	3	2	3	2	4	1	0	0	0	5	3	4	--	--
Other Incineration	13	1	12	0	5	6	5	1	0	0	0	0	0	0	0	0	--	--
Other Thermal Treatment	6	0	6	0	2	4	3	0	0	0	0	0	0	0	0	0	--	--

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES (Continued)[1]

Remedial Technology Or Treatment[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out[3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State[4] Concerns	Community[4] Concerns
Vitrification	12	0	11	1	2	8	5	0	0	0	0	0	0	0	0	0	--	--
Wet Air Oxidation	6	1	5	0	1	4	3	0	1	0	0	0	1	1	1	0	--	--
Low Temperature Thermal Desorp/ Stripping	13	10	3	0	1	1	2	3	7	2	1	1	2	7	3	4	--	--
In-situ Steam Stripping	3	2	1	0	0	1	0	2	0	0	0	0	0	0	0	0	--	--
Soil Flushing	15	3	12	0	0	9	5	0	3	1	1	1	2	2	1	3	--	--
Soil Washing	14	2	12	0	1	10	9	0	2	0	0	1	0	2	2	1	--	--
In-situ Vacuum Extraction	17	11	6	0	0	6	2	10	2	0	0	0	1	0	0	2	--	--
B.E.S.T. Process	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	--	--
Liquified Gas	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	--	--
Other Physical Extraction	4	0	4	0	0	3	0	0	0	0	0	0	0	0	0	0	--	--
Fixation	7	1	6	0	0	6	0	0	1	0	0	1	1	0	1	1	--	--
Stabilization/ Solidification	13	2	7	4	0	6	2	0	2	0	0	2	2	2	0	2	--	--
Aeration	12	2	10	0	1	9	2	1	1	0	0	0	1	1	1	0	--	--

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES (Continued)[1]

Remedial Technology Or Treatment[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out[3]				# RODs Tech. Selected	# RODs Tech Not Selected	# RODs Where Criterion Contributed to Non-Selection							
					Cost	Effectiveness	Implement	Protect			ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State[4] Concerns	Community[4] Concerns
In-situ Hydrolysis	4	0	4	0	0	3	2	0	0	0	0	0	0	0	0	0	--	--
Soil Slurries	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	--	--

1 This study was conducted on 21 RODs and their corresponding FSs.
2 This does not the include the no-action or institutional control only alternatives. No RODs selected either of these as remedies.
3 FSs and RODs may contain more than one criterion for screening or non-selection of technology. Also, some FSs did not fully explain the criteria for screening out a technology. Thus, the totals for screening and non-selection criteria are not equal to the number of FSs and RODs considered.
4 Information on State and community concerns was not included in this analysis because FSs do not contain this information and RODs generally only reference supporting documentation (i.e., State concurrence letter and responsiveness summary).

APPENDIX B
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil

	CRITERIA						
	Overall Protection of Human Health and the Environment	Compliance With Federal ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [1]
SOIL VAPOR EXTRACTION	• Provides both short- and long-term protection by reducing concentration and exposure to VOCs in soil. • Depending on site-specific conditions, prevents further ground water contamination.	• Does not trigger LDRs because it does not involve placement of waste. • Because waste is removed in place through limited construction and no excavation, few impacts to wetlands, floodplains, or water quality are likely. • Depending on site-specific conditions, treats wastes to levels that will prevent exceedance of groundwater clean-up levels. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil/sludge. • Requires some treatment of residuals (spent carbon or concentrated VOC waste stream) generally through regeneration or disposal. • Hazardous wastes left in place will require 5-year review.	• Significantly reduces toxicity, mobility, or volume through treatment. • Produces few waste streams.	• Does not present substantive risks to onsite workers or community; potential for some dust generation during well installation. • Potential air emissions are easily controlled through activated carbon adsorption or other technologies. • Generally involves relatively short time frame to achieve clean-up levels; however, difficulty in estimating timeframe may exist due to site uncertainties (e.g., irregular soil permeabilities). • Effective for treating waste under buildings. Can be performed on active facilities. • Hardware, such as vacuum blower, is readily available from many sources, but SVE system performance is highly dependent upon the lithology of the site and system design.	• Few administrative difficulties. Technology is readily available from many sources. • Used successfully at numerous Superfund sites to address VOC contamination. • Installing and operating extraction wells requires fewer engineering controls than other technologies (i.e., excavation and incineration). • Requires series of soil gas sampling to determine when clean-up levels are achieved.	$10 - 150/ton $50/ton avg.

1. Note: Actual cost of a remediation technology is highly site-specific. It is dependent upon the original and target clean-up level concentrations of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil
(continued)

	CRITERIA						
	Overall Protection of Human Health and the Environment	Compliance With Federal ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost (1)
THERMAL DESORPTION	• Provides both short- and long-term protection by eliminating exposure to VOCs in soil/sludge. • Prevents further groundwater contamination and offsite migration. • Requires measures to protect workers and community during excavation, handling, and treatment.	• Requires compliance with RCRA removal, treatment, transportation (if offsite treatment), and land disposal regulations (if a hazardous waste). • Excavation, construction, and operation of onsite treatment unit may require compliance with wetlands and other location-specific ARARs. • Treats hazardous waste to BDAT levels; thus, there is no LDR problem with residuals. • Generally, treats wastes to levels that will prevent exceedance of groundwater clean-up levels. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil/sludge. • Involves some treatment or disposal of residuals generally through use of carbon adsorption/ regeneration or disposal.	• Significantly reduces toxicity, mobility, or volume of contaminants through treatment. • Generally requires test runs to ensure effective treatment.	• Presents potential short-term risks to workers and community from air release during excavation and treatment (if onsite treatment). • Involves potential short-term risks from handling and transporting waste (if offsite treatment). • Relatively short timeframe to achieve clean-up levels.	• Construction and substantive permit requirements of an onsite treatment unit may present some difficulties. Mobile incineration units for onsite treatment are available. • Limited offsite treatment capacity exists. • Used successfully at other Superfund sites to address solvent contamination. • Requires engineering measures to control air emissions, fugitive dust, run-off, erosion and sedimentation, site access, and transportation.	$200 - 300/ ton $250/ton avg.

1. Note: Actual cost of a remediation technology is highly site-specific. It is dependent upon the original and target clean-up level concentrations of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil (continued)

	CRITERIA						
	Overall Protection of Human Health and the Environment	Compliance With Federal ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost (1)
INCINERATION	• Provides both short- and long-term protection by eliminating exposure to solvent contaminants in soil. • Prevents further ground-water contamination and offsite migration. • Requires measures to protect workers and community during excavation, handling, and treatment.	• Requires compliance with RCRA removal, treatment, transportation (if offsite treatment), and land disposal regulations (if a hazardous waste). • Excavation, construction, and operation of onsite incinerators may require compliance with wetlands and other location-specific ARARs. • Treats hazardous waste to BDAT levels; thus, there is no LDR problem with residuals. • Treats wastes to levels that will prevent exceedance of ground-water clean-up levels. • Emission controls may be needed to ensure compliance with air quality standards during excavation and construction.	• Effectively destroys source of contamination. • Is a well-demonstrated technique for treating VOCs in soil/sludge. • No organic residuals contamination will exist if treating soil/sludge contaminated only with VOCs.	• Significantly reduces toxicity, mobility, or volume of contaminants through treatment.	• Presents potential short-term risks to workers and community from air release during excavation and treatment (if onsite treatment). • Involves potential short-term risks from handling and transporting waste (if offsite treatment). • Relatively short timeframe to achieve clean-up levels.	• Construction and substantive permit requirements of an onsite incinerator may be somewhat difficult. Mobile incinerators are readily available. • Limited offsite incineration capacity exists. • Used successfully at other Superfund sites to address VOC contamination.	$200 - 1700/ton $400/ton avg.

1. Note: Actual cost of a remediation technology is highly site-specific and dependent upon the original and target clean-up level concentrations of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX C
U.S. Waste Exchanges

CALIFORNIA WASTE EXCHANGE
Robert McCormick
Department of Health Services
Toxic Substances Control Division
400 P Street
Sacramento, CA 95812
(916) 324-1807

INDIANA WASTE EXCHANGE
Environmental Quality Control
1220 Waterway Boulevard
P.O. Box 1220
Indianapolis, IN 46206
(317) 232-8188

INDUSTRIAL MATERIAL EXCHANGE SERVICE
Diane Shockey
2200 Churchill Road, #31
Springfield, IL 62794-9276
(217) 782-0450
FAX: (217) 782-9142

INDUSTRIAL MATERIALS EXCHANGE
Bill Lawrence
172 20th Avenue
Seattle, WA 98122
(206) 296-4899
FAX: (206) 296-0188

PACIFIC MATERIALS EXCHANGE
Bob Smee
1522 North Washington Street, Suite 202
Spokane, WA 99205
(905) 325-0551
FAX: (509) 325-2086

NATIONAL WASTE EXCHANGE NETWORK
1-800-858-6625

RENEW
Hope Castillo
Texas Water Commission
P.O. Box 13087
Austin, TX 78711
(512) 463-7773
FAX: (512) 463-8317

INDUSTRIAL WASTE INFORMATION EXCHANGE
William E. Payne
New Jersey Chamber of Commerce
5 Commerce Street
Newark, NJ 07102
(201) 623-7070

MONTANA INDUSTRIAL WASTE EXCHANGE
Don Ingles
Montana Chamber of Commerce
P.O. Box 1730
Helena, MT 59624
(406) 442-2405

NORTHEAST INDUSTRIAL WASTE EXCHANGE
Lewis M. Culter
90 Presidential Plaza, Suite 122
Syracuse, NY 13202
(315) 422-6572
FAX: (315) 422-9051

SOUTHEAST WASTE EXCHANGE
Maxi May
Urban Institute
Department of Civil Engineering
University of North Carolina
Charlotte, NC 28223
(704) 547-2307

SOUTHERN WASTE INFORMATION EXCHANGE
Gene Jones
P.O. Box 960
Tallahassee, FL 32313
(904) 644-5516
FAX: (904) 574-6704

APPENDIX D
GLOSSARY

Applicable or Relevant and Appropriate Requirements (ARARs) - CERCLA Section 121(d) and the NCP require that onsite remedial actions must attain (or justify a waiver of) requirements of environmental laws that are determined to be Federal or more stringent State applicable or relevant and appropriate requirements.

Dense Non-Aqueous Phase Liquid (DNAPL) - DNAPLs are immiscible hydrocarbon liquids that are denser than water, such as chlorinated solvents (either as a single component or as mixtures of solvents), wood preservative wastes, coal tar wastes, PCBs and some pesticides. DNAPLs can sink to great depths, can penetrate into bedrock fractures, can move as a liquid in a direction different from the flow of groundwater and can act as a continual source of groundwater contamination over time.

Engineering Evaluation/Cost Assessment (EE/CA) - An analysis of removal alternatives for non-time critical removal actions.

Ex-Situ Treatment - Removal of material from the ground for treatment.

Feasibility Study (FS) - A description and analysis of the potential clean-up alternatives for a site. It is generally conducted concurrently with the remedial investigation (RI); together the studies are referred to as an RI/FS. (See remedial investigation.)

In-Situ Treatment - The treatment or remediation of media occurring in-place.

Innovative Treatment Technologies - Technologies that have been tested, selected, or used for treatment of hazardous substances or contaminated materials but lack well-documented cost and performance data under a variety of operating conditions.

Land Disposal Restrictions (LDRs) - The Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) include specific restrictions on the land disposal of RCRA hazardous wastes. These restrictions, known as LDRs, prohibit the land disposal of restricted RCRA hazardous wastes unless these wastes meet treatment standards specified in 40 CFR 268 or other compliance options.

Light Non-Aqueous Phase Liquids (LNAPL) - Like DNAPLs, LNAPLs are immiscible liquids, but are lighter than water and therefore float on water. As they are lighter than water, they are most frequently found at the groundwater table/vadoze zone interface.

Record of Decision (ROD) - A public document that explains the basis for selecting the clean-up alternative(s) that will be taken or served under CERCLA.

Remedial Design (RD) - The remedial action that involves designing and testing to determine whether the remedy will be effective at a site.

Remedial Investigation (RI) - An in-depth study designed to gather the data necessary to determine the nature and extent of the threat posed by contamination at a Superfund site. It also helps to establish the preliminary criteria for cleaning up the site in the FS and supports the technical and cost analyses of the alternatives. It is generally completed and combined with the FS and referred to as the RI/FS.

Risk Assessment - The qualitative and/or quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by actual and potential exposures to specific pollutants in air, water, soil or other media.

Superfund Accelerated Cleanup Model (SACM) - An initiative designed to accelerate all aspects of the Superfund clean-up process.

Vadose Zone - The zone in soil that lies above the permanent water table.

Volatile Organic Compounds (VOCs) - Any organic compound which readily dissipates into the air.

REFERENCES

Primary Reference:

U.S. EPA (In-Progress). Contaminants and Remedial Options at Solvent Sites.

Compound Properties:

RREL Treatability Data Base - Available through ATTIC (Contact Glenn Shaul (513) 569-7408)

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United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

Directive No. 9355.0-63FS
EPA 540/F-96/008
PB 96-963308
July 1996

EPA

User's Guide to the VOCs in Soils Presumptive Remedy

Office of Emergency and Remedial Response

User's Guide

In order to expedite remedy selection at similar types of sites, EPA recommends the use of presumptive remedies — preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. This User's Guide recommends the soil vapor extraction (SVE) technology as the preferred presumptive remedy for sites where volatile organic components (VOCs) are present in soil and treatment is warranted, although the thermal desorption and incineration technologies may be selected as presumptive remedies at sites where conditions are appropriate. Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances. This guide is based on the VOCs in Soils Presumptive Remedy Guidance, *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils*, OSWER 9355.0-48FS. Please refer to that guidance for a more detailed description of how the presumptive remedy can be applied at sites where volatile organic components (VOCs) are present in soil.

PURPOSE

This User's Guide is intended to aid the site manager. It:

- Explains the benefits of using the "presumptive remedy approach";
- Highlights how to decide if the presumptive remedy approach can be applied to your site;
- Explains which presumptive remedy approach to select for your site (the preferred presumptive remedial alternative for sites with VOCs in the soils is soil vapor extraction (SVE));
- Describes how to write the feasibility study (FS) or engineering evaluation/cost analysis (EE/CA) for a presumptive remedy; and
- Outlines administrative record requirements.

WHY USE THE PRESUMPTIVE REMEDY APPROACH?

Time and cost savings can be realized by following the presumptive remedy approach during a remedial investigation/feasibility study (RI/FS). First, since a preferred cleanup technology can be identified prior to or early in the RI, technology-specific remedial design data can be collected and analyzed sooner. In addition, use of the presumptive remedy approach eliminates the need to:

- Identify potential treatment technologies
- Screen technologies in your site-specific FS or EE/CA.

In addition, the steps of assembling technologies into alternatives and reducing alternatives are streamlined since the number of technologies under consideration have been minimized. Figure 1 presents the presumptive remedy technologies for VOCs in soils and important features of each.

Figure 1. Presumptive Remedies for VOCs in Soils

Soil Vapor Extraction (SVE): ***The preferred presumptive remedy***

- In-situ process
- Removes contaminants from vadose zone soils by inducing air flow through the soil
- Highly cost effective alternative
- Vapor treatment may be required

Thermal Desorption

- Soil excavation required
- Uses direct or indirect heat to vaporize VOCs from soil
- Vapor treatment may be required

Incineration

- Soil excavation required
- Employs thermal decomposition via oxidation
- Destroys the organic fraction of the waste
- Vapor treatment may be required

CAN YOU APPLY THE VOCS IN SOILS PRESUMPTIVE REMEDY APPROACH TO YOUR SITE?

In order to determine if you can use the presumptive remedy approach at your site, you need to answer the following questions. Regardless of the status of your RI or removal evaluation, these questions can be addressed once you establish the nature of any VOC and non-VOC waste contained in the soil, where treatment is warranted.

Are VOCs present in soil or sludge?

VOCs include halogenated and non-halogenated organics such as trichloroethylene, carbon tetrachloride, acetone and benzene. A complete a list of typical VOCs is found in the master VOCs presumptive remedy guidance referenced on page 1. If your site does not have VOCs in the soil, then this User's Guide is not applicable for use in remedy selection at the site.

Are non-VOCs present that will preclude the use of the presumptive remedy guidance?

For sites with a mixture of VOCs and other contaminants in soil, the presumptive remedies should be considered only if they also can also be effective in removing the non-VOC contaminants, or can be used in combination with other remedies. For combination remedies, this presumptive remedy approach can be used to select the VOC portion of the remedy. For example, sites with VOCs and metals commingled in soil may be effectively remediated by employing SVE to remove VOCs and fixation or solidification to address the metal contamination. The presumptive remedy approach can still be used for the selection of the SVE rem whereas a traditional FS analysis would be necessary for treatment of metals.

In conclusion, if VOCs are present in soils and non-VOCs do not preclude a VOC remedy, you may also select the presumptive remedy for the VOC component of the site.

Have all key stakeholders been notified?

Please keep in mind that it is important to notify the community, (especially any community working groups) the State, and any PRPs that a presumptive remedy is being considered at your site. It is important to get their buy-in early in the cleanup process.

This notification should begin as early as possible and can continue to occur throughout the RI/FS in the form of fact sheets and agenda items during public meetings. Early discussions about the rationale for presumptive remedies creates confidence in both the technology and remedy selection process.

> Once a candidate presumptive remedy site has been identified and a response action involving treatment is warranted under the NCP, you can decide which of the 3 VOCs in soils presumptive remedy technologies to select.

WHICH VOCs IN SOILS PRESUMPTIVE REMEDY IS BEST FOR MY SITE?

Once you have determined that your site is a candidate for a presumptive remedy, SVE should be analyzed first since it is the preferred presumptive remedial alternative. In most cases, SVE is extremely cost effective and can be implemented in-situ. The SVE Checklist (Figure 2) can help you decide if SVE is appropriate at your site[1]. The questions posed in the SVE Checklist provide a preliminary "first-cut" assessment of basic site characteristics that relate to potential SVE treatment effectiveness. Your site is a strong candidate for SVE if you answer "yes" to all of these questions. At this point, you may wish to assume SVE as the preferred technology for VOC remedial action at your site. Therefore, you may immediately proceed to an SVE Pilot Study and a Presumptive Feasibility Study (see p. 3).

For the purposes of this User's Guide, the terms "Presumptive FS or EE/CA" refer to the FS or EE/CA developed at sites where the presumptive remedy is applied. The SVE Checklist is not a definitive screening test for SVE. So, even if you answer "no" to one or more of these questions, SVE may still be an appropriate presumptive technology for your site, but greater technical analysis may be warranted. Considerations such as best professional judgment and community opinion should guide your decision to proceed with an SVE Pilot Study to confirm the appropriateness of the SVE technology at your site.

If SVE is determined to be ineffective based on site-specific circumstances, thermal desorption is the next technology that should be assessed for use at your site. Thermal Desorption is the primary VOC presumptive remedy at sites where soil excavation is required to remediate a non-VOC contaminant. At some sites, public perception is that incineration can be disruptive to a community, and it has been ruled out due to that perception. Be aware of this if you prove incineration as a remedy. For a complete discussion of the characteristics that affect the use of SVE, thermal desorption and incineration technologies, refer to Tables 3 and 4 of the master VOC presumptive remedy guidance.

Figure 2. SVE Checklist

Site Characteristics[2]	Yes	No
Soil Permeability > 10^{-6} cm^2		
Soil Moisture Content < 50%?		
VOC Vapor Pressure > 0.5mm Hg?		
Dimensionless Henry's constants > 0.01?		
Soil/Air Filled Porosity < 40%?		
Low organic carbon content?		

[1]If you are scoping an RI or a removal evaluation, the information requested in Figure 2 should be identified as a "presumptive remedy data need" along with common data needs for an RI/FS. As you develop the RI/FS Work Plan, you should establish site-specific data quality objectives for each set of RI data needs. All presumptive remedy data needs should be collected during the first round of environmental data collection of the RI if not before.

[2]See Table 4 of the VOCs in Soils Presumptive Remedy Guidance for a description for each of the terms listed in Figure 2.

HOW DO I WRITE THE FS OR EE/CA FOR A PRESUMPTIVE REMEDY?

After determining that your site can use a VOCs in soils presumptive remedy, the next step is to prepare a presumptive FS or EE/CA. Note that for non-time-critical removals, you can prepare an EE/CA. Regardless of the status of your RI or removal evaluation, the Presumptive FS or EE/CA for the soil remedy should begin immediately.

As highlighted on page 1, the presumptive remedy approach allows you to streamline and focus the FS or EE/CA by eliminating the technology screening step because EPA has already conducted this step on a generic basis in the document *Feasibility Study Analysis for VOCs in Soils Sites.* Basically, only the "No- Action" alternative and presumptive remedy alternative require further consideration. If SVE is appropriate, the other presumptive technologies (thermal desorption and incineration) may be eliminated from further consideration. To tailor the Presumptive FS to the specific conditions at your site, you may first need to refine the presumptive remedy alternative, as necessary. For example, if off gas treatment is required, the technology for off gas treatment is not selected presumptively and should be addressed in the FS. As shown in Figure 3, the presumptive technology should be matched with an appropriate mix of conventional and innovative vapor treatment technologies. The final step of the Presumptive FS would consist of analyzing the No-Action and Presumptive Remedy alternatives against the nine NCP evaluation criteria.

An example format for critical elements of a Presumptive FS is provided in Figure 4. Please note that it is advisable to expand the Introduction Chapter of your Presumptive FS or EE/CA to include a brief discussion of the presumptive remedy approach and justification for using this approach at your site.

You may wish to consider technologies that enhance the performance of the presumptive remedy based on site-specific conditions. For example, SVE enhancements include bioventing, capping, hot air injection, steam injection, and subsurface mining. Additionally, you may consider using a phased approach to designing and implementing an SVE system similar to EPA's suggested phased approach to characterizing and remediating contaminated groundwater sites. In order to maximize engineering flexibility during remedial design and remedial action, it is not always necessary to address potential enhancements in your Presumptive FS. Only where: (a) there is a high degree of confidence that the enhancement is essential for cost-effective remediation; or, (b) the addition of the enhancement significantly changes the cost or scope of the base SVE alternative, should such enhancements be included in the Presumptive FS. For more information on whether to include enhancements in your FS and determining what would require changes to a ROD, see "Guide to Addressing Pre-ROD and Post-ROD changes, OSWER 9355.3-02FS-4, April 1991.

Figure 3. Example of a Possible SVE Alternative Refinement

Alternative 1 - No Action

Alternative 2 - SVE with No Off Gas Treatment

Alternative 3 - SVE with Off Gas Treatment (e.g. activated carbon, catalytic oxidation, flameless thermal oxidation, resin adsorption, etc.)

Alternative 4 - SVE with Off Gas Treatment and Capping

Figure 4. Example Format For Critical Elements of A Presumptive FS

I. Introduction
   A. Background to the Site
   B. Introduction to the Presumptive Remedy Approach
   C. Determination to use the Presumptive Remedy Approach

II. Description of the No Action Alternative, the Presumptive Remedy Alternatives, and ARARs

III. Detailed (Nine Criteria) Analysis of the No Action Alternative and the Presumptive Remedy Alternative

IV. Description of the Preferred Alternative
   A. Rationale for the Preferred Alternative

ADMINISTRATIVE RECORD REQUIREMENTS

You must compile an administrative record in accordance with the *Final Guidance on Administrative Records for Selecting CERCLA Response Actions,* OSWER Directive 9833.3A.1. The administrative record must contain both EPA guidance and site-specific information documenting the selection of the VOCs in soils presumptive remedy. Other required EPA guidance documents include:

- *Presumptive Remedies: Policies and Procedures,* OSWER 9355.0-47FS
- *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with VOCs in Soils,* OSWER 9355.0-48FS
- *Feasibility Study Analysis for VOCs in Soils Sites,* OSWER 9356.0-01. [Note: The administrative record file index should include a notice specifying the location of and times when public access is available to the generic file of backup materials used in developing this document. The generic file contains background materials such as technical references and previous feasibility studies. Each EPA Regional office has a copy of this file.]
- *"Guide to Principal Threat and Low Level Threat Wastes,"* OSWER 9380.3-06FS

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

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EPA

Presumptive Remedy: Supplemental Bulletin Multi-Phase Extraction (MPE) Technology for VOCs in Soil and Groundwater

United States Air Force
Air Combat Command

Quick Reference Fact Sheet

This Quick Reference Fact Sheet is issued jointly by the U.S. EPA and Air Combat Command (ACC) of the United States Air Force (USAF) to provide information on the Multi-Phase Extraction (MPE) technology for extraction of volatile organic compounds (VOCs) present in soil and groundwater. This fact sheet recommends MPE as a potentially valuable enhancement for the SVE option under the presumptive remedy for sites with VOCs in soils.

PURPOSE

This Fact Sheet will:

- Provide an explanation of the MPE technology;
- Explain how to determine if MPE is applicable to your site;
- Explain how to select between the three MPE applications;
- Discuss the advantages and disadvantages of the MPE applications;
- Provide contaminant extraction costs for MPE; and
- Provide references and points-of-contact (POCs) for more information on MPE.

BACKGROUND

Presumptive remedies are preferred technologies for common categories of sites based on historical patterns of remedy selection and U.S. EPA's scientific and engineering evaluation of performance data on technology implementation. By streamlining site investigation and accelerating the remedy selection process, presumptive remedies are expected to ensure the consistent selection of remedial alternatives and reduce time and costs required to clean up similar sites. Presumptive remedies are generally expected to be used at all appropriate sites; however, site-specific circumstances dictate whether a presumptive remedy is appropriate at a given site. The U.S. EPA has established presumptive remedies for sites with soils contaminated by VOCs. The U.S. EPA guidance documents on these presumptive remedies are *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils, OSWER 9355.0-48FS* and *User's Guide to the VOCs in Soils Presumptive Remedy.*

This fact sheet is a supplemental bulletin for the VOC Presumptive Remedy. It is intended to provide site managers with recent information that may be useful in making decisions about the specific type of extraction technology to employ at a VOC, presumptive remedy site.

What is MPE Technology?

The MPE process was developed for the remediation of VOCs and other contaminants in low to moderate permeability subsurface formations. The process is a modification of the conventional soil vapor extraction (SVE) technology. Traditional SVE is the process of stripping and extracting volatile compounds from the soil by inducing air flow through the soil. Soil vapor flow is induced by applying a vacuum to extraction wells. Generally, SVE is applied to soil above the groundwater table.

MPE is an enhancement of the traditional SVE system. Unlike SVE, MPE simultaneously extracts both groundwater and soil vapor. The groundwater table is lowered in order to dewater the saturated zone so that the SVE process can be applied to the newly exposed soil. This allows the volatile compounds sorbed on the previously saturated soil to be stripped by the induced vapor flow and extracted. In addition, soluble VOCs present in the extracted groundwater are also removed.

MPE is a generic term for technologies that extract soil vapor and groundwater, simultaneously. Under this generic term, this fact sheet presents two technologies, the two-phase extraction technology (TPE) and the dual-phase extraction technology (DPE). Both technologies extract groundwater and soil vapor from a single well. You can consider MPE as a tool for VOC remediation as illustrated in Highlight 1.

The TPE technology employs a high vacuum (approximately 18 to 26 inches of mercury) pump to extract both groundwater and soil vapor from an extraction well. A suction pipe is lowered into the extraction well to extract the soil vapor and groundwater from the subsurface. A typical two-phase type system is illustrated in Figure 1.

For some TPE methods, turbulence generated within suction pipe facilitates the transfer of aqueous phase contaminants to the vapor phase (up to 98% stripping).

By comparison, the DPE technology employs a submersible or pneumatic pump to extract the groundwater, and a high vacuum (approximately 18 to 26 inches of mercury) or low vacuum (approximately 3 to 12 inches of mercury) extraction blower is used to extract the soil vapor as illustrated in Figure 2. For DPE wells using submersible pump, a sump is installed at the bottom of the well to prevent cavitation of the submersible pump. Under vacuum conditions, a net positive suction head may be maintained, to prevent cavitation of the submersible pump, using a standing water column. Under high vacuum conditions, a sump as deep as 20 feet may be required to provide proper water column at the pump intake.

Note that some specific hardware and well configurations associated with the MPE technologies are patented. In those cases, potential users should contact the patent owners about the patent owner's licensing

Highlight 1

Multi-Phase Extraction (MPE) - A remediation tool for simultaneous extraction of VOC contaminated soil vapor and groundwater.

The two types of MPE are:

- Two-Phase Extraction (TPE)
- Low or High Vacuum Dual-Phase extraction (DPE)

requirements. Description, or use of specific products, methods or companies does not constitute an endorsement by the USEPA or the U.S. Air Force's Air Combat Command.

Is MPE Appropriate at my Site?

Once you have determined that your site is a candidate for a presumptive remedy using the VOC User's Guide, you must determine if MPE can be implemented to treat the VOC contaminated media at your site. MPE is most cost effective for cleaning up low to moderate permeability sites with halogenated VOC contamination in the soil and groundwater. MPE is also effective at cleaning up sites contaminated with non-halogenated VOCs and total petroleum hydrocarbons (TPH). MPE may be particularly useful when expedited cleanups are necessary.

When considering use of MPE, it is important to choose an engineering firm that has experience implementing the MPE technologies. Prior to implementation, a treatability pilot study should be performed and the results evaluated to maximize the effectiveness of the MPE technology selected.

To determine if the MPE technologies may be effective at your site, compare your site conditions to the guidelines presented in Table 1. These guidelines provide a preliminary assessment of the basic site characteristics that relate to MPE treatment effectiveness. The MPE technologies are generally applied below the water table. They also may be applied above and below the water table simultaneously. Note that if you wish to apply MPE above the water table, your site should also meet the air permeability guidelines. If your site conditions meet these guidelines, then your site is a candidate for MPE. At this point you may wish to select one of the MPE technologies as the preferred technology for VOC remedial action at your site and proceed with a treatability pilot study. These guidelines are not a definitive screening test for MPE. So, even if one of your site conditions does not meet these guidelines, MPE may still be an appropriate technology for your site, but greater technical analysis may be warranted. An engineering evaluation, by experienced professionals, should guide your decision to proceed with an appropriate MPE treatability Pilot Study to confirm the applicability of the MPE technologies.

Table 1. MPE General Guidelines

Site Conditions	Guideline
Contaminant	1. Halogenated VOCs. 2. Non-Halogenated VOCs and/or Total Petroleum Hydrocarbons (TPH).
Contamination location	1. Below groundwater table. 2. Both above and below groundwater table.
Henry's Law Constant of majority of contaminants	> 0.01 at 20 C° (dimensionless)[a]
Vapor pressure of majority of contaminants	> 1.0 mm Hg at 20 C°
Geology below groundwater table	Sands to Clays
MPE application above the groundwater table	
Air permeability of soil above the groundwater table.	Moderate and low permeability (k< 0.1 darcy[b]) soils.

[a] Dimensionless Henry's Law Constant in the form: (concentration in gas phase) / (concentration in liquid phase)

[b] Soil Gas permeability (k): 1 darcy = 1×10^{-8} cm^2

The effectiveness of the MPE technologies are directly dependent on site characteristics including geologic, hydrogeologic, and contaminant characteristics. The MPE technologies tend to be less effective under conditions outside of the guidelines shown above. MPE has shown to be less effective for sites that have very high permeabilities and lithologies consisting primarily of gravels or cobbles. For effective MPE, the aquifer must be able to be dewatered. Sites with extremely high groundwater flow rates may be not as suitable for MPE. MPE is not recommended for sites where the target contaminants are not volatile compounds (i.e. inorganic and semi-volatile).

Which Type of MPE is Best for my Site?

Once you have determined that a MPE technology will be effective at your site, you must determine which variation of MPE will be most effective for contaminant removal. All of the MPE technologies; low-vacuum DPE (LVDPE), high-vacuum DPE (HVDPE), or TPE, have optimum site conditions where they are considered to be the most cost effective for VOC contaminant removal. To determine which MPE technology will be most effective at your site, compare your site conditions to the guidelines presented in Table 2. These guidelines provide a preliminary assessment of the basic site characteristics that relate to potential treatment effectiveness of LVDPE, HVDPE, and TPE.

Table 2. MPE Technology Selection Guide: LVDPE, HVDPE, or TPE

Site Conditions	LVDPE Guideline	HVDPE Guideline	TPE Guideline
Groundwater production rate[a]	not limited by typical groundwater production rate, however aquifer must be able to be dewatered.	not limited by typical groundwater production rate, however aquifer must be able to be dewatered.	< 5 gpm
Maximum depth of targeted contamination	not limited by depth of contaminant	Not limited by depth of contaminant	1. Up to 50∀ feet below ground surface bgs (for groundwater production < 2 gpm). 2. Up to 20-30 feet bgs (for groundwater production between 2 and 5 gpm).
Geology below groundwater table	Sands to silty sands	Sandy silts to clays	Sandy silts to clays
For MPE application above the groundwater table			
Air permeability of soil above the groundwater table.	Moderate permeability (greater than 1 x 10^{-3} darcy)	Low permeability (less than 1 x 10^{-2} darcy)	Low permeability (less than 1 x 10^{-2} darcy)

[a] For MPE, the aquifer must be able to be dewatered.

Generally, the high vacuum (approximately 18-26 inches mercury) applications, HVDPE and TPE, are most cost effective where the target geologic formations have low permeabilities (i.e., sandy silts to clays). Both HVDPE and TPE will be effective at depths less than 50 feet BGS with low ground water production rates (<5 gpm). However, HVDPE has a broader range of application and may also be applied at greater depths and higher flow rates.

The low vacuum (3 to 12 inches of mercury) application, LVDPE, is suitable for more permeable soils (i.e., sands to silty sands). LVDPE is not limited by depth of commitment or typical groundwater flow rates, however the aquifer must be able to be dewatered. Generally MPE is applied below the groundwater table. However, MPE may also be applied simultaneously above and below the water table. Where MPE is to be applied above the groundwater table, the air permeability must also be considered. Figure 3 presents a decision logic flowchart that may assist you in the selection of LVDPE, HVDPE, or TPE.

Prior to implementation of the chosen MPE technology, a treatability pilot study should be performed by an experienced engineering firm. Proper interpretation of the pilot study results are needed to maximize the effectiveness of MPE.

Case Studies and Costs

The MPE technology has been applied at dozens of low to moderate permeability sites and has consistently proven to be more effective at removing subsurface VOCs than conventional pump-and-treat or soil vapor extraction systems alone. This is due to the increase in groundwater and contaminated soil vapor removal rates, and the volatilization of contaminants in the previously saturated soils. The increased mass removal rates result in decreased total removal costs. Note that the effectiveness of the MPE technologies are directly dependent on site characteristics (geologic, hyrogeologic, and contaminant characteristics, etc).

Pilot study and/or full-scale MPE system field data, demonstrating the effectiveness of MPE at multiple military sites (including McClellan AFB, Travis AFB, Nellis AFB, FE Warren AFB, Offutt AFB, Ellsworth AFB, DDRW-Tracy Depot, and Air Force Plant-44 [AFP-44]) are currently available. Appendix A presents the results of selected case studies. Appendix A also includes estimated full-scale contaminant extraction costs, presented in dollars per pound of contaminant removed ($/lb), for each of the case studies. These costs are based on a single well extraction system operated for one year. They include capital costs, installation costs and operation and maintenance costs. The costs do not include design, well installation, or soil vapor/groundwater treatment costs. These costs also do not include any costs associated with patent requirements. As demonstrated in Appendix A, the contaminant extraction costs for MPE applications are highly site-specific. It is dependent upon the original and target clean-up level concentrations of contaminants, aquifer/vadose zone characteristics, groundwater and vapor flowrates, as well as the design and operation of the technology used.

LESSONS LEARNED

The key to designing an effective MPE system is experience and performing a treatability pilot study beforehand. Pilot study results provide key parameters, such as effective well vacuum, groundwater and vapor radii of influence, and groundwater and soil vapor extraction flowrates. These parameters are essential for the selection and design of vacuum pumps, submersible pumps, and eventually, groundwater and vapor treatment.

Because TPE and HVDPE application parameters overlap, other site parameters will also affect your decision on which MPE technology to use. The ability to use existing extraction wells at a site may be the key factor in deciding to use HVDPE or TPE.

Table 3 provides the advantages and disadvantages of HVDPE, LVDPE, TPE which may assist you in final selection of a MPE technology.

Table 3. Advantages and Disadvantages Between HVDPE/LVDPE and TPE

	HVDPE and LVDPE	TPE
Advantages	No limitation on depth of targeted contamination. Lower vacuum losses within extraction well. No limitation on groundwater production rate.	Groundwater stripping: up to 98% transfer of aqueous phase contaminants to vapor phase. No pumps or mechanical equipment required in well. Can be applied at existing extraction or monitoring wells.
Disadvantages	Where submersible pumps are used, a standing water column above the pump is required, therefore, installation of a new extraction well with a sump may be required. More controls required for pump as compared with TPE.	Limited to a maximum groundwater depth of approximately 50 feet below ground surface. Limited to a maximum groundwater flowrate of approximately 5 gpm. Higher vacuum losses due to lifting water from the well.

CONCLUSION

For sites with VOC-contamination in the soil and/or groundwater and appropriate site characteristics, MPE is a cost effective technology. MPE has been applied at dozens of low- to moderate-permeability sites and has consistently proven to be more effective at removing subsurface VOCs than conventional pump-and-treat or soil-vapor extraction systems alone. For further information or assistance on MPE applications, refer to Table 4 for points of contact or reference information.

Table 4. MPE Points-of-Contact and References

Points of Contact	Affiliation	Name	Title	Phone Number
Site Contacts	DDRW-Tracy	Marshall Cloud	Project Manager/ Environmental Specialist	(209) 982-2086
	Travis AFB	Mark Sandy	Remedial Program Manager	(707) 424-3172
	Nellis AFB	Jim Pedrick	Chief of Environmental Restoration Division	(702) 652-6103
	McClellan AFB	Kevin Wong	Remedial Program Manager	(916) 643-0830
	FE Warren AFB	Barry Mountain	Chief of Missile Engineering	(307)-775-2532
	Ellsworth AFB	John DeYoe	Remedial Program Manager	(605) 385-2675
	Offutt AFB	Phil Cork	Installation Restoration Program Manager	(402) 294-7621
	Wright-Patterson AFB (AFP-44)	Dennis Scott	Remedial Program Manager	(513) 255-0258 x417
EPA Contacts	U.S.EPA Headquarters	Scott Fredericks	Environmental Protection Specialist	(703) 603-8771
	U.S.EPA Headquarters	Michael Hurd	Chemist	(703) 603-8836
	U.S.EPA Headquarters	John Blanchard	P.E.	(703) 603-9031
ACC Contacts	ACC Headquarters	Margaret Patterson	Program Manager	(757) 764-6249
Existing U.S.EPA Guidance	"Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils," OSWER 9355.0-48FS.			
	"Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites," Final, October 1996, OSWER 9283.1-12.			
	"User's Guide to the VOCs in Soils Presumptive Remedy," April 1996.			

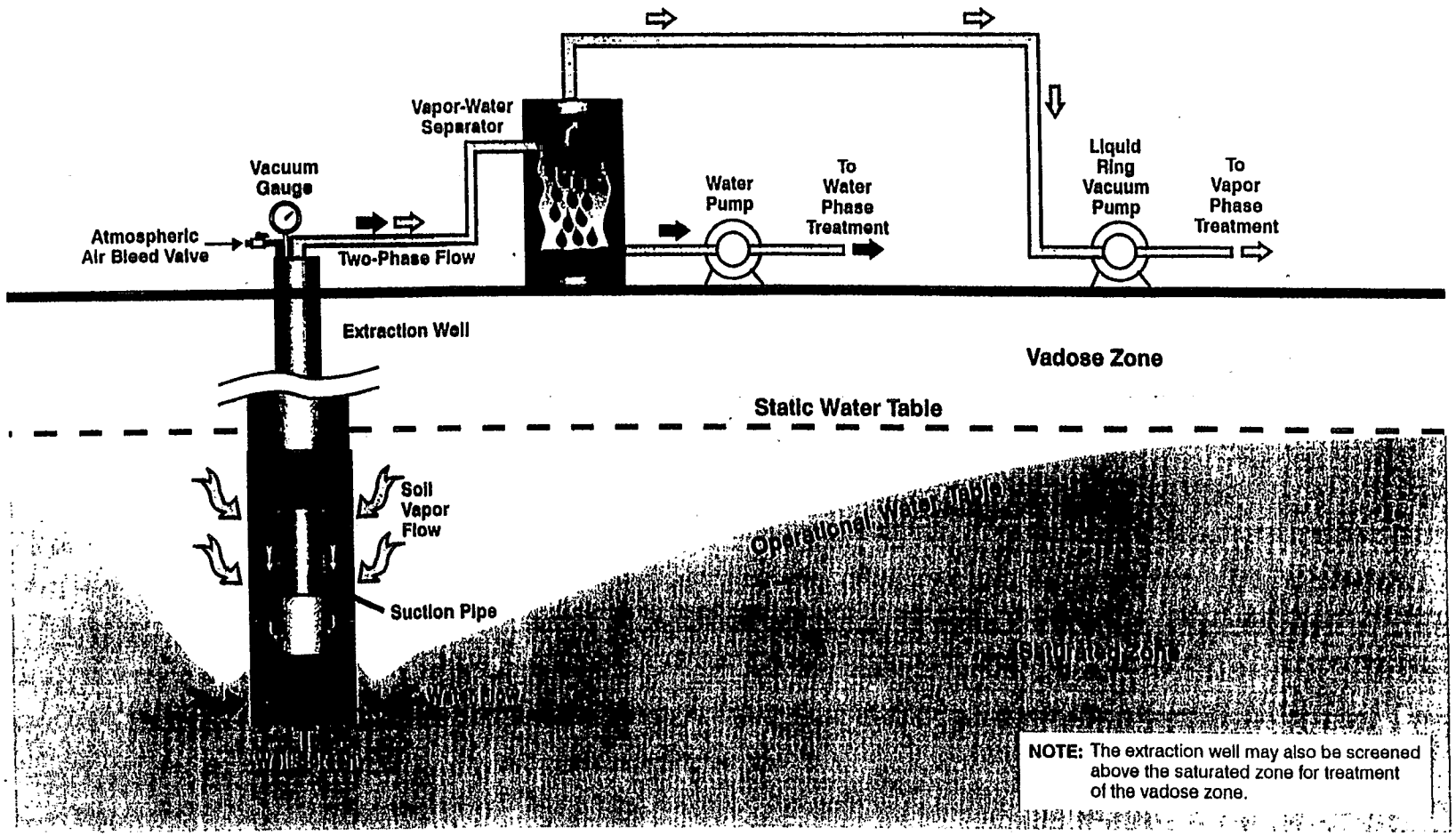


Figure 1. Schematic of a TPE System

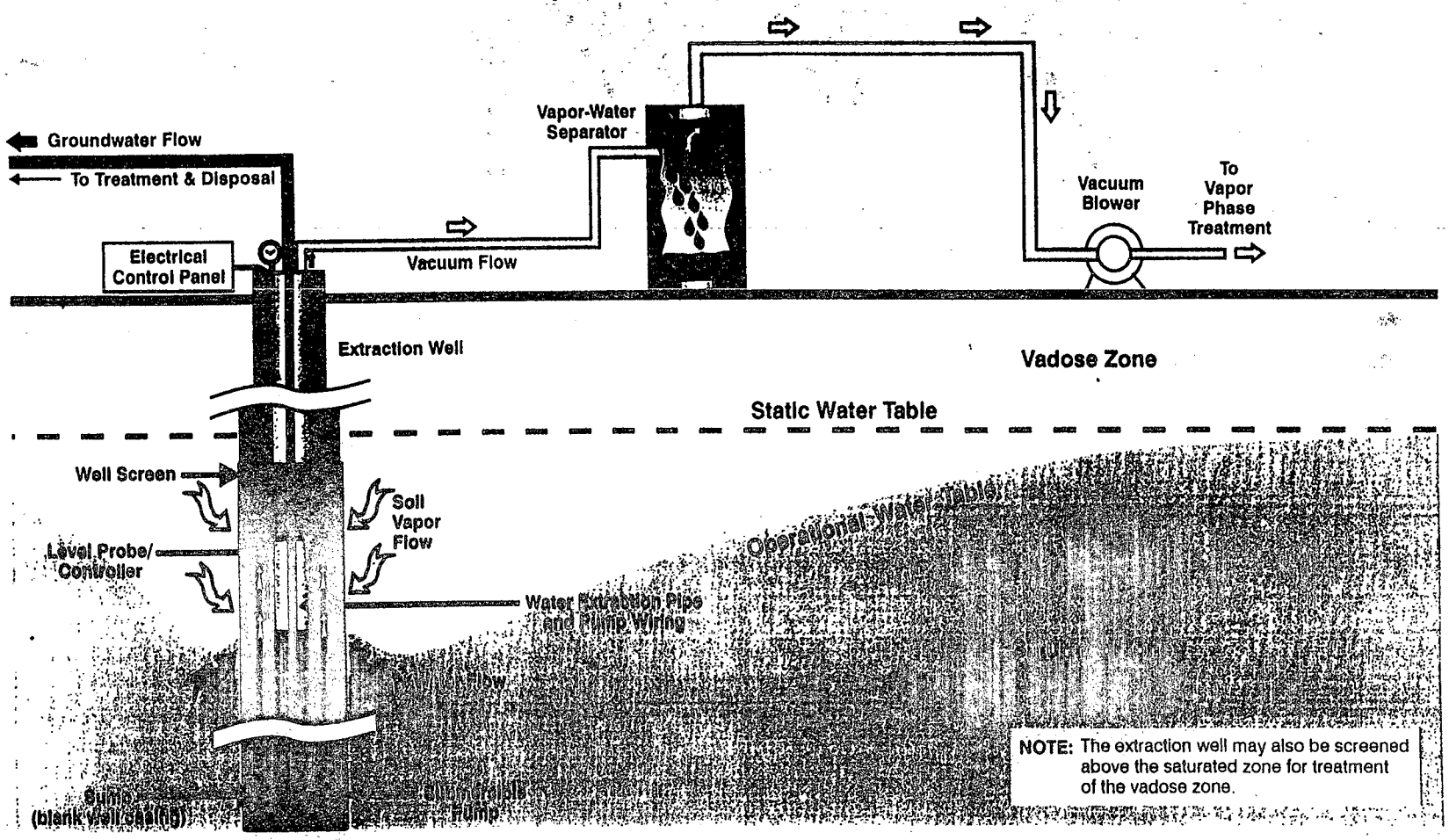
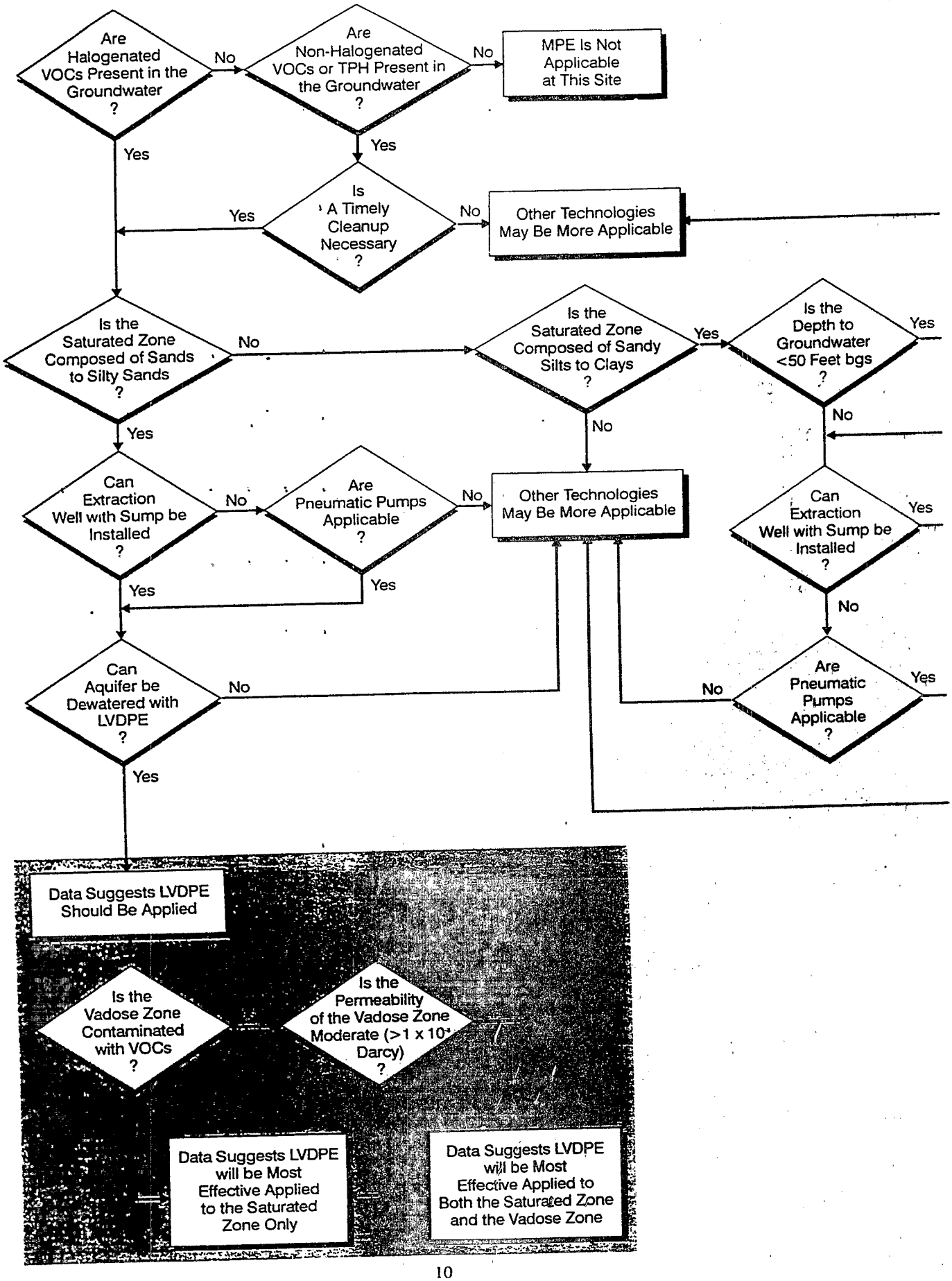


Figure 2. Schematic of a DPE System (Low Vacuum or High Vacuum)


Are Halogenated VOCs Present in the Groundwater ?
No
Are Non-Halogenated VOCs or TPH Present in the Groundwater ?
No
MPE Is Not Applicable at This Site
Yes
Yes
Is A Timely Cleanup Necessary ?
Yes
No
Other Technologies May Be More Applicable
Is the Saturated Zone Composed of Sands to Silty Sands ?
No
Is the Saturated Zone Composed of Sandy Silts to Clays ?
Yes
Is the Depth to Groundwater <50 Feet bgs ?
Yes
No
Yes
No
Can Extraction Well with Sump be Installed ?
No
Are Pneumatic Pumps Applicable ?
No
Other Technologies May Be More Applicable
Can Extraction Well with Sump be Installed ?
Yes
Yes
Yes
No
Can Aquifer be Dewatered with LVDPE ?
No
Are Pneumatic Pumps Applicable ?
No
Yes
Yes
Data Suggests LVDPE Should Be Applied
Is the Vadose Zone Contaminated with VOCs ?
Is the Permeability of the Vadose Zone Moderate (>1 x 10⁻⁴ Darcy) ?
Data Suggests LVDPE will be Most Effective Applied to the Saturated Zone Only
Data Suggests LVDPE will be Most Effective Applied to Both the Saturated Zone and the Vadose Zone

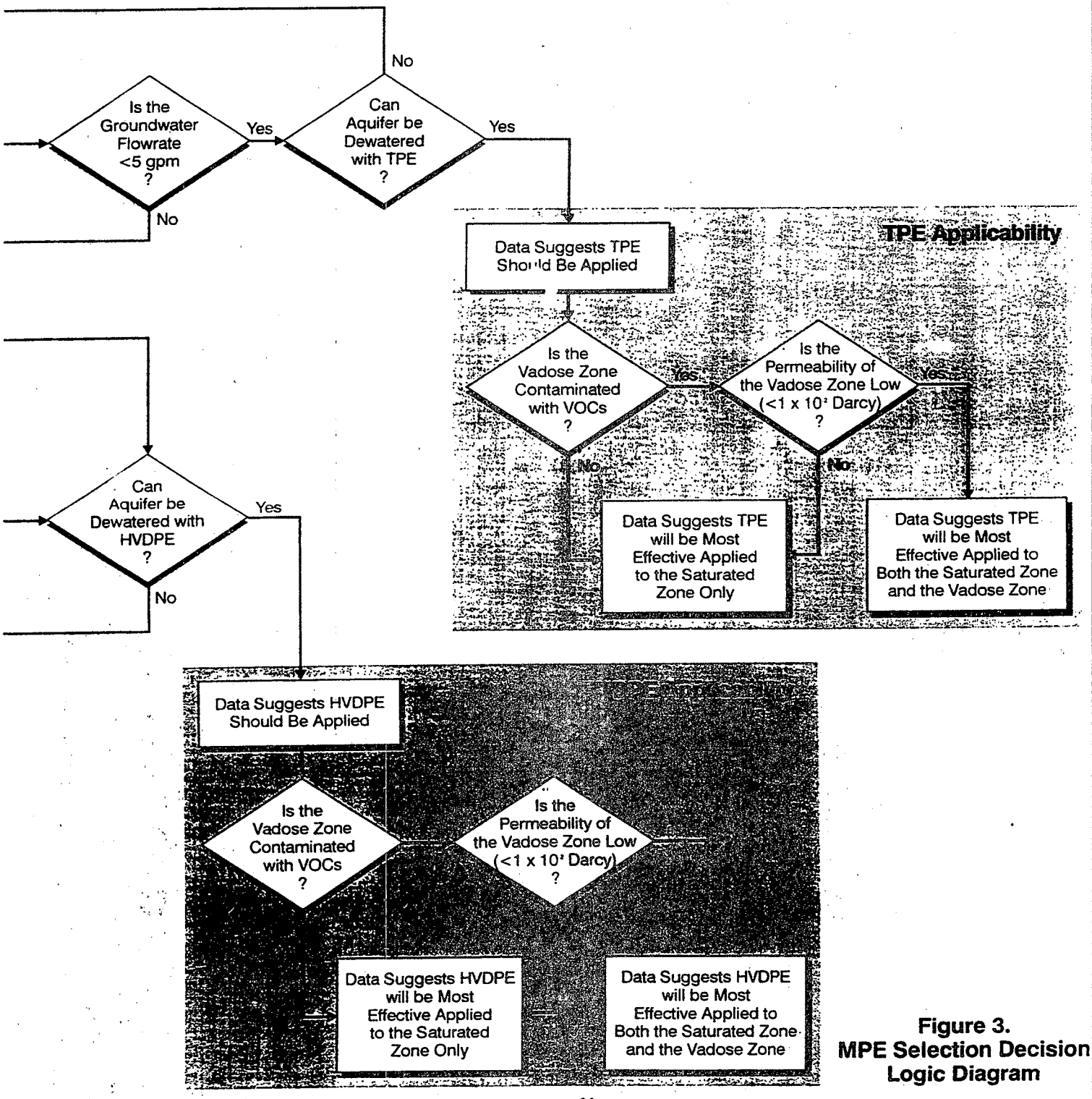


Figure 3.
MPE Selection Decision Logic Diagram

Appendix A. Summary of Case Study Results

SITE	Treatment Type	Depth of Water (feet BGS)	Lithology		Targeted Contaminant	Groundwater Concentration (µg/L)	Number of Extraction Wells	Depth of Extraction Well (feet BGS)	Effective Well Vacuum (in. of Hg)	Screened Interval (feet BGS)	Initial Total Mass of VOCs Removed (lbs/day)		Groundwater Flow rate (GPM)		Vapor Flow rate (scfm)	Estimated Cost of Contaminant Extraction ($/lb)	Remarks
			Vadose Zone	Saturated Zone							MPE	P&T	MPE	P & T			
DDRW-Tracy OU1	TPE	24.0	silty clay	silty clay	TCE	3.5-6.5	1	31	18	15.5-30.5	2.5×10^{-3}	8.7×10^{-5}	3.5	0.5	13-17	38,000	a
Travis AFB, MW 269	TPE	13.7	silts, clays	silts, clays	TCE	1,030	1	22.5	19-22	11.7-21.7	0.113	0.008	3.72	0.8	6-10	848	
Travis AFB, Ragsdale & V, MW-7	TPE	10.0	silts, clays	silts, clays	TCE, TPH, Benzene	3,700	1	29	17	8.5-28.5	24	0.29	5	2	17	4	
Travis AFB, OSA	TPE	8.0	silty clay	silty clay	TCE, PCE	900	1	29	22.5	8-28	0.875	0.11	0.5	<0.25	3.5-5	110	
Nellis AFB, Site 44	TPE	45.0	silty clay	caliche, silty clay	TCE (VOCs)	1,760	1	60	6.5	30-60	0.39	0.012	1.7	0.8	87-97	351	b
McClellan AFB, Bld.666	TPE	109.0	sandy silt	sandy silt	TCE, PCE, Freon	8,400	1	124.5	20	105.5-124.5	9	0.36	5.2	4	94	58	c
FE Warren AFB, OU2, EW1	TPE	10.0	clayey, gravely, silty, sands	clayey sands and clay	TCE	0-150	1	25	9-13	12.7-24.7	0.029	0.011	2.7-3.0	2-3	2-4	3,300	
Ellsworth AFB OU-11, BG-04	TPE	18	sandy silty clay, clayey sand	clayey gravel, pierre shale	TCE	40.5	1	33	9-14	13-23	0.003	0.001	2-3	<2 gpm (estimated)	15-30	32,000	a
Offutt AFB, Bld. 301	LVDPE	50.0	clay	silty sand	TCE	24,600	1	92	9-14.5	50-70	0.7	0.33	3.1	1.5	9-14.5	137	d
McClellan AFB, Bld. 360, EW - 321	LVDPE	112.0	clays, silts	sandy silts, silty sand	TCE (VOCs)	10,500	1	160	10	110-140	11.4	0.28	5.9	2.75	58	245	e
	HVDPE	112.0	clays, silts	sandy silts, silty sand	TCE (VOCs)	10,500	1	160	15	110-140	13.6	0.28	6.7	2.75	78	225	e
McClellan AFB, Bld. 360, MW-224	LVDPE	112.5	sandy silt	sandy silt	TCE (VOCs)	11,000	1	119.5	10	110-140	0.68	0.08	1.6	0.6	4.5	1,700	f
	HVDPE	112.5	sandy silt	sandy silt	TCE (VOCs)	11,000	1	119.5	24	109.5-119.5	2.54	0.08	1.8	0.6	11	1,290	f
Air Force Plant - 44, IRP Site 3,	LVDPE	132.0	interbedded sandy gravel & sandy clay	interbedded sandy gravel & sandy clay	TCE, DCE, TCA, Freon 113	190-510	1	175	6.5	42-184	177	0.21	58	47	231	3	
Air Force Plant - 44, IRP Site 2,	LVDPE	145.0	interbedded sandy gravel & sandy clay	interbedded sandy gravel & sandy clay	TCE	240-2,100	1	250	6	120-245	735	1.55	112	110	181	<1	
Air Force Plant - 44, IRP Site 5	LVDPE	118.0	interbedded sand	interbedded sand	TCE, DCE	25-58	1	180	6	120-150	23.5	0.032	69	64	220	12	

Remarks:
a. High contaminant removal costs are due to low groundwater concentrations.
b. Test results indicate that LVDPE would be more effective than TPE at this site.
c. Test results indicate that HVDPE would be more effective than TPE at this site.
d. Test results indicate that HVDPE would be more effective than LVDPE at this site.
e. HVDPE and LVDPE shown to be nearly equally cost effective for EW-321 at McClellan
f. HVDPE shown to be most cost effective for MW-224 at McClellan.
N/A = Not applicable

Note: Costs associated with any patent requirements are not included in the cost.

United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

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Presumptive Remedy for CERCLA Municipal Landfill Sites

Office of Emergency and Remedial Response
Hazardous Site Control Division 5203G

Quick Reference Fact Sheet

Since Superfund's inception in 1980, the remedial and removal programs have found that certain categories of sites have similar characteristics, such as types of contaminants present, types of disposal practices, or how environmental media are affected. Based on information acquired from evaluating and cleaning up these sites, the Superfund program is undertaking an initiative to develop presumptive remedies to accelerate future cleanups at these types of sites. The presumptive remedy approach is one tool of acceleration within the **Superfund Accelerated Cleanup Model (SACM).**

Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The objective of the presumptive remedies initiative is to use the program's past experience to streamline site investigation and speed up selection of cleanup actions. Over time presumptive remedies are expected to ensure consistency in remedy selection and reduce the cost and time required to clean up similar types of sites. Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances.

This directive establishes **containment** as the presumptive remedy for CERCLA municipal landfills. The framework for the presumptive remedy for these sites is presented in a streamlining manual entitled *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, February 1991 (OSWER Directive 9355. 3-11). This directive highlights and emphasizes the importance of certain streamlining principles related to the scoping (planning) stages of the remedial investigation/feasibility study (RI/FS) that were identified in the manual. The directive also provides clarification of and additional guidance in the following areas: (1) the level of detail appropriate for risk assessment of source areas at municipal landfills and (2) the characterization of hot spots.

BACKGROUND

Superfund has conducted pilot projects at four municipal landfill sites[1] on the National Priorities List (NPL) to evaluate the effectiveness of the manual *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (hereafter referred to as "the manual") as a streamlining tool and as the framework for the municipal landfill presumptive remedy. Consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (or NCP), EPA's expectation was that containment technologies generally would be appropriate for municipal landfill waste because the volume and heterogeneity of the waste generally make treatment impracticable. The results of the pilots support this expectation and demonstrate that the manual is an effective tool for streamlining the RI/FS process for municipal landfills.

Since the manual's development, the expectation to contain wastes at municipal landfills has evolved into a presumptive remedy for these sites.[2] Implementation of the streamlining principles outlined in the manual at the four pilot sites helped to highlight issues requiring further clarification, such as the degree to which risk assessments can be streamlined for source areas and the characterization and remediation of hot spots. The pilots also demonstrated the value of focusing streamlining efforts at the scoping stage, recognizing that the biggest savings in time and money can be realized if streamlining is incorporated at the beginning of the RI/FS process. Accordingly, this directive addresses those issues identified during the pilots and highlights streamlining opportunities to be considered during the scoping component of the RI/FS.

[1] Municipal landfill sites typically contain a combination of principally municipal and to a lesser extent hazardous wastes.

[2] See EPA Publication 9203.1-02I, SACM Bulletins, *Presumptive Remedies for Municipal Landfill Sites*, April 1992, Vol. 1, No. 1, and February 1993, Vol. 2, No.1, and SACM Bulletin *Presumptive Remedies*, August 1992, Vol.1, No. 3.

Finally, while the primary focus of the municipal landfill manual is on streamlining the RI/FS, Superfund's goal under SACM is to accelerate the entire clean-up process. Other guidance issued under the municipal landfill presumptive remedy initiative identifies design data that may be collected during the RI/FS to streamline the overall response process for these sites (see Publication No. 9355.3-18FS, *Presumptive Remedies: CERCLA Landfill Caps Data Collection Guide*, to be published in October 1993).

CONTAINMENT AS A PRESUMPTIVE REMEDY

Section 300.430(a)(iii)(B) of the NCP contains the expectation that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat or where treatment is impracticable. The preamble to the NCP identifies municipal landfills as a type of site where treatment of the waste may be impracticable because of the size and heterogeneity of the contents (55 FR 8704). Waste in CERCLA landfills usually is present in large volumes and is a heterogeneous mixture of municipal waste frequently co-disposed with industrial and/or hazardous waste. Because treatment usually is impracticable, EPA generally considers containment to be the appropriate response action, or the "presumptive remedy," for the source areas of municipal landfill sites.

The presumptive remedy for CERCLA municipal landfill sites relates primarily to containment of the landfill mass and collection and/or treatment of landfill gas. In addition, measures to control landfill leachate, affected ground water at the perimeter of the landfill, and/or upgradient ground-water that is causing saturation of the landfill mass may be implemented as part of the presumptive remedy.

The presumptive remedy does not address exposure pathways outside the source area (landfill), nor does it include the long-term ground-water response action. Additional RI/FS activities, including a risk assessment, will need to be performed, as appropriate, to address those exposure pathways outside the source area. It is expected that RI/FS activities addressing exposure pathways outside the source generally will be conducted concurrently with the streamlined RI/FS for the landfill source presumptive remedy. A response action for exposure pathways outside the source (if any) may be selected together with the presumptive remedy (thereby developing a comprehensive site response), or as an operable unit separate from the presumptive remedy.

Highlight 1 identifies the components of the presumptive remedy. Response actions selected for individual sites will include only those components that are necessary, based on site-specific conditions.

Highlight 1: Components of the Presumptive Remedy: Source Containment

- Landfill cap;
- Source area ground-water control to contain plume;
- Leachate collection and treatment;
- Landfill gas collection and treatment; and/or
- Institutional controls to supplement engineering controls.

The EPA (or State) site manager will make the initial decision of whether a particular municipal landfill site is suitable for the presumptive remedy or whether a more comprehensive RI/FS is required. Generally, this determination will depend on whether the site is suitable for a streamlined risk evaluation, as described on page 4. The community, state, and potentially responsible parties (PRPs) should be notified that a presumptive remedy is being considered for the site before work on the RI/FS work plan is initiated. The notification may take the form of a fact sheet, a notice in a local newspaper, and/or a public meeting.

Use of the presumptive remedy eliminates the need for the initial identification and screening of alternatives during the feasibility study (FS). Section 300.430(e)(1) of the NCP states that, "... the lead agency shall include an alternatives screening step, when needed, (emphasis added) to select a reasonable number of alternatives for detailed analysis."

EPA conducted an analysis of potentially available technologies for municipal landfills and found that certain technologies are routinely and appropriately screened out on the basis of effectiveness, feasibility, or cost (NCP Section 300.430(e)(7)). (See Appendix A to this directive and "Feasibility Study Analysis for CERCLA Municipal Landfills," September 1993 available at EPA Headquarters and Regional Offices.) Based on this analysis, the universe of alternatives that will be analyzed in detail may be limited to the components of the containment remedy identified in Highlight 1, unless site-specific conditions dictate otherwise or alternatives are considered that were not addressed in the FS analysis. The FS analysis document, together with this directive, must be included in the administrative record for each municipal landfill presumptive remedy site to support elimination of the initial identification and screening of site-specific alternatives. Further detailed and comprehensive

supporting materials (e.g., FS reports included in analysis, technical reports) can be provided by Headquarters, as needed.

While the universe of alternatives to address the landfill source will be limited to those components identified in Highlight 1, potential alternatives that may exist for each component or combinations of components may be evaluated in the detailed analysis. For example, one component of the presumptive remedy is source area ground-water control. If appropriate, this component may be accomplished in a number of ways, including pump and treat, slurry walls, etc. These potential alternatives may then be combined with other components of the presumptive remedy to develop a range of containment alternatives suitable for site-specific conditions. Response alternatives must then be evaluated in detail against the nine criteria identified in Section 300.430(e)(g) of the NCP. The detailed analysis will identify site-specific ARARs and develop costs on the basis of the particular size and volume of the landfill.

EARLY ACTION AT MUNICIPAL LANDFILLS

EPA has identified the presumptive remedy site categories as good candidates for early action under SACM. At municipal landfills, the upfront knowledge that the source area will be contained may facilitate such early actions as installation of a landfill cap or a ground-water containment system. Depending on the circumstances, early actions may be accomplished using either removal authority (e.g., non-time-critical removal actions) or remedial authority. In some cases, it may be appropriate for an Engineering Evaluation/Cost Analysis to replace part or all of the RI/FS if the source control component will be a non-time-critical removal action. Some factors may affect whether a specific response action would be better accomplished as a removal or remedial action including the size of the action, the associated state cost share, and/or the scope of O&M. A discussion of these factors is contained in *Early Action and Long-term Action Under SACM - Interim Guidance*, Publication No. 9203.1-05I, December 1992.

SCOPING A STREAMLINED RI/FS UNDER THE PRESUMPTIVE REMEDY FRAMEWORK

The goal of an RI/FS is to provide the information necessary to: (1) adequately characterize the site; (2) define site dynamics; (3) define risks; and (4) develop the response action. As discussed in the following sections, the process for achieving each of these goals can be streamlined for CERCLA municipal landfill sites because of the upfront presumption that landfill contents will be contained. The strategy for streamlining each of these areas should be developed early (i.e., during the scoping phase of the RI/FS).

1. Characterizing the Site

The use of existing data is especially important in conducting a streamlined RI/FS for municipal landfills. Characterization of a landfill's contents is not necessary or appropriate for selecting a response action for these sites except in limited cases; rather, existing data are used to determine whether the containment presumption is appropriate. Subsequent sampling efforts should focus on characterizing areas where contaminant migration is suspected, such as leachate discharge areas or areas where surface water runoff has caused erosion. It is important to note that the decision to characterize hot spots should also be based on existing information, such as reliable anecdotal information, documentation, and/or physical evidence (see page 6).

In those limited cases where no information is available for a site, it may not be advisable to initiate use of the presumptive remedy until some data are collected. For example, if there is extensive migration of contaminants from a site located in an area with several sources, it will be necessary to have some information about the landfill source in order to make an association between on-site and off-site contamination.

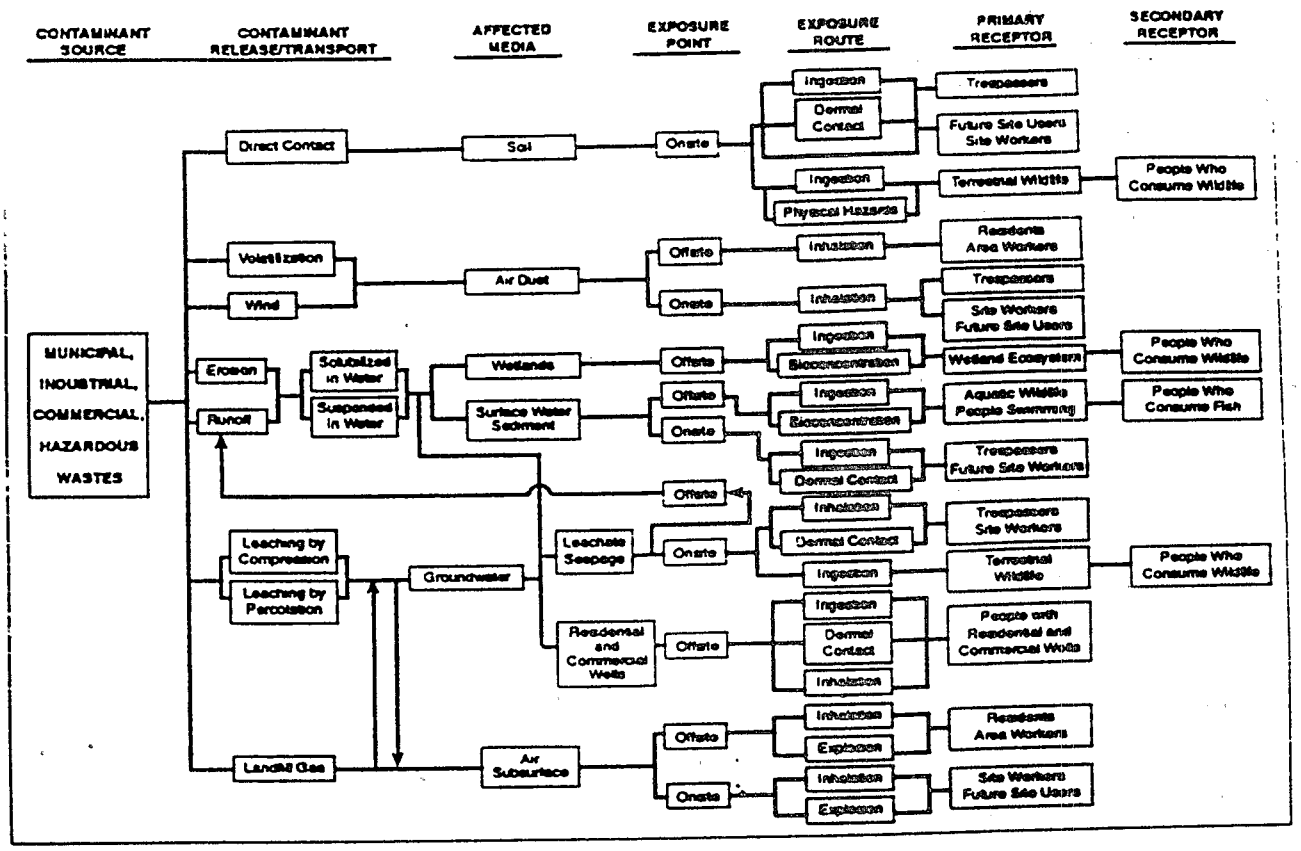
Sources of information of particular interest during scoping include records of previous ownership, state files, closure plans, etc., which may help to determine types and sources of hazardous materials present. In addition, a site visit is appropriate for several reasons, including the verification of existing data, the identification of existing site remediation systems, and to visually characterize wastes (e.g., leachate seeps). Specific information to be collected is provided in Sections 2.1 through 2.4 of the municipal landfill manual.

2. Defining Site Dynamics

The collected data are used to develop a conceptual site model, which is the key component of a streamlined RI/FS. The conceptual site model is an effective tool for defining the site dynamics, streamlining the risk evaluation, and developing the response action. Highlight 2 presents a generic conceptual site model for municipal landfills. The model is developed before any RI field activities are conducted, and its purpose is to aid in understanding and describing the site and to present hypotheses regarding:

- The suspected sources and types of contaminants present;
- Contaminant release and transport mechanisms;

Highlight 2: Generic Conceptual Site Model



- Rate of contaminant release and transport (where possible);
- Affected media;
- Known and potential routes of migration; and
- Known and potential human and environmental receptors.

After the data are evaluated and a site visit is completed, the contaminant release and transport mechanisms relevant to the site should be determined. The key element in developing the conceptual site model is to identify those aspects of the model that require more information to make a decision about response measures. Because containment of the landfill's contents is the presumed response action, the conceptual site model will be of most use in identifying areas beyond the landfill source itself that will require further study, thereby focusing site characterization away from the source area and on areas of potential contaminant migration (e.g., ground water or contaminated sediments).

3. Defining Risks

The municipal landfill manual states that a streamlined or limited baseline risk assessment will be sufficient to initiate response action on the most obvious problems at a municipal landfill (e.g., ground water, leachate, landfill contents, and landfill gas). One method for establishing risk using a streamlined approach is to compare contaminant concentration levels (if available) to standards that are potential chemical-specific applicable or relevant and appropriate requirements (ARARs) for the action. The manual states that where established standards for one or more contaminants in a given medium are clearly exceeded, remedial action generally is warranted.[3]

It is important to note, however, that based on site-specific conditions, an active response is not required if ground-water contaminant concentrations exceed chemical-specific standards but the site risk is within the Agency's acceptable risk range (10^{-4} to 10^{-6}). For example, if it is determined that the release of

[3]See also OSWER Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, April 22, 1991, which states that if MCLs or non-zero MCLGs are exceeded, [a response] action generally is warranted.

contaminants from a particular landfill is declining, and concentrations of one or more ground-water contaminants are at or barely exceed chemical-specific standards, the Agency may decide not to implement an active response. Such a decision might be based on the understanding that the landfill is no longer acting as a source of ground-water contamination, and that the landfill does not present an unacceptable risk from any other exposure pathway.

A site generally will not be eligible for a streamlined risk evaluation if ground-water contaminant concentrations do not clearly exceed chemical-specific standards or the Agency's accepted level of risk, or other conditions do not exist that provide a clear justification for action (e.g., direct contact with landfill contents resulting from unstable slopes). Under these circumstances, a quantitative risk assessment that addresses all exposure pathways will be necessary to determine whether action is needed.

Ultimately, it is necessary to demonstrate that the final remedy addresses all pathways and contaminants of concern, not just those that triggered the remedial action. As described in the following sections, the conceptual site model is an effective tool for identifying those pathways and illustrating that they have been addressed by the containment remedy.

Streamlined Risk Evaluation Of The Landfill Source

Experience from the presumptive remedy pilots supports the usefulness of a streamlined risk evaluation to initiate an early response action under certain circumstances. As a matter of policy, for the source area of municipal landfills, a quantitative risk assessment that considers all chemicals, their potential additive effects, etc., is not necessary to establish a basis for action if ground-water data are available to demonstrate that contaminants clearly exceed established standards or if other conditions exist that provide a clear justification for action.

A quantitative risk assessment also is not necessary to evaluate whether the containment remedy addresses all pathways and contaminants of concern associated with the source. Rather, all potential exposure pathways can be identified using the conceptual site model and compared to the pathways addressed by the containment presumptive remedy. Highlight 3 illustrates that the containment remedy addresses all exposure pathways associated with the source at municipal landfill sites.

Finally, a quantitative risk assessment is not required to determine clean-up levels because the type of cap will be determined by closure ARARs, and ground water that is extracted as a component of the presumptive remedy will be required to meet discharge limits, or other standards for its disposal. Calculation of clean-up levels for ground-water contamination that has migrated away from the source will not be accomplished under the presumptive remedy, since such contamination will require a conventional investigation and a risk assessment.

Highlight 3: Source Contaminant Exposure Pathways Addressed by Presumptive Remedy

1. Direct contact with soil and/or debris prevented by landfill cap;
2. Exposure to contaminated ground water within the landfill area prevented by ground-water control;
3. Exposure to contaminated leachate prevented by leachate collection and treatment; and
4. Exposure to landfill gas addressed by gas collection and treatment, as appropriate.

Streamlining the risk assessment of the source area eliminates the need for sampling and analysis to support the calculation of current or potential future risk associated with direct contact. It is important to note that because the continued effectiveness of the containment remedy depends on the integrity of the containment system, it is likely that institutional controls will be necessary to restrict future activities at a CERCLA municipal landfill after construction of the cap and associated systems. EPA has thus determined that it is not appropriate or necessary to estimate the risk associated with future residential use of the landfill source, as such use would be incompatible with the need to maintain the integrity of the containment system. (Long-term waste management areas, such as municipal landfills, may be appropriate, however, for recreational or other limited uses on a site-specific basis.) The availability and efficacy of institutional controls should be evaluated in the FS. Decision documents should include measures such as institutional controls to ensure the continued integrity of such containment systems whenever possible.

Areas of Contaminant Migration

Almost every municipal landfill site has some characteristic that may require additional study, such as leachate discharge to a wetland or significant surface water run-off caused by drainage problems. These migration pathways, as well as ground-water contamination that has migrated away from the source, generally will require characterization and a more comprehensive risk assessment to determine whether action is warranted beyond the source area and, if so, the type of action that is appropriate.

While future residential use of the landfill source area itself is not considered appropriate, the land adjacent to

landfills is frequently used for residential purposes. Therefore, based on site-specific circumstances, it may be appropriate to consider future residential use for ground water and other exposure pathways when assessing risk from areas of contaminant migration.

4. Developing the Response Action

As a first step in developing containment alternatives, response action objectives should be developed on the basis of the pathways identified for action in the conceptual site model. Typically, the primary response action objectives for municipal landfill sites include:

Presumptive Remedy

- Preventing direct contact with landfill contents;
- Minimizing infiltration and resulting contaminant leaching to ground water;
- Controlling surface water runoff and erosion;
- Collecting and treating contaminated ground water and leachate to contain the contaminant plume and prevent further migration from source area; and
- Controlling and treating landfill gas.

Non-Presumptive Remedy

- Remediating ground water;
- Remediating contaminated surface water and sediments; and
- Remediating contaminated wetland areas.

As discussed in Section 3, "Defining Risks," the containment presumptive remedy accomplishes all but the last three of these objectives by addressing all pathways associated with the source. Therefore, the focus of the RI/FS can be shifted to characterizing the media addressed in the last three objectives (contaminated ground water, surface water and sediments, and wetland areas) and on collecting data to support design of the containment remedy.

Treatment of Hot Spots

The decision to characterize and/or treat hot spots is a site-specific judgement that should be based on the consideration of a standard set of factors. Highlight 4 lists questions that should be answered before making the decision to characterize and/or treat hot spots. The overriding question is whether the combination of the waste's physical and chemical characteristics and volume is such that the integrity of the new containment system will be threatened if the waste is left in place. This question should be answered on the basis of what is known about a site (e.g., from operating records or other reliable information). An answer in the affirmative to all of the questions listed in Highlight 4 would indicate that it is likely that the integrity of the containment system would be threatened, or that excavation and treatment of hot spots would be practicable, and that a significant reduction in risk at the site would occur as a result of treating hot spots. EPA expects that few CERCLA municipal landfills will fall into this category; rather, based on the Agency's experience, the majority of sites are expected to be suitable for containment only, based on the heterogeneity of the waste, the lack of reliable information concerning disposal history, and the problems associated with excavating through refuse.

The volume of industrial and/or hazardous waste co-disposed with municipal waste at CERCLA municipal landfills varies from site to site, as does the amount of information available concerning disposal history. It is impossible to fully characterize, excavate, and/or treat the source area of municipal landfills, so uncertainty about the landfill contents is expected. Uncertainty by itself does not call into question the containment approach. However, containment remedies must be designed to take into account the possibility that hot spots are present in addition to those that have been identified and characterized. The presumptive remedy must be relied upon to contain landfill contents and prevent migration of contaminants. This is accomplished by a combination of measures, such as a landfill cap combined with a leachate collection system. Monitoring will further ensure the continued effectiveness of the remedy.

The following examples illustrate site-specific decision making and show how these factors affect the decision whether to characterize and/or treat hot spots.

Examples of Site-Specific Decision Making Concerning Hot Spot Characterization/ Treatment

Site A

There is anecdotal information that approximately 200 drums of hazardous waste were disposed of at this 70-acre former municipal landfill, but their location and contents are unknown. The remedy includes a landfill cap and ground-water and landfill gas treatment.

A search for and characterization of hot spots is not supported at Site A based on the questions listed in

Highlight 4: Characterization of Hot Spots

If all of the following questions can be answered in the affirmative, it is likely that characterization and/or treatment of hot spots is warranted:

1. Does evidence exist to indicate the presence and approximate location of waste?
2. Is the hot spot known to be principal threat waste?*
3. Is the waste in a discrete, accessible part of the landfill?
4. Is the hot spot known to be large enough that its remediation will reduce the threat posed by the overall site but small enough that it is reasonable to consider removal (e.g., 100,000 cubic yards or less)?

*See *A Guide to Principal Threat and Low Level Threat Wastes*, November 1991, Superfund Publication No. 9380.3-06FS.

Highlight 4: (1) no reliable information exists to indicate the location of the waste; (2) the determination of whether the waste is principal threat waste cannot be made since the physical/chemical characteristics of the wastes are unknown; (3) since the location of the waste is unknown, the determination of whether the waste is in a discrete accessible location cannot be made; (4) in this case, the presence of 200 drums in a 70-acre landfill is not considered to significantly affect the threat posed by the overall site. Rather, the containment system will include measures to ensure its continued effectiveness (e.g., monitoring and/or leachate collection) given the uncertainty associated with the landfill contents and suspected drums.

Site B

Approximately 35,000 drums, many containing hazardous wastes, were disposed of in two drum disposal units at this privately owned 80-acre inactive landfill, which was licensed to receive general refuse. The site is divided into two operable units. The remedy for Operable Unit 1 (OU 1) is incineration of drummed wastes in the two drum disposal units. The remedy for OU 2 consists of treatment of contaminated ground water and leachate and containment of treatment residuals (from OU 1) and remaining landfill contents, including passive gas collection and flaring.

Treatment of landfill contents is supported at Site B because all of the questions in Highlight 4 can be answered in the affirmative: (1) existing evidence from previous investigations and sampling conducted by the state (prior to the RI) indicated the presence and approximate location of wastes; (2) the wastes were considered principal threat wastes because they were liquids and (based on sampling) were believed to contain contaminants of concern; (3) the waste is located in discrete accessible parts of the landfill; and (4) the waste volume is large enough that its remediation will significantly reduce the threat posed by the overall site.

CLOSURE REQUIREMENTS

Subtitle D

In the absence of Federal Subtitle D closure regulations, State Subtitle D closure requirements generally have governed CERCLA response actions at municipal landfills as applicable or relevant and appropriate requirements (ARARs). New Federal Subtitle D closure and post-closure care regulations will be in effect on October 9, 1993 (56 FR 50978 and 40 CFR 258).[4] State closure requirements that are ARARs and that are more stringent than the Federal requirements must be attained or waived.

The new Federal regulations contain requirements related to construction and maintenance of the final cover, and leachate collection, ground-water monitoring, and gas monitoring systems. The final cover regulations will be applicable requirements for landfills that received household waste after October 9, 1991. EPA expects that the final cover requirements will be applicable to few, if any, CERCLA municipal landfills, since the receipt of household wastes ceased at most CERCLA landfills before October 1991. Rather, the substantive requirements of the new Subtitle D regulations generally will be considered relevant and appropriate requirements for CERCLA response actions that occur after the effective date.

Subtitle C

RCRA Subtitle C closure requirements may be applicable or relevant and appropriate in certain circumstances. RCRA Subtitle C is applicable if the landfill received waste that is a listed or characteristic waste under RCRA, and:

1. The waste was disposed of after November 19, 1980 (effective date of RCRA), or

[4] An extension of the effective date has been proposed but not finalized at this time.

2. The new response action constitutes disposal under RCRA (i.e., disposal back into the original landfill).[5]

The decision about whether a Subtitle C closure requirement is relevant and appropriate is based on a variety of factors, including the nature of the waste and its hazardous properties, the date on which it was disposed, and the nature of the requirement itself. For more information on RCRA Subtitle C closure requirements, see *RCRA ARARs: Focus on Closure Requirements*, Directive No. 9234.2-04FS, October 1989.

[5]Note that disposal of only small quantity hazardous waste and household hazardous waste does not make Subtitle C applicable.

Notice:

The policies set out in this document are intended solely as guidance to the U.S. Environmental Protection Agency (EPA) personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change the guidance at any time without public notice.

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES

This Appendix summarizes the analysis that EPA conducted of feasibility study (FS) and Record of Decision (ROD) data from CERCLA municipal landfill sites which led to the establishment of containment as the presumptive remedy for these sites. The objective of the study was to identify those technologies that are consistently included in the remedies selected, those that are consistently screened out, and to identify the basis for their elimination. Results of this analysis support the decision to eliminate the initial technology identification and screening steps on a site-specific basis for this site type. The technical review found that certain technologies are appropriately screened out based on effectiveness, implementability, or excessive costs.

The methodology for this analysis entailed reviewing the technology identification and screening components of the remedy selection process for a representative sample of municipal landfill sites. The number of times each technology was either screened out or selected in each remedy was compiled. A detailed discussion of the methodology used is provided below.

METHODOLOGY

Identification of Sites for Feasibility Study Analysis

Of the 230 municipal landfill sites on the NPL, 149 sites have had a remedy selected for at least one operable unit. Of the 149 sites, 30 were selected for this study on a random basis, or slightly greater than 20 percent. The sites range in size from 8.5 acres to over 200 acres and are located primarily in Regions 1, 2, 3, and 5. This geographical distribution approximates the distribution of municipal landfills on the NPL.

Technology Screening and Remedial Alternative Analysis

The FS analysis involved a review of the technology identification and screening phase, including any pre-screening steps, followed by a review of the detailed analysis and comparative analysis phases. Information derived from each review was documented on site-specific data collection forms, which are available for evaluation as part of the Administrative Record for this presumptive remedy directive. The review focused on the landfill source contamination only; ground-water technologies and alternatives were not included in the analysis.

For the screening phase, the full range of technologies considered was listed on the data collection forms, along with the key reasons given for eliminating technologies from further consideration. These reasons were categorized according to the screening criteria: cost, effectiveness, or implementability. The frequency with which specific reasons were given for eliminating a technology from further consideration was then tallied and compiled into a screening phase summary table.

For the detailed analysis and comparative analysis, information on the relative performance of each technology/alternative with respect to the seven NCP criteria was documented on the site-specific data collection forms. The advantages and disadvantages associated with each clean-up option were highlighted. In some cases, a technology was combined with one or more technologies into one or more alternatives. The disadvantages of a technology/alternative were then compiled into a detailed analysis/comparative analysis summary table, under the assumption that these disadvantages contributed to non-selection. All summary tables are available for review as part of the Administrative Record.

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES (continued)

RESULTS

The information from the technology screening and remedial alternative analyses is provided in Table 1. It demonstrates that containment (the presumptive remedy), was chosen as a component of the selected remedy at all thirty of the sites analyzed. No other technologies or treatments were consistently selected as a remedy or retained for consideration in a remedial alternative. However, at eight of the thirty sites, there were circumstances where technologies were included in the selected remedy to address a site-specific concern, such as principal threat wastes. These technologies are included in the column entitled "Tech. Not Primary Component of Alternative"[1] in Table 1 and include incineration at two sites, waste removal and off-site disposal at two sites, soil vapor extraction at two sites, and bioreclamation at one site.

Leachate collection and gas collection systems were also tracked as part of the detailed analysis and comparison of remedial alternatives. These types of systems generally were not considered as remediation technologies during the screening phases. At fifteen sites, leachate collection was selected as part of the overall containment remedy. At seventeen sites, gas collection systems were selected as part of the overall containment remedy.

This analysis supports the decision to eliminate the initial technology identification and screening step for municipal landfill sites. On a site-specific basis, consideration of remediation technologies may be retained as needed.

[1] This column title is used for record-keeping purposes only and is not meant to imply that these treatment technologies are not considered important components of the selected remedies.

TABLE 1• SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS [1]

TECHNOLOGY [2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out [3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs WHERE CRITERION CONTRIBUTED TO NON-SELECTION								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns [4]	Community Concerns [4]
Multi-layer Cap	28	25	3	0	2	2	0	18	7	1	0	0	1	3	5	3	--	--
Clay Cap	16	8	8	0	1	8	0	4	4	2	2	1	2	1	0	1	--	--
Asphalt Cap	17	0	17	0	2	14	5	0	0	0	0	0	0	0	0	0	--	--
Concrete Cap	17	0	17	0	3	14	5	0	0	0	0	0	0	0	0	0	--	--
Soil Cover	16	7	5	4	0	5	1	5	2	1	0	0	0	0	0	0	--	--
Synthetic Cap	13	3	10	0	0	10	1	2	1	1	1	1	1	1	1	1	--	--
Chemical Seal	5	0	5	0	0	4	0	0	0	0	0	0	0	0	0	0	--	--
Slurry Wall	22	5	14	3	2	8	6	2	3	3	2	2	1	2	0	2	--	--
Grout Curtain	18	0	18	0	3	15	9	0	0	0	0	0	0	0	0	0	--	--
Sheet Piling	17	1	16	0	0	13	5	0	1	0	0	0	0	0	0	0	--	--
Grout Injection	8	0	8	0	0	8	2	0	0	0	0	0	0	0	0	0	--	--
Block Displacement	5	0	5	0	0	3	3	0	0	0	0	0	0	0	0	0	--	--
Bottom Sealing	5	0	5	0	0	3	4	0	0	0	0	0	0	0	0	0	--	--

TABLE 1 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS (Continued)[1]

Technology[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out[3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns[4]	Community Concerns[4]
Vibrating Beam	5	0	5	0	0	3	3	0	0	0	0	0	0	0	0	0	--	--
Liners	2	0	2	0	0	1	2	0	0	0	0	0	0	0	0	0	--	--
Offsite Nonhazardous Landfill	3	0	3	0	0	0	3	0	0	0	0	0	0	0	0	0	--	--
Offsite RCRA Landfill	17	0	13	4	8	3	12	0	0	0	0	0	0	0	0	0	--	--
Offsite Landfill (unspecified)	9	1	8	0	5	3	5	1	0	0	0	0	0	0	0	0	--	--
Onsite Nonhazardous Landfill	2	0	2	0	1	1	1	0	0	0	0	0	0	0	0	0	--	--
Onsite RCRA Landfill	14	1	11	2	3	2	10	0	1	0	0	0	0	0	0	1	--	--
Onsite Landfill (unspecified)	7	0	6	1	3	3	6	0	0	0	0	0	0	0	0	0	--	--
Bioremediation (unspecified)	13	0	13	0	0	13	1	0	0	0	0	0	0	0	0	0	--	--
Bioremediation Ex-situ	10	0	10	0	0	7	7	0	0	0	0	0	0	0	0	0	--	--
Bioremediation In-situ	15	1	14	0	1	13	7	1	0	0	0	0	0	0	0	0	--	--
Dechlorinization/ APEG	6	0	5	1	1	4	2	0	0	0	0	0	0	0	0	0	--	--
Oxidation/ Reduction	12	0	12	0	1	8	5	0	0	0	0	0	0	0	0	0	--	--

TABLE 1 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS (Continued)[1]

TECHNOLOGY [2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out [3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns [4]	Community Concerns [4]
Neutralization	4	0	3	1	0	2	1	0	0	0	0	0	0	0	0	0	--	--
Thermal Destruction (unspecified)	6	0	6	0	0	3	4	0	0	0	0	0	0	0	0	0	--	--
Offsite Incineration (unspecified)	19	2	14	3	9	5	10	1	1	0	0	0	0	1	1	0	--	--
Onsite Incineration (unspecified)	12	0	8	3	5	5	6	0	1	0	0	0	0	1	1	1	--	--
Fluidized Bed	9	0	9	0	5	6	4	0	0	0	0	0	0	0	0	0	--	--
Infrared	8	0	7	1	6	3	3	0	0	0	0	0	0	0	0	0	--	--
Pyrolysis	5	2	3	1	2	2	1	0	1	0	1	0	0	1	1	1	--	--
Multiple Hearth	4	0	4	0	2	2	1	0	0	0	0	0	0	0	0	0	--	--
Rotary Kiln	10	0	9	1	6	5	4	0	0	0	0	0	0	0	0	0	--	--
Vitrification	21	0	21	0	8	15	11	0	0	0	0	0	0	0	0	0	--	--
Low Temperature Thermal Desorp/ Stripping	13	1	11	1	2	9	3	0	1	0	0	0	0	0	1	0	--	--
In-situ Steam Stripping	5	0	5	0	1	4	2	0	0	0	0	0	0	0	0	0	--	--
Soil Flushing	16	2	14	0	2	9	10	0	0	0	0	0	0	0	0	0	--	--

TABLE 1 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS (Continued)[1]

Technology[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	#FSs Where Criterion Contributed To Screening Out[3]			# RODs Tech. Selected	# RODs Tech. Not Selected	# RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State[4] Concerns	Community[4] Concerns
Soil Washing	12	2	9	1	1	8	6	0	0	0	0	0	0	0	0	0	--	--
Soil Vapor Extraction (SVE)	14	1	11	2	2	9	5	1	0	0	0	0	0	0	0	0	--	--
Fixation	7	1	5	1	0	4	2	2	0	0	0	0	0	0	0	0	--	--
Stabilization/ Solidification	20	0	19	2	1	13	6	0	0	0	0	0	0	0	0	0	--	--
Aeration	7	0	7	0	0	5	3	0	0	0	0	0	0	0	0	0	--	--

1 This study was conducted on 30 RODs and their corresponding FSs.
2 This does not the include the no-action or institutional control only alternatives. No RODs selected either of these as remedies.
3 FSs and RODs may contain more than one criterion for screening or non-selection of technology. Also, some FSs did not fully explain the criteria for screening out a technology. Thus, the totals for screening and non-selection criteria are not equal to the number of FSs and RODs considered.
4 Information on State and community concerns was not included in this analysis because FSs do not contain this information and RODs generally only reference supporting documentation (i.e., State concurrence letter and responsiveness summary).

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Office of Solid Waste and Emergency Response

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EPA

Landfill Presumptive Remedy Saves Time and Cost

Office of Emergency and Remedial Response (5202G)

Intermittent Bulletin
Volume 1 Number 1

Since Superfund's inception in 1980, the removal and remedial programs have found that certain categories of sites have similar characteristics, such as types of contaminants present, past industrial use, or environmental media affected. Based on a wealth of information acquired from evaluating and cleaning up these sites, Superfund undertook the presumptive remedy initiative to develop remedies that are appropriate for specific site types and/or contaminants. One site category for which EPA developed a presumptive remedy is municipal landfills. This bulletin summarizes the results of implementing the containment presumptive remedy at three CERCLA municipal landfill sites. At each of the sites, both time and costs were saved in conducting the RI/FS. When compared to similar "control" sites, EPA estimates time savings ranging from 36 to 56 percent, and cost savings up to 60 percent. In addition to demonstrating significant time and cost savings, the pilots also indicate that municipal landfill sites are good candidate sites for implementing the presumptive remedy as an early action, such as a non-time-critical removal. The combination of this presumptive remedy with an early action resulted in significant savings at one pilot site.

Introduction

EPA expects that the use of presumptive remedies will streamline removal actions, site studies, and cleanup actions while improving consistency, reducing costs, and increasing the speed with which hazardous waste sites are remediated. EPA has developed several presumptive remedies to date; a list of presumptive remedy directives is provided at the end of this document. The results of implementing the *containment presumptive remedy* at three CERCLA municipal landfill sites are discussed in this bulletin.

The Containment Presumptive Remedy

EPA established containment as the presumptive remedy for municipal landfills in September 1993. The containment presumptive remedy includes the following components, as appropriate on a site-specific basis:

- Landfill cap;
- Source area ground-water control to contain plume;
- Leachate collection and treatment;
- Landfill gas collection and treatment;
- Institutional controls to supplement engineering controls.

The presumptive remedy does not address exposure pathways outside the source area (landfill), nor does it include long-term ground-water response actions.

The Pilot Sites

Prior to establishing the presumptive remedy, EPA initiated a pilot project at three sites to assess the effectiveness of the containment remedy in streamlining the remedial investigation/feasibility study (RI/FS) process for municipal landfills. The pilots implemented the streamlining principles outlined in the document, "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites," February 1991, Directive No. EPA/540/P-91001 (hereafter referred to as the "1991 MLF RI/FS guidance"). This 1991 MLF RI/FS guidance provides the implementation framework of the containment presumptive remedy.

EPA found the containment remedy to be a very effective tool for streamlining the RI/FS at municipal landfills. This bulletin describes the pilot sites, the ways in which each RI/FS was streamlined, and the time and cost savings realized at each of the sites. See Attachment A at the end of this bulletin for brief site summaries.

Who Can Use The Presumptive Remedy?

If you are the manager of a municipal landfill site, it is likely that **the presumptive remedy can help you save time and money on the RI/FS at your site.** Although the presumptive remedy is most beneficial when incorporated at the scoping stage of the RI/FS, if your site has progressed beyond that point, you may still be able to streamline your site characterization sampling strategy, baseline risk assessment, and/or feasibility study.

EPA piloted the containment remedy at the following municipal landfills beginning in the Spring of 1992:

- Albion-Sheridan Township Landfill, Michigan
- Lexington County Landfill, South Carolina
- BFI/Rockingham Landfill, Vermont

These sites were selected as pilots because they were in the scoping phase of the RI/FS at the time. The biggest savings in time and cost can be realized if streamlining is incorporated at the very beginning of the scoping phase of the RI/FS. All of these sites now have signed Records of Decision (RODs), with containment selected as part of the remedy at each of the sites.

EPA evaluated the impact of the containment remedy as a streamlining tool at the three pilot sites by estimating time and cost savings. The sites were evaluated in a paired analysis, comparing the pilot sites to the three "control" sites listed in Highlight 1. Remedy selection at the control sites was based on the results of conventional RI/FSs.

The factors considered in selecting the "control" sites included (listed in order of priority): (1) the state in which the landfill is located since State closure requirements often affect aspects of remedy selection; (2) the lead for the site (e.g., Fund-lead); and (3) the size of the landfill (in acres). Summary information on the pilot and control sites is provided in Highlight 1.

Highlight 1
Pilot/Control Site Characteristics

PILOT SITES				CORRESPONDING CONTROL SITES			
Name	State	Lead	Size	Name	State	Lead	Size
Albion-Sheridan	MI	F	30	West KL	MI	F	87
BFI	VT	PRP	19	Parker	VT	PRP	19
Lexington Co.	SC	PRP	70	Cedar-town LF	GA	PRP	6.8

Pilot Results

Two areas of the RI/FS process presented the greatest opportunity for streamlining at the pilot sites: 1) a phased approach to site characterization, and 2) streamlining the risk assessment.

Phased Approach to Site Characterization

The containment presumptive remedy emphasizes the use of existing data to the degree possible, and discourages characterization of landfill contents since it is presumed that the landfill will be contained, unless information is available indicating the need to investigate and potentially remove or treat hot spots. In keeping with these principles, a **phased approach** to sampling is recommended.

The phased approach to site characterization is a site-specific strategy that frames the data collection effort within the context of determining whether a risk is present at a site rather than characterizing the nature and extent of all contamination in a landfill.[1] A site-specific determination is made as to the environmental medium most likely to present a risk based upon any existing data available, and sampling of that pathway is conducted first.

At many landfill sites, ground-water contamination is likely to present a significant risk, and thus trigger the need for action.[2] At the pilot sites, ground water was the first medium sampled, and at each of the pilot sites, ground-water contamination supported the need for a response action. In two cases, soil sampling of the landfill source area was never conducted; sampling was limited to determining risk from the ground water. At one site, the State conducted additional sampling of the landfill area.

If ground-water data had not clearly demonstrated a risk at the pilot sites, additional sampling would have been conducted (in sequence) to determine whether a risk was present from other media or exposure pathways, such as contaminated soil and/or landfill gas. At the pilot sites, additional sampling was not necessary to determine risk, and since containment of the landfill was presumed, sampling and analysis was not required for the purpose of site characterization.

Streamlined Risk Assessment

For many landfill sites, it will be possible to streamline the risk assessment portion of the RI/FS. This is possible because the containment remedy addresses all migration pathways presented by the landfill source. The basis of the streamlined risk assessment process to be employed at MLFs is the conceptual site model (discussed in Section 2.5 of the 1991 RI/FS MLF guidance), which is used to identify all exposure pathways associated with the landfill source (i.e., direct contact with soil, exposure to contaminated ground water, contaminated

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[1]This phased approach applies to the landfill source only. Contamination that has migrated away from the landfill source must be characterized, and the associated risk estimated.

[2]See OSWER Directive 9355.0-30, "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions," April 22, 1991, which states that if MCLs or non-zero MCLGs are exceeded, [a response] action generally is warranted.

leachate, and/or landfill gas). The exposure pathways are then compared to those addressed by the containment remedy, as follows:

- direct contact with soil and/or debris prevented by landfill cap;
- exposure to contaminated ground water prevented by ground-water control;
- exposure to contaminated leachate prevented by leachate collection and treatment; and
- exposure to landfill gas addressed by gas collection and treatment, as appropriate.

This comparison reveals that the containment remedy addresses all pathways associated with the landfill source. The phased approach can be implemented at landfill sites using the conceptual site model because it demonstrates that all exposure pathways are addressed by the containment remedy, and field sampling is therefore not required to characterize the nature and extent of contamination once it has been demonstrated that the site presents a risk and warrants action.

A streamlined risk evaluation was successfully conducted at the three pilot sites, with contaminated ground water presenting the justification for a response action. Sampling, analysis, and a conventional risk assessment were required to characterize contamination, if any, that had migrated away from the source areas.

Quantitative Results

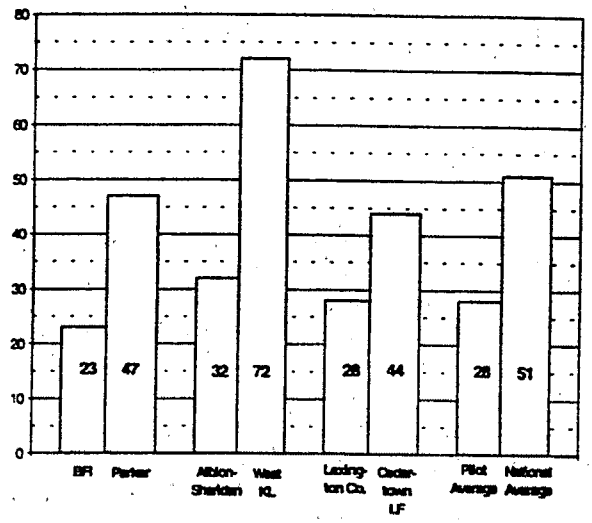
As illustrated in Highlight 2, the RI/FS durations for the pilot sites ranged from 23 to 32 months, compared to 44 to 72 months for the control sites. The average pilot RI/FS duration was 28 months, as compared to the national average of 51 months. The RI/FS durations for the pilot sites represent a time savings ranging from 16 to 40 months when compared to the control sites, and 23 months when compared to the national average. These results translate into an estimated time savings ranging from 36-56 percent when comparing the pilots to the control sites, and an estimated 45 percent when comparing the average pilot duration to the national average.

The figures for the BFI/Rockingham site include completion of an Engineering Evaluation/Cost Analysis (EE/CA) to support implementation of source control (i.e., cap, leachate and gas collection) as a non-time-critical removal action. The EE/CA was completed in 12 months, which is a subset of the 23 months indicated in Highlight 2. The 23 months was the time required to complete the RI/FS for the entire site, including ground-water contamination.

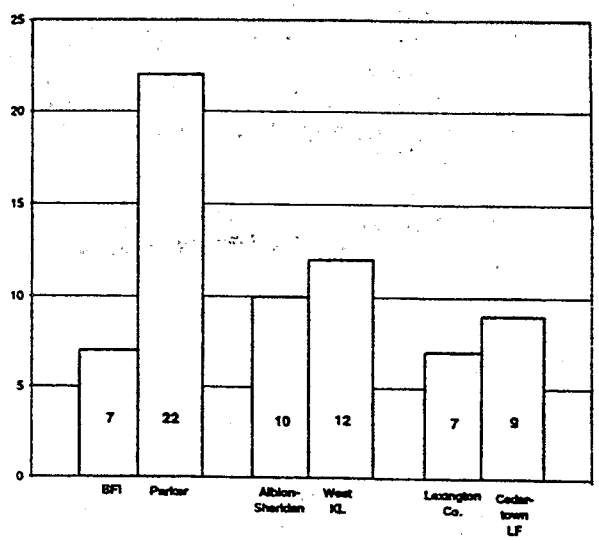
The pilot results for the BFI/Rockingham site are particularly noteworthy because the source control action was initiated just 12 months after the RI/FS start, and construction of the cap was completed in July 1995, just three years after the RI/FS start.

A savings in time was also realized as a result of the streamlined risk evaluations conducted at the pilot sites, as illustrated in Highlight 3. The time required to complete the risk assessments at the pilot sites ranged from 7 to 10 months, as compared to 9 to 22 months for the controls, which represents a savings ranging from 17 to 68 percent when compared to the control sites.

Highlight 2
RI/FS Durations (Months) for Pilot/Control Site and National Averages



Highlight 3
Risk Assessment Durations (Months) for Pilot/Control Sites



Cost savings were estimated in one of two ways for the pilot sites. The RI/FS costs for Albion-Sheridan Landfill and Lexington County were compared to the national average RI/FS cost of $1 million, resulting in an estimated 10 percent and 1 percent savings, respectively, for those sites. The cost savings estimate for the BFI/Rockingham site was developed by the PRP, and was based upon a comparison with their costs for RI/FSs conducted at other similar sites. A savings of 60 percent was estimated for the RI/FS, which included the source area and areas of migration, and an engineering evaluation/cost analysis (EE/CA) to support the non-time-critical removal action on the landfill cap.

Conclusion

EPA found that the containment presumptive remedy resulted in a savings of time and costs at each of the pilot sites. The savings were the result of implementing a phased approach to site characterization and streamlining the risk assessment, both of which were possible because the landfill contents were contained.

The savings in time and costs were most significant at the BFI/Rockingham site, where the cap was completed three years after initiation of the RI/FS, and an estimated $3 million was saved. This significant savings was the result of combining the containment presumptive remedy with an early action accomplished as a non-time-critical removal action. Based on these results, municipal landfill sites appear to be well suited to the combined application of these streamlining and acceleration tools.

Next Steps

Since establishment of the presumptive remedy, EPA has tracked implementation at two additional landfill sites (demonstration sites): (1) Bennington Landfill, Vermont, and (2) Tomah Municipal Landfill, Wisconsin. EPA will summarize findings from the demonstration sites upon signature of their respective Records of Decision (RODs).

Presumptive Remedy Directives

To date, EPA has issued the following presumptive remedy directives:

(1) "Presumptive Remedies: Policy and Procedures," September 1993, Directive No. 9355.0-47FS;

(2) "Conducting Remedial Investigations/Feasibilities Studies for CERCLA Municipal Landfill Sites," EPA/540/P-91/001, February 1991.

(3) "Presumptive Remedy for CERCLA Municipal Landfill Sites," September 1993, Directive No. 9355.0-49FS;

(4) "CERCLA Landfill Caps RI/FS Data Collection Guide," August 1995, Directive No. 9355.3-18FS;

(5) "Site Characterization and Technology Selection for Volatile Organic Compounds in Soil/Sludge," September 1993, Directive No. 9355.4-048FS;

(6) "Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites," December 1995, Directive No. 9200.5-162.

(7) "Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites," EPA/540/R-96/023, October 1996.

In addition, presumptive remedies directives for the following types of sites or contaminants are forthcoming:

(1) PCBs

(2) Manufactured gas plants

(3) Grain storage sites

(4) Metals in soils (in cooperation with the U.S. Department of Energy).

Additional Information

For additional information on the pilot sites or the presumptive remedy for municipal landfills, please call Andrea McLaughlin, Office of Emergency and Remedial Response, 703-603-8793.

Attachment A: Pilot Case Studies

Albion-Sheridan Landfill

Anecdotal evidence indicated that some quantity of industrial wastes were disposed of at the 30-acre Albion-Sheridan Landfill, but the location, volume and identity of wastes were unknown. No data were available for the site at the beginning of the RI/FS. EPA implemented the streamlining principles of the 1991 MLF RI/FS guidance, and scoped a phased approach to characterization of the Albion-Sheridan site with the goal of implementing the containment remedy. The draft work plan was revised to incorporate the phased investigation, focusing first on ground-water contamination to establish whether there was a basis for a response action.

Ground-water contamination did support the need for action at the site, so it was not necessary to quantify additional exposure pathways for this purpose. The remainder of the risk assessment was streamlined by using a conceptual site model to demonstrate that the other potential pathways of concern (e.g. direct contact) would be addressed by the components of the presumptive remedy (e.g. landfill cap).

EPA conducted a geophysical survey of the site to identify potential drum storage areas. Based on the results of the geophysics, EPA concluded that while there were anomalies in the results, there were no areas that appeared to consist of large numbers of drummed waste, thereby warranting further investigation. Because the State had remaining concerns with EPA's approach to hot spots, the State conducted its own geophysical survey and dug test pits at 12 locations. At one location approximately 300-400 drums were uncovered, and EPA reiterated its agreement to send any drums of hazardous waste off-site for disposal. Of the 300-400 drums, the number containing hazardous waste is unknown at this time.

Lexington County Landfill

Ground-water data were available for this 70-acre landfill prior to initiation of the RI, which indicated exceedences of MCLs, and therefore a basis for a response action. The strategy for the Lexington County Landfill RI was similar to the Albion-Sheridan Landfill, in that a phased approach was implemented. Sampling focused on further characterization of ground-water contamination, and the risk assessment was streamlined, focusing also on the ground-water pathway. Planned soil sampling and analysis to estimate direct contact threats was eliminated, and it was demonstrated (using a conceptual site model) that other potential pathways of concern would be addressed by components of the presumptive remedy.

A planned drum search of the 70-acre landfill was eliminated based on the guidelines for hot spot characterization contained in the 1991 MLF RI/FS guidance. At Lexington County Landfill, as at Albion Sheridan Landfill, it is likely that some industrial waste was disposed of at the site, but the location, quantity and identity of the wastes were unknown. Because there was no evidence to guide such a search, EPA decided that the best approach was to contain the landfill, accounting for uncertainties in the nature of the wastes during the design.

The selected remedy includes consolidation and capping of the waste areas, landfill gas collection and venting; extraction of contaminated groundwater/leachate with discharge to POTW; additional sampling of surface water and sediment to characterize any off-site contamination; and monitoring of ground water, surface water, sediment and landfill gas. Additionally, to address a plume, a ground-water pump and treat remedy was put in place.

BFI/Rockingham

Extensive ground-water data were available for this site at the initiation of the RI, and the first step in implementation of the presumptive remedy was to evaluate the potential for using the data. The data were found to be useable to establish an initial basis for action, which allowed streamlining of the risk assessment and RI. Only confirmational ground-water sampling was conducted during the RI; characterization of the landfill surface soil and debris mass did not occur. Geotechnical information regarding settlement, cover quality, and stability was also collected. The knowledge that containment was the likely remedy allowed the RI to become primarily a design-related investigation. In addition, based on historical information, hot spots were not of concern at this site.

Levels of volatile organic compounds (VOCs) and certain metals clearly indicated that a ground-water risk was present. The existence of ground-water risk confirmed that a "No Action" decision was unlikely, and that a landfill cap would be a component of the source control action. The risk assessment was streamlined by quantifying the ground-water risk and qualitatively discussing the other pathways that would be addressed by the source control action. All pathways outside the landfill, which included off-site ground water and off-site soils, were fully quantified. An early action was conducted as a non-time-critical removal at this site in order to begin construction of the landfill cap. The combination of the presumptive remedy with the early action resulted in a significant time savings in the remedy selection and construction processes.

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

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EPA

Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills

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Quick Reference Fact Sheet

Presumptive remedies are preferred technologies for common categories of sites based on historical patterns of remedy selection and the U.S. Environmental Protection Agency's (EPA's) scientific and engineering evaluation of performance data on technology implementation. By streamlining site investigation and accelerating the remedy selection process, presumptive remedies are expected to ensure the consistent selection of remedial actions and reduce the cost and time required to clean up similar sites. Presumptive remedies are expected to be used at all appropriate sites. Site-specific circumstances dictate whether a presumptive remedy is appropriate at a given site.

EPA established source containment as the presumptive remedy for municipal landfill sites regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in September of 1993 (see the directive *Presumptive Remedy for CERCLA Municipal Landfill Sites*). The municipal landfill presumptive remedy should also be applied to all appropriate military landfills. This directive highlights a step-by-step approach to determining when a specific military landfill is an appropriate site for application of the containment presumptive remedy. It identifies the characteristics of municipal landfills that are relevant to the applicability of the presumptive remedy, addresses characteristics specific to military landfills, outlines an approach to determining whether the presumptive remedy applies to a given military landfill, and discusses administrative record documentation requirements.

PURPOSE

This directive provides guidance on applying the containment presumptive remedy to military landfills. Specifically, this guidance:

- Describes the relevant characteristics of municipal landfills for applicability of the presumptive remedy;
- Presents the characteristics specific to military installations that affect application of the presumptive remedy;
- Provides a decision framework to determine applicability of the presumptive remedy to military landfills; and
- Provides relevant contacts/specialists in military wastes, case histories, administrative record documentation requirements, and references.

BACKGROUND

Municipal landfills are those facilities in which a combination of household, commercial and, to a lesser extent, industrial wastes have been co-disposed. The presumptive remedy for municipal landfills – source containment – is described in detail in the directive *Presumptive Remedy for CERCLA Municipal Landfill Sites*. Highlight 1 outlines the components of the containment presumptive remedy. Highlight 2 lists the characteristics of municipal landfills that are compatible with the presumptive remedy of containment.

Highlight 1

Components of the Containment Presumptive Remedy

- Landfill cap
- Source area groundwater control to contain plume
- Leachate collection and treatment
- Landfill gas collection and treatment
- Institutional controls to supplement engineering controls

Highlight 2

Appropriate Municipal Landfill Characteristics for Applicability of the Presumptive Remedy

- Risks are low-level, except for "hot spots"
- Treatment of wastes is usually impractical due to the volume and heterogeneity of waste
- Waste types include household, commercial, nonhazardous sludge, and industrial solid wastes
- Lesser quantities of hazardous wastes are present as compared to municipal wastes
- Land application units, surface impoundments, injection wells, and waste piles are not included

The presumptive remedy process involves streamlining of the remedial investigation/feasibility study (RI/FS) or, for non-time-critical removals, an Engineering Evaluation/Cost Analysis (EE/CA) by:

- Relying on existing data to the extent possible rather than characterizing landfill contents (limited or no landfill source investigation unless there is information indicating a need to investigate hot spots);
- Conducting a streamlined risk assessment; and
- Developing a focused feasibility study that analyzes only alternatives consisting of appropriate components of the presumptive remedy and, as required by the National Contingency Plan, the no action alternative.

Several directives, including *Presumptive Remedy for CERCLA Municipal Landfill Sites*, *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, and *Streamlining the RI/FS for CERCLA Municipal Landfill Sites*, provide a complete discussion of these streamlining principles.

USE OF THIS GUIDANCE

EPA anticipates that the containment presumptive remedy will be applicable to a significant number of landfills found at military facilities. Although waste types may differ between municipal and military landfills, these differences do not preclude use of source containment as the primary remedy at appropriate military landfills.

Additionally, EPA continues to seek greater consistency among cleanup programs, especially in the process of selecting response actions for sites regulated under CERCLA and corrective measures for facilities regulated under the Resource Conservation and Recovery Act (RCRA). In general, even though the Agency's presumptive remedy guidances were developed for CERCLA sites, they should also be used at RCRA Corrective Action sites to focus RCRA Facility Investigations, simplify evaluation of remedial alternatives in the Corrective Measures Study, and influence remedy selection in the Statement of Basis. For more information, refer to the *RCRA Corrective Action Plan*, the proposed *Subpart S regulations*, and the *RCRA Corrective Action Advance Notice of Proposed Rulemaking*.

CHARACTERISTICS OF MILITARY LANDFILLS

The size of the landfill and the presence, proportion, distribution, and nature of wastes are fundamental to the application of the containment presumptive remedy to military landfills.

An examination of 31 Records of Decisions (RODs) that document the remedial decisions for 51 landfills at military installations revealed that no action was chosen for 10 landfills and remedial actions were chosen at 41 landfills (see Appendix). Of these 41 landfills, containment was selected at 23 (56 percent). For the remaining 18 landfills where other remedies were selected, institutional controls only were selected at three landfills, excavation and on-site consolidation were selected at four landfills, and excavation and off-site disposal were selected for 11 landfills.

The military landfills examined in the 51 RODs mentioned above ranged in size from 100 square feet to 150 acres and contained a wide variety of waste types. Of the 41 landfills for which remedial actions were chosen, 14 (34 percent) were one acre or less in size; containment was not selected for any of these landfills. Containment was chosen at 23 (85 percent) of the 27 landfills that were greater than one acre in size. This information suggests that the size of the landfill area is an important factor in determining the use of source containment at military landfills.

The wastes most frequently deposited at these military landfills were municipal-type wastes: household, commercial (e.g., hospital wastes, grease, construction debris), and industrial (e.g., process wastes, solvents, paints) wastes. Containment was the remedy selected at the majority of these sites. Military-specific wastes (e.g., munitions) were found at only 5 of the 51 landfills (10 percent).

Highlight 3 lists typical municipal and military wastes, including:

(1) Wastes that are common to both municipal landfills and military landfills;

(2) Wastes that are usually specific to military bases but that do not necessarily pose higher risks than other industrial wastes commonly found in municipal landfills (i.e., low-hazard military-specific wastes), depending on the volume and heterogeneity of the wastes; and

(3) High-hazard military wastes that, because of their unique characteristics, would require special consideration (i.e., high-hazard military-specific wastes).

The proportion and distribution of hazardous wastes in a landfill are important considerations. Generally, municipal landfills produce low-level threats with occasional hot spots. Similarly, most military landfills present only low-level threats with pockets of some high-hazard waste. However, some military facilities (e.g., weapons fabrication or testing, shipbuilding, major aircraft or equipment repair depots) have a high level of industrial activity compared to overall site activities. In these cases, there may be a higher proportion and wider distribution of industrial (i.e., potentially hazardous) wastes present than at other less industrialized facilities.

PRACTICAL CONSIDERATIONS

Sensitive Environments

Site-specific conditions may limit the use of the containment presumptive remedy at military landfills. For example, the presence of high water tables, wetlands and other sensitive environments, and the possible destruction or alteration of existing habitats as a result of a particular remedial action could all be important factors in the selection of the remedy.

Land Use

Reasonably anticipated future land use is also an important consideration at all sites. However, at military bases undergoing base closure procedures, where expeditiously converting property to civilian use is one of the primary goals, land use may receive heightened attention. Thus, at bases that are closing, it is particularly important for reuse planning to proceed concurrently with environmental investigation and restoration activities. The local reuse group is responsible for developing the preferred reuse alternatives. The Base Realignment and Closure Team should work closely with the reuse group to integrate reuse planning into the cleanup process, where practicable (see the *Land Use in CERCLA Remedy Selection* directive).

Highlight 3
Examples of Municipal-Type and Military-Specific Wastes

Municipal-Type Wastes

Municipal landfills contain predominantly nonhazardous materials. However, industrial solid waste and even some household refuse (e.g., pesticides, paints, and solvents) can possess hazardous components. Further, hazardous wastes are found in most municipal landfills as a result of past disposal practices.

Predominant Constituents

Household refuse, garbage, and debris
Commercial refuse, garbage, and debris
Construction debris
Yard wastes

Found in Low Proportion

Asbestos
Batteries
Hospital wastes
Industrial solid waste(s)
Paints and paint thinner
Pesticides
Transformer oils
Other solvents

Military-Specific Wastes

The majority of military landfills contain primarily nonhazardous wastes. The materials listed in this column are rarely predominant constituents of military landfills.

Low-Hazard Military-Specific Wastes

These types of wastes are specific to military bases but generally are no more hazardous than some wastes found in municipal landfills.

Low-level radioactive wastes
Decontamination kits
Munitions hardware

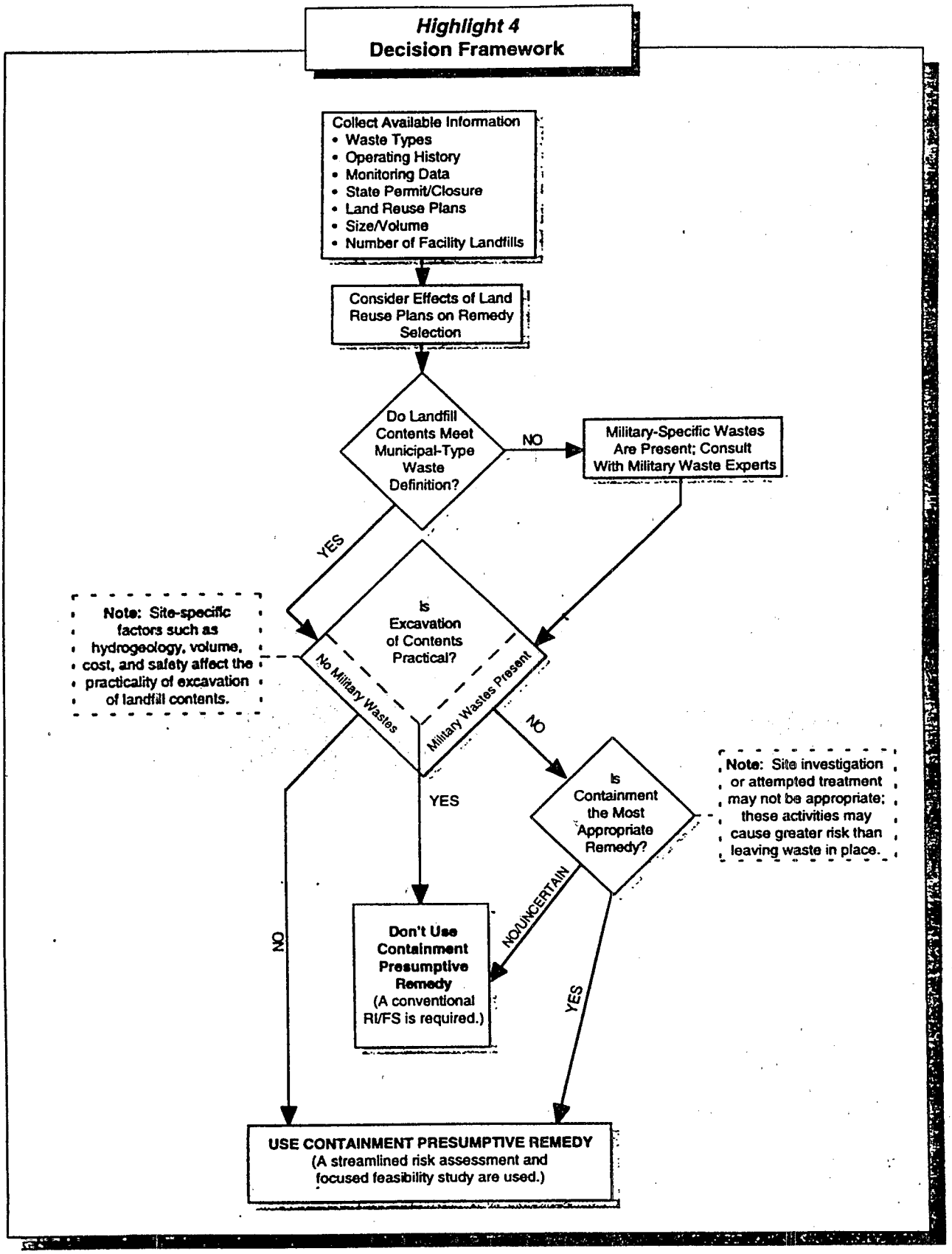
High-Hazard Military-Specific Wastes

These wastes are extremely hazardous and may possess unique safety, risk, and toxicity characteristics. Special consideration and expertise are required to address these wastes.

Military Munitions

Chemical warfare agents
(e.g., mustard gas, tear agents)
Chemical warfare agent training kits
Artillery, small arms, bombs
Other military chemicals
(e.g., demolition charges, pyrotechnics, propellants)
Smoke grenades

Highlight 4
Decision Framework



DECISION FRAMEWORK TO EVALUATE APPLICABILITY OF THE PRESUMPTIVE REMEDY TO MILITARY LANDFILLS

This Section and Highlight 4 describe the steps involved in determining whether the containment presumptive remedy applies to a specific military landfill.

1. What Information Should Be Collected? Determine the sources, types, and volumes of landfill wastes using historical records, state files, closure plans, available sampling data, etc. This information should be sufficient to determine whether source containment is the appropriate remedy for the landfill. If adequate data do not exist, it may be necessary to collect additional sampling or monitoring data. The installation point of contact (environmental coordinator, base civil engineer, or public works office) should be contacted to obtain records of disposal practices. Current and former employees are also good sources of information.

2. How May Land Reuse Plans Affect Remedy Selection? For smaller landfills (generally less than two acres), land reuse plans may influence the decision on the practicality of excavation and consolidation or treatment of landfill contents. Excavation is a remedial alternative that is fundamentally incompatible with the presumptive remedy of source containment.

3. Do Landfill Contents Meet Municipal Landfill-Type Waste Definition? To determine whether a specific military landfill is appropriate for application of the containment presumptive remedy, compare the characteristics of the wastes to the information in Highlights 2 and 3.

4. Are Military-Specific Wastes Present? Military wastes, especially high-hazard military wastes, may possess unique safety, risk, and toxicity characteristics. Highlight 3 presents examples of these types of materials. If historical records or sampling data indicate that these wastes may have been disposed at the site, special consideration should be given to their handling and remediation. Caution is warranted because site investigation or attempted treatment of these contaminants may pose safety issues for site workers and the community. Some high-hazard military-specific wastes could be considered to present low-level risk, depending on the location, volume, and concentration of these materials relative to environmental receptors. Consult specialists in military wastes (see Highlight 5) when determining whether military-specific wastes at a site fall into either the low-hazard or the high-hazard military-specific waste category found in Highlight 3.

Highlight 5
Specialists in Military Wastes

The installation point of contact will notify the major military command's specialists in military wastes (Explosive Ordnance Disposal Team) for assistance with regard to safety and disposal issues related to any type of military items.

Army chemical warfare agents specialists:

- Project Manager, Non-Stockpile Chemical Materiel, Aberdeen Proving Ground, Maryland 21010-5401, (410) 671-1083.

Navy ordnance related items specialists:

- The Navy Ordnance Environmental Support Office, Naval Surface Warfare Center, Indian Head, Maryland 20460-5035, (301) 743-4534/4906/4450.

Navy low-level radioactive wastes specialists:

- The Naval Sea Systems Command Detachment, Radiological Affairs Support Office, Yorktown, Virginia 23691-0260, (804) 887-4692.

Air Force ordnance specialists:

- The Air Force Civil Engineering Support Agency, Contingency Support Division, Tyndall AFB, Florida 32403-5319, (904) 283-6410.

Responsibilities for response are clearly spelled out in the regulation *Interservice Responsibilities For Explosive Ordnance Disposal.*

5. Is Excavation of Contents Practical? The volume of landfill contents, types of wastes, hydrogeology, and safety must be considered when assessing the practicality of excavation and consolidation or treatment of wastes. Consideration of excavation must balance the long-term benefits of lower operation and maintenance costs and unrestricted land use with the initial high capital construction costs and potential risks associated with excavation. Although no set excavation volume limit exists, landfills with a content of more than 100,000 cubic yards (approximately two acres, 30 feet deep) would normally not be considered for excavation. If military wastes are present, especially high-hazard military wastes such as ordnance, safety considerations may be very important in determining the practicality of excavation.

If excavation of the landfill contents is being considered as an alternative, the presumptive remedy should not be used. Therefore, a standard RI/FS would be required to adequately analyze and select the appropriate remedial actions.

6. Can the Presumptive Remedy Be Used? The site manager will make the initial decision of whether a particular military landfill site is suitable for the presumptive remedy or whether a more comprehensive RI/FS is required. This determination must be made before the RI/FS is initiated. This decision will depend on whether the site is a potential candidate for excavation, and if not, whether the nature of contamination is such that a streamlined risk evaluation can be conducted.* A site generally is eligible for a streamlined risk evaluation if groundwater contaminant concentrations clearly exceed chemical-specific standards or the Agency's level of risk or if other conditions exist that provide a justification for action (e.g., direct contact with landfill contents due to unstable slopes). If these conditions do not exist, a quantitative risk assessment that addresses all exposure pathways will be necessary to determine whether action is needed. Before work on the RI/FS workplan is initiated, the community and state should be notified that a presumptive remedy is being considered for the site. It is important for all stakeholders to understand completely how the presumptive remedy process varies from the usual clean-up process, and the benefits of using the presumptive remedy process.

TREATING "HOT SPOTS"

The presumptive remedy also allows for the treatment of hot spots containing military-specific (or other) waste. While the analysis, *Feasibility Study Analysis for CERCLA Municipal Landfill Sites,* that justified the selection of source containment as the presumptive remedy for municipal landfill sites did not specifically take into account high-hazard military wastes, the high-hazard materials present in some military landfills may be compared to the hazardous wastes at municipal landfills and could potentially be treated as hot spots. For further information and case studies on treatment of hot spots, see the *Presumptive Remedy for CERCLA Municipal Landfill Sites* directive.

CASE HISTORIES

The case histories below illustrate how use of the municipal landfill presumptive remedy at military landfills follows the decision framework in Highlight 4.

* See *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, which states that if MCLs or non-zero MCLGs are exceeded [a response] action generally is warranted.

The decision to use the presumptive remedy can be made for one landfill or as a part of a site-wide strategy (as in the Loring Air Force Base example below), depending on factors such as the nature of the wastes, size of the landfill, land reuse potential, and public acceptance.

The following case histories present examples of where the containment presumptive remedy was or was not applied, based on site-specific conditions.

Disposal of Municipal-Type Wastes

The **Naval Reactor Facility (NRF)** site in Idaho Falls, Idaho, was established in 1949 as a testing site for the nuclear propulsion program. The three landfill units at the site received solid wastes similar to municipal landfills. These wastes included petroleum and paint products, construction debris, and cafeteria wastes. Historical records do not indicate that any radioactive wastes were disposed of in these landfill units. The selected remedy for the landfills at the site included the installation of a 24-inch native soil cover designed to incorporate erosion control measures to reduce the effects from rain and wind. The remedy also provided for maintenance of the landfill covers, including subsidence correction and erosion control. Monitoring of the landfills will include sampling of soil gas to assess the effectiveness of the cover and sampling of the groundwater to ensure that the remedy remains protective. Institutional controls will also be implemented to prevent direct exposure to the landfill. The NRF site is an example of where the streamlining principles of the presumptive remedy process, including a streamlined risk assessment and a focused feasibility study, were successfully employed.

Co-Disposal of High-Hazard Wastes

At the **Massachusetts Military Reservation**, in Cape Cod, Massachusetts, anecdotal information indicated that munitions had been disposed of at an unidentified location in a landfill that primarily contained municipal-type waste. Ground penetrating radar was utilized to determine if there were any discrete disposal areas containing potential hot spots at this site and found none. Because the munitions waste was not in a known discrete and accessible area, it could not be treated as a hot spot. Consequently, without excavating or treating the munitions waste as a hot spot, the authorities decided to cap the landfill. In this case, the streamlining principles of the presumptive remedy process were applied. For example, site investigation was limited and treatment options were not considered.

Land Reuse Considerations

At **Loring Air Force Base**, a closing base in Limestone, Maine, base landfills 2 and 3 (9 and 17 acres, respectively) consisted primarily of municipal and flightline wastes. The selected remedy for these landfills included a multi-layer cap, passive venting system, and institutional controls. The RODs for the landfills, signed in September 1994, required placing a RCRA Subtitle C cap on the landfills. To construct the RCRA cap, the designers estimated that 400,000 to 600,000 cyds of material would have to be placed on the landfills prior to construction of the cap to ensure proper drainage and slopes.

At Loring, the streamlining principles of the containment remedy, a focused feasibility study, and a streamlined risk assessment were applied for landfills 2 and 3. Additionally, the RODs signed for these landfills specified that excavated material from other parts of the base would be used at the landfills to meet subgrade design specifications. To date, more than 500,000 cyds of contaminated soils have been excavated and used as subgrade for the landfills (after demonstrating compliance with RCRA Land Disposal Restrictions). In addition to cost savings realized by providing subgrade, other benefits have been realized, such as limiting the number of parcels requiring deed restrictions and minimizing locations requiring operation and maintenance. At this base, the landfill consolidation efforts resulted in an estimated total cost savings of $12–20 million while incorporating future land use considerations into the decision process.

The Brunswick Naval Air Station in Brunswick, Maine, contained several landfill sites. One of the first RODs signed, for Sites 1 and 3, called for construction of a 12-acre RCRA Subtitle C cap and a slurry wall, as well as for groundwater extraction and treatment. Subsequently, during the remedy selection process for Site 8, the public objected to containment as the proposed remedy for this relatively small (0.6 acre) site on the grounds that should the base eventually close, containment would create several useless parcels of land. After public comment, the Navy reconsidered, proposing instead to excavate Site 8 and consolidate the removed materials (which consisted of construction debris and soil contaminated with nonhazardous levels of polycyclic aromatic hydrocarbons) as part of the necessary subgrade fill for the landfill cap to be constructed at Sites 1 and 3. In this case, land reuse considerations preempted the selection of a containment remedy.

PRESUMPTIVE REMEDY ADMINISTRATIVE RECORD DOCUMENTATION REQUIREMENTS

As stated earlier, it must be determined whether the military landfill in question contains military-specific wastes, as described in Highlight 3. This should be followed by a determination of whether anything about these wastes would make the engineering controls specified in the presumptive remedy for municipal landfills less suitable at that site. These determinations must be documented in the administrative record, which supports the final decision. This information, in turn, will assist the public in understanding the evaluation of the site as a candidate for use of the presumptive remedy and the advantage it provides. For further reference, the administrative record requirements for all Superfund sites including military landfills are explained in the *Final Guidance on Administrative Records for Selecting CERCLA Response Actions*.

The administrative record must contain the following generic and site-specific information, which documents the selection or non-selection of the containment presumptive remedy.

Generic Information

A. **Generic Documents.** These documents should be placed in the docket for each federal facility site where the containment presumptive remedy is selected. Each EPA Regional Office has copies of the following presumptive remedy documents:

- *Presumptive Remedy: Policy and Procedures*
- *Presumptive Remedy for CERCLA Municipal Landfill Sites*
- *Application of the Municipal Landfill Presumptive Remedy to Military Landfills*
- *Feasibility Study Analysis for CERCLA Municipal Landfill Sites*

B. **Notice Regarding Backup File.** The docket should include a notice specifying the location of and times when public access is available to the generic file of backup materials used in developing the *Feasibility Study Analysis for CERCLA Municipal Landfill Sites*. This file contains background materials such as technical references and portions of the feasibility studies used in the generic study. Each EPA Regional Office has a copy of this file.

Site-specific Information

Focused FS or EE/CA. Military-specific wastes need to be addressed in site-specific analyses when determining the applicability of the containment presumptive remedy to military landfills. High-hazard military-specific waste materials (e.g., military munitions) require special consideration when applying the presumptive remedy.

As noted on pages 1 and 2 of this directive, the presumptive remedy approach allows you to streamline and focus the FS or EE/CA by eliminating the technology screening step from the feasibility study process. EPA has already conducted this step on a generic basis in the *Feasibility Study Analysis for CERCLA Municipal Landfill Sites*. Thus, the FS analyzes only alternatives comprised of components of the containment remedy identified in Highlight 1. In addition, the focused FS or EE/CA should include a site-specific explanation of how the application of the presumptive remedy satisfies the National Contingency Plan's three site-specific remedy selection criteria (i.e., compliance with state applicable or relevant and appropriate requirements, state acceptance, and community acceptance).

CONCLUSION

This directive provides guidance for the use of the containment presumptive remedy at appropriate military landfills. The remedies selected at numerous military installations indicate that source containment is applicable to a significant number of military landfills. These landfills need not be identical to municipal landfills in all regards. Key factors determining whether the containment presumptive remedy should be applied to a specific military landfill include the size of the landfill; volume and the type of landfill contents; future land use of the area; and the presence, proportion, and distribution of military-specific wastes.

REFERENCES

California Base Closure Environmental Committee, *Integrating Land Use and Cleanup Planning at Closing Bases*, December 1994.

Federal Register, 1996. Volume 61, No. 85, May 1, 1996; *Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities, Advance Notice of Proposed Rulemaking.*

Federal Register, 1990. Volume 55, No. 145, July 27, 1990; 40 CFR Parts 264, 265, 270 and 271; *Corrective Action for Solid Waste Management Units at Hazardous Waste Facilities; Proposed* (proposed Subpart S regulations).

U.S. Environmental Protection Agency, OSWER Directive 93557-04, *Land Use in the CERCLA Remedy Selection*, May 25, 1995.

U.S. Environmental Protection Agency, OSWER Directive 9356.0-03, EPA/540/R-94/081, *Feasibility Study Analysis for CERCLA Municipal Landfill Sites*, August 1994.

U.S. Environmental Protection Agency, OSWER Directive 9902.3-2A, EPA/520/R-94/004, *RCRA Corrective Action Plan*, May 1994.

U.S. Environmental Protection Agency, OSWER Directive 9355.0-49FS, *Presumptive Remedy for CERCLA Municipal Landfill Sites*, September 1993.

U.S. Environmental Protection Agency, OSWER Directive 9355.0-47FS, EPA/540/F-93/047, *Presumptive Remedy: Policy and Procedures*, September, 1993.

U.S. Environmental Protection Agency, OSWER Publication 9380.3-06FS, *Guide to Principal Threat and Low Level Threat Wastes*, November 1991.

U.S. Environmental Protection Agency, OSWER Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, April 22, 1991.

U.S. Environmental Protection Agency, OERR, EPA/540/P-91/001, *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, February 1991.

U.S. Environmental Protection Agency, OSWER Directive 9833.3A.1, *Final Guidance on Administrative Records for Selecting CERCLA Response Actions*, December 3, 1990.

U.S. Environmental Protection Agency, OSWER Directive 9355.3-11FS, *Streamlining the RI/FS for CERCLA Municipal Landfill Sites*, September 1990.

U.S. Department of Navy, *Interservice Responsibilities for Explosive Ordnance Disposal* OPNAVINST 8027.1G (also known as MCO 8027.1D, AR 75-14; or AFR 32-3002), February 14, 1992.

NOTICE

The policies set out in this document are intended solely as guidance to the EPA personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change this guidance at any time without public notice.

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Brunswick NAS, Sites 1 and 3 (OU1), ME, Region 1 6/16/92	Site 1, 8.5 acres; Site 3, 1.5 acres. Sites are in close proximity and not easily distinguishable; the combined volume of Sites 1 and 3 is 300,000 cy	Household refuse, waste oil, solvents, pesticides, paints, isopropyl alcohol	Metals, VOCs, PAHs, PCBs, pesticides	**Remedy:** Capping (permanent, low-permeability, RCRA Subtitle C cap), of 12 acres with a slurry wall and pump and treat ground water within cap and slurry wall.
Brunswick NAS, Sites 5 and 6 (OU3), ME, Region 1 8/31/93	Site 5, 0.25 acres, 12 cy	Asbestos-covered pipes	Asbestos	**Remedy:** Excavation, containerization, and transport to landfill Sites 1 and 3 for use as fill under cap.
Brunswick NAS, Sites 5 and 6 (OU3), ME, Region 1 8/31/93	Site 6, 1.0 acre, 8,800 - 18,700 cy	Construction debris, and aircraft parts, asbestos pipes	Asbestos	**Remedy:** Excavation, containerization, and transport to Sites 1 and 3 landfill for use as fill under cap.
Brunswick NAS, Site 8 (OU4), ME, Region 1 8/31/93	Site 8, 0.6 acres, 5,600 - 14,000 cy	Rubble, debris, trash, and possibly solvents	Metals, pesticides, PCBs[1]	**Remedy:** Excavation, containerization, and transport to landfill Sites 1 and 3 for use as fill under cap.
Loring AFB, Landfills 2 and 3 (OU2), ME, Region 1 9/30/94	Landfill 2, 9 acres	Domestic waste, construction debris, flightline wastes, sewage sludge and oil-filled switches	PCBs, VOCs, SVOCs, metals, DDT[1]	**Remedy:** Capping (low-permeability cover system which meets RCRA Subtitle C and Maine hazardous waste landfill cap requirements), passive gas venting system and controls, and institutional controls.
Loring AFB, Landfills 2 and 3 (OU2), ME, Region 1 9/30/94	Landfill 3, 17 acres	Waste oil/fuels, solvents, paints, thinners, and hydraulic fluids	VOCs, SVOCs, DDT, PCBs, metals[1]	**Remedy:** Capping (low-permeability cover system which meets RCRA Subtitle C and Maine hazardous waste landfill cap requirements), passive gas venting system and controls, and institutional controls.

[1] Contaminants of Potential Concern

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Newport Naval Education and Training Center, McAllister Point Landfill, RI, Region 1 9/27/93	McAllister Point Landfill, 11.5 acres	Domestic refuse, spent acids, paints, solvents, waste oils, and PCB-contaminated transformer oil	VOCs, PAHs, PCBs, pesticides, phenols, metals	**Remedy:** Capping (RCRA Subtitle C, multi-layer cap), landfill gas management, surface controls, and institutional controls.
Otis Air National Guard, Camp Edwards, Massachusetts Military Reservation, MA, Region 1 1/14/93	Landfill Number 1 (LF-1), 100 acres	General refuse, fuel tank sludge, herbicides, blank ammunition, paints, paint thinners, batteries, DDT, hospital wastes, sewage sludge, coal ash, possibly live ordnance	VOCs, SVOCs, inorganics	**Remedy:** Capping (composite-low-permeability cover system), institutional controls, soil cover inspection, and ground water monitoring.
Pease AFB (OU1), NH, Region 1 9/27/93	LF-5, 23 acres	Domestic and industrial wastes, waste oils and solvents, and industrial wastewater treatment plant sludge	VOCs, PAHs, arsenic and other metals	**Remedy:** Excavation, dewatering and consolidation and regrading of waste under a composite-barrier type cap, institutional controls, and extraction and treatment of ground water with discharge to base wastewater treatment facility.
Fort Dix Landfill Site, NJ, Region 2 9/24/91	Main area, 126 acres	Domestic waste, paints and paint thinners, demolition debris, ash, and solvents	VOCs, metals	**Remedy:** Capping 50-acre portion (New Jersey Administrative Code 7:26 closure plan for hazardous waste), installing gas venting system and an air monitoring system, ground water, surface water, and air monitoring, and institutional controls.
Naval Air Engineering Center (OU3), NJ, Region 2 9/16/91	Site 26, 1500 sq. ft., volume not reported	Oil, roofing materials, building debris	No contamination was detected	**Remedy:** Source: No action.
Naval Air Engineering Center (OU3), NJ, Region 2 9/16/91	Site 27, 6.4 acres	Scrap steel cable	No contamination was detected	**Remedy:** Source: No action.

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX (CONT.)

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Naval Air Engineering Center (OU17), NJ, Region 2 9/26/94	Site 29, 20 acres	Construction debris, metal, asbestos, solvents, other miscellaneous wastes	VOCs, SVOCs, metals	**Remedy:** Source: No action.
Plattsburgh AFB, LF-022, NY, Region 2 9/30/92	LF-022, approx. 13.7 acres, approx. 524,000 cy	Household refuse	Metals, pesticides	**Remedy:** Capping (NY State requirements for solid waste landfills, 12 inch soil cap), and institutional controls.
Plattsburgh AFB, LF-023, NY, Region 2 9/30/92	LF-023, approx. 9 acres, approx. 406,000 cy	Household refuse, debris, car parts	Metals, VOCs, SVOCs, PCB, pesticides	**Remedy:** Capping (NY State requirements for solid waste landfills, low permeability cap), and institutional controls.
U.S. Army Aberdeen Proving Grounds (OU 1), MD, Region 3 6/30/92	Michaelsville Landfill, 20 acres, greater than 100,000 cy	Household refuse, limited quantities of industrial waste, burned sludges, pesticide containers, paint, asbestos shingles, solvents, waste motor oils, grease, PCB transformer oils, possible pesticides	Metals, pesticides, VOCs, PCBs, PAHs	**Remedy:** Capping (multi-layer cap in accordance with MDE requirements for sanitary landfills, using a geosynthetic membrane, 0-2 feet compacted earth material), surface water controls, and gas venting system.
Marine Corps Base, Camp Lejeune (OU1), NC, Region 4 9/15/94	Site 24, 100 acres, volume not reported	Fly ash, cinders, solvents, used paint stripping compounds, sewage sludge, spiractor sludge, construction debris	Pesticides, metals, SVOCs, PCBs	**Remedy:** Source: No action.
Robins AFB (OU1), GA, Region 4 6/25/91	Main area (Landfill No. 4), 45 acres, greater than 100,000 cy	Household refuse, industrial waste	VOCs, metals	**Remedy:** Capping (to maintain a minimum 2-foot cover over the waste materials), renovation of current soil cover including clearing, filling, regrading, adding soil and clay cover material and seeding to maintain a minimum 2-foot cover over the waste material.

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Twin Cities AFB Reserve, MN, Region 5 3/31/92	Main area, approx. 2 acres, volume not reported	Household refuse, small amounts of industrial; some burned waste	VOCs, metals	**Remedy:** Source: Institutional controls, natural attenuation, ground water and surface water monitoring.
Wright-Patterson AFB, (Source Control Operable Unit) OH, Region 5 7/15/93	LF-8, 11 acres, 187,300 cy	General refuse and hazardous materials	PAHs, pesticides, PCBs, VOCs, metals, inorganics	**Remedy:** Capping (low-permeability clay cap that complies with Ohio EPA regulations for sanitary landfills which meet or exceed RCRA Subtitle D requirements), institutional controls, ground water treatment and monitoring.
Wright-Patterson AFB, (Source Control Operable Unit) OH, Region 5 7/15/93	LF-10, 8 acres, 171,600 cy	General refuse and hazardous materials	PAHs, pesticides, PCBs, VOCs, metals, inorganics	**Remedy:** Capping (low-permeability clay cap that complies with Ohio EPA regulations for sanitary landfills which meet or exceed RCRA Subtitle D requirements), institutional controls, ground water treatment and monitoring.
Hill AFB (OU4), UT, Region 8 6/14/94	Landfill 1, 3.5 acres, 140,000 cy	Burned solid waste, small amounts of waste oils and solvents (from vehicle maintenance facility).	VOCs (TCE)	**Remedy:** Capping (clay or multi-media cap), pumping, treating, and discharging ground water to POTW, treating contaminated surface water, soil vapor extraction, implementing institutional controls and access restrictions.
Defense Depot, Ogden (OU1), UT, Region 8 6/26/92	Plain City Canal Backfill Area, 4,000 cy	Electrical wire, glass, ash, charcoal, asphalt, wood, concrete, plastic and metal fragments	Metals, PCBs, dioxins, furans, VOCs	**Remedy:** Excavation, sorting, and off-site disposal in a RCRA permitted facility.
Defense Depot, Ogden (OU3), UT, Region 8 9/28/92	Burial Site 3-A: Chemical Warfare Agent Identification Kit Burial Area, 100 cy	Vials of chemical surety agents, broken glass	Metals, chemical warfare agents	**Remedy:** Excavation, sorting, and off-site disposal in a RCRA permitted facility.
Defense Depot, Ogden (OU3), UT, Region 8 9/28/92	Burial Site 3-A: Riot Control and Smoke Grenade Burial Area, 90 cy	Unfused grenades and grenade fragments, as well as riot control grenades	No contaminants identified	**Remedy:** Excavation, sorting, and off-site disposal in a RCRA permitted facility.

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Defense Depot, Ogden (OU3), UT, Region 8 9/28/92	Burial Site 3-A: Compressed Gas Cylinder Reburial Area	Two compressed gas cylinders and four smaller steel tanks removed from the Chemical Warfare Agent Identification Kit and Riot Control and Smoke Grenade burial areas	Unknown, possible chemical warfare agents	**Remedy:** Excavation of compressed gas cylinders and disposal by a commercial operator.
Defense Depot, Ogden (OU3), UT, Region 8 9/28/92	Burial Site 3-A: Miscellaneous Items Burial Area, 230 cy	Chemical Warfare Agent Identification Kits containing no CWAs, World War II gas mask canisters, paint, broken glass, wooden boxes, and pieces of iron	No contaminants identified	**Remedy:** Excavation and transportation for off-site disposal in a RCRA permitted hazardous waste landfill.
Defense Depot, Ogden (OU3), UT, Region 8 9/28/92	Water Purification Tablet Burial Area, 110 cy	Bottles containing halazone water purification tablets	No contaminants identified	**Remedy:** Excavation and transportation for off-site disposal in a RCRA permitted industrial waste landfill.
Defense Depot, Ogden (OU4), UT, Region 8 9/28/92	4-A, 7500, sq. ft., 3000 cy	Wood, crating materials, paper, greases, debris, medical waste, oils, some burned waste	Pesticides, VOCs, PCBs	**Remedy:** Excavation and transportation for off-site disposal in a RCRA permitted hazardous waste landfill.
Defense Depot, Ogden (OU4), UT, Region 8 9/28/92	4-B, (inside 4-E), less than 7,500, sq. ft.	Fluorescent tubes	No contaminants identified	**Remedy:** Excavation and transportation for off-site disposal in a RCRA permitted landfill.
Defense Depot, Ogden (OU4), UT, Region 8 9/28/92	4-C, 6,000 sq. ft	Food products, sanitary landfill waste	Pesticides, VOCs, PCBs	**Remedy:** Excavation and transportation for off-site disposal in a RCRA permitted landfill.

ROD / S ame, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Defense Depot, Ogden (OU4), UT, Region 8 9/28/92	4-D, 2,000 sq. ft.	Methyl bromide cylinders, halazone tablets (jars)	Possibly methyl bromide	**Remedy:** Excavation and transportation for off-site disposal in a RCRA permitted industrial landfill.
Defense Depot, Ogden (OU4), UT, Region 8 9/28/92	4-E, 7,500 sq. ft., volume not reported	Oils, spent solvents, industrial waste	PCBs, VOCs, pesticides	**Remedy:** Excavation and transportation for off-site disposal in a RCRA permitted hazardous landfill.
Rocky Mountain Arsenal, Shell Section 36 Trenches (OU23), CO, Region 8 5/3/90	Shell Trench Area, 8 acres	Rags, plastic and metal cans, glass jars, piping, pipe fittings, insulation, refuse, insulation, liquid and solid wastes generated from the manufacture of pesticides	VOCs, SVOCs, pesticides[2]	**Remedy:** Capping (physical barrier with a soil and vegetative cover).
Fort Ord Landfills (OU2), CA, Region 9 8/23/94	Landfills, 150 acres	Household and commercial refuse, dried sewage sludge, construction debris, small amounts of chemical waste including paint, oil, pesticides, and epoxy adhesive, electrical equipment	VOCs	**Remedy:** Capping (California Code of Regulations for non-hazardous waste), institutional controls, extraction, treatment, and recharge of ground water.
Riverbank Army Ammunition Plant Site, CA, Region 9 3/24/94	Landfill, 4.5 acres	Paper, oils, greases, solvents, hospital wastes, construction debris, and industrial sludges	Metals	**Remedy:** Capping (a multi-layer cap as specified in Dispute Resolution Agreement), pump and treat ground water, discharge treated water to on-site ponds.

[2] Contaminants identified as emanating from the trenches but not contaminants of concern

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Williams AFB (OU1), AZ, Region 9 5/18/94	Landfill LF-04, 90 acres, 59,000 cy	Dried sewage sludge, domestic trash and garbage, wood, metal, brush, construction debris, some solvents and chemicals	Soil, pesticides, SVOCs, inorganics, including beryllium, lead, zinc	**Remedy:** Capping (a permeable cap with a 24 inch soil cover), stormwater runoff controls, institutional actions, and soil and ground water monitoring.
Williams AFB (OU1), AZ, Region 9 5/18/94	Pesticide Burial Area (DP-13), 0.4 acre	Pesticides	Pesticides, VOCs, metals	**Remedy:** Source: No action.
Williams AFB (OU1), AZ, Region 9 5/18/94	Radioactive Instrumentation Burial Area (RW-11), 100 sq. ft.	Cement; radioactive instruments	Radium (background levels)	**Remedy:** Source: No action.
Elmendorf AFB (OU1), AK, Region 10 9/29/94	LF05, 17 acres	General refuse, scrap metal, used chemicals and other scrap material	VOCs, PCBs, metals, PAHs	**Remedy:** Source: No action.
Elmendorf AFB (OU1), AK, Region 10 9/29/94	LF07, 35 acres	Base generated refuse, scrap metal, construction rubble, drums of asphalt, empty pesticide containers, small amounts of shop wastes, and asbestos wastes	VOCs, PCBs, metals, PAHs	**Remedy:** Source: No action.
Elmendorf AFB (OU1), AK, Region 10 9/29/94	LF13, 2 acres	Empty drums, metal piping, drums of asphalt, and small quantities of quicklime	VOCs, PCBs, metals, PAHs	**Remedy:** Source: No action.

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Elmendorf AFB (OU1), AK, Region 10 9/29/94	LF59, 2 landfills (.5 acres each)	General refuse and construction debris, and tar seep	VOCs, PCBs, metals, PAHs	**Remedy:** Source: No action.
Fairchild AFB (OU1), WA, Region 10 2/13/93	Southwest area, 12.6 acres, 407,300 cy	Coal ash, solvents, dry cleaning filters, paints, thinners, possibly electrical transformers.	VOCs	**Remedy:** Capping (low-permeability cap designed to meet the closure requirements of Washington State's Minimum Functional Standards for Solid Waste handling and of federal RCRA Subtitle D), SVE/ treatment system, extracting contaminated ground water and treating by air stripping and granular activated carbon, disposal off-site, monitoring off-site water supply wells.
Fairchild AFB (OU1), WA, Region 10 2/13/93	Northeast area, 6 acres, 291,000 cy	Coal ash, solvents, dry cleaning filters, paints, thinners, possibly electrical transformers.	VOCs	**Remedy:** Capping (low-permeability cap designed to meet the closure requirements of Washington State's Minimum Functional Standards for Solid Waste handling and of federal RCRA Subtitle D), SVE/ treatment system, extracting contaminated ground water and treating by air stripping and granular activated carbon, disposal off-site, monitoring off-site water supply wells.
Fort Lewis Military Reservation, Landfill 4 and the Solvent Refined Coal Pilot Plant, WA, Region 10 9/24/93	LF4, 52 acres	Domestic and light industrial solid waste (no landfill records were maintained).	VOCs, metals	**Remedy:** Source: Institutional controls, treat ground water and soil using SVE and air sparging system.
Naval Air Station, Whidbey Island, Ault Field (OU1), WA, Region 10 12/20/93	Area 6 Landfill, 40 acres. Within Area 6 there are 2 distinct areas where wastes were disposed.	Household waste, construction debris, and yard waste	VOCs	**Remedy:** Capping (low-permeability cap to meet Washington State Minimum Functional Standards for non-hazardous closure), air stripping ground water, ground water monitoring, and institutional controls.
Naval Air Station, Whidbey Island, Ault Field (OU2), WA, Region 10 12/20/93	Area 2, 13 acres; Area 3, 1.5 acres. Both treated together due to close proximity.	Solid waste from the base, industrial wastes, and construction and demolition debris	Metals, PAHs	**Remedy:** Source: Institutional controls, ground water monitoring.

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Naval Reactor Facility, ID, Region 10 9/27/94	Landfill Unit 8-05-1, (350 ft. by 450 ft. by 4-25 ft.)	Construction debris, small quantities of paints, solvents, cafeteria wastes, and petroleum products	Metals, VOCs	**Remedy:** Capping (24-inch native soil cover), institutional controls.
Naval Reactor Facility, ID, Region 10 9/27/94	Landfill Unit 8-05-51, (450 ft. by 100 -175 ft. by 10-15 ft.)	Construction debris, small quantities of paints, solvents, cafeteria wastes, and petroleum products	Metals, VOCs	**Remedy:** Capping (24-inch native soil cover), institutional controls.
Naval Reactor Facility, ID, Region 10 9/27/94	Landfill Unit 8-06-53, (900 ft. by 1200 ft. by 7- 10 ft.)	Construction debris, small quantities of paints, solvents, cafeteria wastes, and petroleum products	Metals, VOCs	**Remedy:** Capping (24-inch native soil cover), institutional controls.

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Superfund Accelerated Cleanup Bulletin

Presumptive Remedies for Municipal Landfill Sites

Superfund Revitalization Activity
Office of Emergency and Remedial Response
Hazardous Site Control Division OS-220W

Intermittent Bulletin
Volume 1 Number 1

The Presumptive Remedy Selection Initiative

Since Superfund's inception in 1980, the removal and remedial programs have found that certain categories of sites have similar characteristics, such as the types of contaminants present, past industrial use, or the environmental media that are affected. Based on a wealth of information acquired from evaluating and cleaning up these sites, Superfund is undertaking an initiative to develop **presumptive remedies** that are appropriate for specific types of sites, contaminants, or both. This initiative is part of a larger program, known as the **Superfund Accelerated Cleanup Model (SACM),** which is designed to speed all aspects of the Superfund clean-up process.

The objective of the presumptive remedies initiative is to use clean-up techniques shown to be effective in the past at similar sites in the future. The use of presumptive remedies will streamline removal actions, site studies, and clean-up actions, thereby improving consistency, reducing costs, and increasing the speed with which hazardous waste sites are remediated

The Municipal Landfill Pilot Project

Superfund kicked off a new pilot project designed to expedite the site investigation and remedy selection process for municipal landfills with a visit to Region V on March 18-20, 1992. Superfund anticipates that remedy selection may be streamlined for municipal landfills because they typically share similar characteristics and because containment and ground water cleanup frequently is the appropriate remedy for these sites.

An existing EPA manual, *Conducting Remedial Investigations/ Feasibility Studies for* CERCLA *Municipal Landfill Sites,* outlines streamlining techniques for municipal landfills. The goal of the initiative is to aid the Regions in implementing the manual, so that site characterization, the baseline risk assessment, and the number of alternatives considered will be streamlined at every municipal landfill site.

Albion Sheridan Township landfill, a municipal landfill in Michigan, was the first site to participate in the pilot Project. A team of Remedial Project Managers (RPMs) from several Regions and experts on landfill construction met with the site RPM in Grand Rapids, Michigan to develop the site strategy. As a result of the meeting, site characterization will be conducted in a phased approach, with criteria established for when additional sampling will occur. Streamlining of the baseline risk assessment will depend upon data obtained in the first phase of sampling.

Four other Superfund municipal landfill sites have been identified as candidates for participation in the project: Lexington County Landfill, Lexington County, South Carolina (Region IV); BFI/ Rockingham, Rockingham, Vermont (Region I); Sparta Landfill, Sparta Township, Michigan (Region V); and Beulah Landfill, Pensacola, Florida (Region IV). The review team anticipates meeting with the RPMs for these sites during April, May, and June 1992.

RPMs who participate in the project and implement the municipal landfill manual at their sites will become members of the team and will be available to assist other RPMs in developing streamlined RI/FSs. These RPMs will be a resource for their Regions, providing assistance in streamlining remedy selection at all future municipal landfill sites.

Questions should be addressed to Andrea McLaughlin at FTS 678-8365.

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Superfund Accelerated Cleanup Bulletin

Presumptive Remedies for Municipal Landfill Sites

Office of Emergency and Remedial Response
Office of Waste Programs Enforcement

Intermittent Bulletin
Volume 2 Number 1

The Presumptive Remedy Selection Initiative

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Purpose

The Superfund Municipal Landfill Expert Team has completed four site visits under the Municipal Landfill Pilot Project.[1] The pilot project implements a 1991 streamlining manual, "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites" (hereafter referred to as "the manual"). This bulletin presents key findings from the pilots completed to date, particularly with respect to the level of detail that was appropriate for establishing risk, and therefore a basis for remedial action, at two of the sites.

Background

The preamble to the National Contingency Plan (NCP) identifies municipal landfills as a type of site where treatment of the waste may be impracticable due to the size and heterogeneity of the contents. Because of this, containment will often be the appropriate response action for the source area of municipal landfill sites. Such containment remedies are likely to include a landfill cap; ground-water treatment or control; leachate collection and treatment; and landfill gas collection and treatment, as appropriate.

The municipal landfill manual states that baseline risk assessments at municipal landfill sites may be streamlined or limited in order to initiate early remedial action on the most obvious landfill problems (e.g., ground water/leachate, landfill contents, and landfill gas). One method for establishing risk using a streamlined approach is to compare contaminant concentration levels (if available) to standards that are potential chemical-specific applicable or relevant and appropriate requirements (ARARs) for the action. The manual states that where established standards for one or more contaminants in a given medium are clearly exceeded, remedial action is generally warranted.[2] The manual further states that ultimately it is necessary to demonstrate that the final remedy addresses all pathways and contaminants of concern, not just those that triggered the remedial action.

Pilot Project Findings

The experience of the expert team supports the usefulness of a limited risk assessment to initiate early action at two of the pilot sites. Specifically, for the source area of these two sites (i.e., the discrete landfill area), a quantitative risk assessment that considered all chemicals, their potential additive effects, etc., was not necessary,

[1] See "Superfund Accelerated Cleanup Bulletin, Presumptive Remedies for Municipal Landfill Sites," Publication 9203.1-02I, Volume 1, Number 1, April 1992.

[2] See also OSWER Directive 9355.0-30, "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions," April 22, 1991, which states that if MCLs or non-zero MCLGs are exceeded, [remedial] action generally is warranted.

either to establish a basis for action or to establish clean-up levels For these two sites, the justification for early remedial action was based on existing ground-water data. Ground-water data are not available for the other two sites.

Sites with Ground-water Data

For the source areas of the two sites with existing ground-water data, the basis for action was ground-water contamination at levels exceeding non-zero MCLGs or MCLs; therefore, a complete quantitative risk assessment was not necessary to establish risk (and therefore a basis for action) at these sites. Furthermore, a quantitative risk assessment was not needed to evaluate whether the containment remedy addressed all pathways and contaminants of concern associated with the source. Rather, all potential migration pathways were identified (using the conceptual site model) and compared to those addressed by the containment remedy as follows:

- direct contact threat and surface water run-off addressed by capping;
- exposure to contaminated ground water (including any contaminated ground water moving off-site) addressed by ground-water treatment/control (including assessment of current exposure); and
- exposure to landfill gas addressed by gas collection and treatment, as appropriate.

This comparison revealed that the containment remedy addressed all pathways associated with the sources at these sites.

Finally, a quantitative risk assessment was not required to determine clean-up levels for the source areas, since the type of cap will be determined by closure ARARs, and ground-water clean-up levels may be based on MCLs, non-zero MCLGs, or more-stringent, promulgated, state levels.

NOTE: In some cases, a risk assessment may be required to determine the risk associated with contaminants in landfill gas. Landfill gas collection will frequently be a necessary component of the remedy to insure cap integrity. There may be an additional need for treatment of the collected gas based upon the contaminants present. In some cases, state ARARs may identify clean-up levels for such contaminants, and in some cases health-based levels will be appropriate. This issue will be addressed in further detail in future guidance.

Sites with No Existing Ground-water Data

Ground-water data are not yet available for two of the pilot sites, for these sites, the following tiered approach was recommended. Once ground-water data are obtained, a clear basis for action may be established, and the remedy selection may be streamlined as described for the two sites with available ground-water data. If contaminants are not identified above MCLs or non-zero MCLGs, however, additional pathways, such as surface contamination and landfill gas, will be characterized next, and a focused quantitative risk assessment conducted to establish a basis for remedial action.

Areas of Contaminant Migration

One of the expert team's key findings is that almost every municipal landfill site has some unique characteristic that may require additional study. Unique characteristics encountered during the pilot visits include leachate discharge to a wetland at one site and significant surface water run-off due to drainage problems at another. These pathways will require characterization and conventional risk assessment to determine whether remedial action is warranted beyond the source area, and if so, the type of action that is appropriate.

Pilot Study Findings and Conclusions

The expert team's conclusions from the four pilots, then, are that:

(1) a quantitative risk assessment was not warranted for the source areas of the two pilot sites where ground-water data were available and contaminants exceeded chemical-specific standards; justification for action was the exceedance of the standards;

Further, streamlining the risk assessment eliminated the need for sampling and analysis of these source areas to support the calculation of current or future risk.

(2) a focused risk assessment generally will be necessary for areas other than the landfill source itself (such as areas where contaminants have migrated from the source) to determine the need for additional remedial action beyond areas normally addressed by the cap; and

(3) a focused risk assessment generally will be necessary to determine the need for remedial action at sites where ground-water concentrations do not exceed MCLs or non-zero MCLGs, unless other conditions provide a clear justification (e.g. unstable slopes).

These conclusions are directly applicable to the four pilot sites only; however, based on these findings, the municipal landfill expert team is developing an Agency directive that will provide additional guidance on conducting baseline risk assessments at municipal landfill sites For additional information on the directive or the municipal landfill pilot project, please call Andrea McLaughlin at 703-603-8793.

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Presumptive Remedies: CERCLA Landfill Caps RI/FS Data Collection Guide

Office of Emergency and Remedial Response
Hazardous Site Control Division (5203G)

Quick Reference Fact Sheet

Municipal landfills constitute approximately 20 percent of all sites on the Superfund National Priorities List. Approximately 75 percent of all CERCLA Municipal Solid Waste Landfill (MSWLF) Remedial Actions call for installation of a landfill cap. The remedy selection process for MSWLFs is the basis of a U.S. Environmental Protection Agency (EPA) guidance, *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (U.S. EPA, 1991), which establishes the framework for containment (including landfill cap construction, leachate collection and treatment, ground water treatment, and landfill gas collection and treatment) as the presumptive remedy for MSWLFs.

In 1992, EPA introduced the *Superfund Accelerated Cleanup Model (SACM)* to accelerate all phases of the remedial process. The presumptive remedy initiative is one tool for speeding up cleanups within SACM. One way that presumptive remedies can streamline the remedial process is through early identification of data collection needs for the remedial design. By collecting design data prior to issuance of the Record of Decision (ROD), the need for additional field investigations during the remedial design (RD) will be reduced, thereby accelerating the overall remedial process for these sites. Data needed for design also can be useful in better defining the scope of the remedy and in improving the accuracy of the cost estimate in the ROD. Since containment is the presumptive remedy for MSWLFs, the Remedial Project Manager (RPM) can begin making arrangements to collect landfill cap design data as soon as a basis for remedial action is established (e.g., ground water contaminant concentrations exceeding maximum contaminant levels [MCLs]).

This fact sheet identifies the data pertinent to landfill cap design that will be required for most sites. These data are organized within six categories: (1) waste area delineation; (2) slope stability and settlement; (3) gas generation/migration; (4) existing cover assessment; (5) surface water run-on/run-off management; and (6) clay sources. For reference, all data requirements and data collection methods discussed in this document are summarized in a table at the end of this document (Table 2). In addition to the following guidance provided in this fact sheet, RPMs should enlist the aid of technical experts familiar with landfill cap design in establishing data collection needs for specific sites.

TECHNICAL AREA 1: WASTE AREA DELINEATION

The area of a landfill cap is determined by the horizontal extent of previous waste disposal. One of the major causes of cost escalation for MSWLF sites has been the failure to establish the actual boundaries of the waste. Costly construction change orders have been required to increase the area of the cap because wastes have been found to extend well beyond the edges of the intended cap. Waste boundaries should be identified as accurately as practicable prior to initiation of the design.

Aerial photographs, maps, and a local newspaper subject search may provide a historical record of the extent and type of disposal activities conducted at the site. If appropriate, residents could be interviewed to confirm or supplement available information.

Field investigation should be used to confirm records and to collect data to delineate the outer boundaries of the waste. Field investigations normally include surface, subsurface, and noninvasive geophysical explorations. Field investigation methods that provide information on the surface and shallow subsurface extent of waste include excavating shallow test pits, using direct-push exploration techniques, and drilling boreholes. Additional subsurface investigation methods are used to provide information on the vertical extent of waste.

Borings can be used to estimate waste thickness and condition of existing cover soils adjacent to or underlying the waste.

However, drilling into or through the waste and into the underlying soils and/or bedrock should be performed only if necessary, and only if the driller is experienced in the methods used to prevent cross-contamination. Additional health and safety concerns (especially exposure to methane gas) must be addressed in the health and safety plan when borings are located in the waste.

Visual evidence of the waste boundary or subsurface contamination from these field investigation activities should be recorded and, if necessary, verification samples should be collected and shipped for laboratory analyses.

Surface geophysical methods also may be useful in delineating the waste boundary. Each method has limitations, and the selection of an appropriate method should be based on landfill characteristics and data needs. The most commonly employed geophysical methods include:

- Magnetometry (measures minor changes in earth's magnetic field)—location of waste boundary and distribution of metallic waste
- Electromagnetic Conductivity (response to artificially induced magnetic field)—location of areas of contrasting conductivity, such as a landfill or natural deposits
- Ground-Penetrating Radar (reflection of electromagnetic waves)—determination of horizontal extent and depth of disturbed soils and buried objects (often used to confirm magnetometry)
- Electrical Resistivity (measures earth's response to electrical current)—determination of edge of landfill by subsurface resistivity difference
- Seismic Refraction (natural or induced compression waves)—estimation of depth to geologic strata and bedrock adjacent to the landfill.

These noninvasive surface geophysical methods should be performed prior to invasive explorations (e.g., borings or test pits). This will allow for the more limited intrusion activities to verify the findings of the noninvasive exploration methods.

TECHNICAL AREA 2: SLOPE STABILITY AND SETTLEMENT

Waste settlement and/or slope failure of the waste and existing cover soils can occur during construction of, or after completion of, the cap. Waste settlement or slope failure (see Figure 1) may expose waste and require costly repairs. Data are needed on degree of slope, existing cover materials, and existing cover soils to create cross-sectional diagrams for use in evaluating landfill slope stability and the potential for settlement damage.

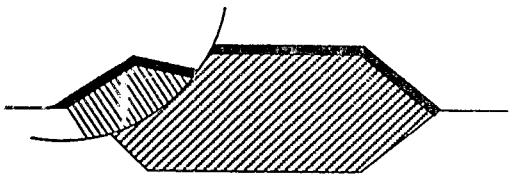

Figure 1. Typical slope failure at MSWLF site.

Settlement in a landfill can be caused by factors such as: biodegradation of wastes, consolidation of waste under the weight of waste material and cap, deterioration of partially filled containers (e.g., drums), or compaction of material during landfill operation or cap installations. Possible consequences of settlement include instability in the waste or cover soil, which can damage the cap. In fact, a recent article on cap design reports that "The center of a 20-foot diameter section of a landfill cover, for instance, could settle only 0.5 to 1.5 feet before significant cracking [of the composite clay liner] could be expected." (Koerner and Daniel, 1992) For this reason, settlement potential and stability of the landfill system should be evaluated concurrently.

The weight of the new cap can be significant enough to cause additional waste settlement and compaction. The effect of this additional weight may initiate differential settlement across the cap, thus compromising the integrity of the cap, or create stability problems such as slippage failures in the waste and/or existing cover soil. Differential settlement occurs when one area of waste settles more readily than another because of differences in moisture content, waste compaction, or waste composition. Settlement (magnitudes typically range from 5 to 25 percent of the initial waste thickness), and especially differential settlement, may create cracks in the cap and allow rainwater to reach the waste. Changes in the topography of the landfill because of settlement may also create areas on the cap surface where rainwater can pond.

In creating the conceptual landfill cap design, three separate calculations are conducted:

- Stability of waste—largely depends on how well the waste was compacted when placed, waste layer thicknesses, and waste composition
- Stability of the cap (existing and proposed)
- Settlement of waste—largely depends on how well the waste was compacted when placed, waste layer thicknesses, age, rate of waste degradation, and waste composition.

Because of their heterogeneous nature, the settlement and stability of municipal wastes are difficult to predict. Settlement rates of selected areas of the waste can be measured by placing survey monuments on top of the waste and taking periodic measurements to determine the change in elevation of

the monuments. Because settlement generally occurs slowly, it is important to begin measurement early, preferably during the remedial investigation.

The settlement of the waste depends on thickness and general composition of the waste and existing topography. Compressibility characteristics are derived from preload tests and empirical correlations to data in the published literature. Data from surveying monuments, settlement plates, and topographic surveys can be used to determine surface settlement rates across the landfill.

The stability of waste can be determined by evaluating the following:

- Potentiometric surface and perched water table information—can be determined using water level measurements from piezometers and monitoring wells
- Thickness of waste
- Existing topography—can be determined from site reconnaissance and topographic surveys.

Ground motions induced by earthquakes (seismic events) can also affect cap performance through a decrease in slope stability. This fact sheet does not address the additional data required for cap designs for landfills located in seismic impact zones.

The waste thickness and composition can be determined by observing and sampling (during completion of test pits, borings, and hand-augered holes with an experienced driller) and by searching through historical records.

The existing cover soil should also be evaluated to determine its stability and potential for settlement. Studies for the stability of the existing cover soil could include:

- Maximum slope
- Soil classification
- Potentiometric surface
- Shear strength
- Thickness
- Density.

Slope measurements and potentiometric surface derivations can be obtained using the same procedures used to determine waste characteristics. The remaining data can be obtained by boring, piezocone penetrometer (PCPT), geophysical techniques, and test pits. Existing cover soils should be classified by grain size and hydrometer analysis, as well as by Atterberg limits performed on borings and test pit samples. See the summary table at the end of this fact sheet (Table 2) for recommended tests to determine the shear strength for fine- and coarse-grained soils.

The stability and settlement estimates for existing cover soil depend largely on the complexity of the landfill site. Investigations necessary to evaluate physical properties of the existing cover soils will depend on the type(s) of soils encountered. If the existing cover soils are soft silts and clays, the settlement and stability evaluations will be more complex than for sands and gravels. These soil samples should be collected during drilling of monitoring wells to save time and money, usually during the remedial investigation (RI).

Additional slope stability evaluations will be performed during landfill cap design. Slopes greater than 3:1 (3 horizontal/1 vertical) and landfills that have been constructed within or adjacent to wetlands or low-strength soils are of particular concern. These areas of concern should be identified during RI/FS data collection to the extent possible.

TECHNICAL AREA 3: GAS GENERATION/MIGRATION

Assessment of the rate and composition of gas generated in the landfill will determine whether or not a gas collection layer should be included as a component of the cap. Dangers of gas generation and uncontrolled migration include vegetative kill, health risks from exposure, and explosive or lethal gas buildup within and outside of the landfill (see Figure 2). Field monitoring for the presence of landfill gases is also important in developing safety parameters and reducing health risks to personnel working on site.

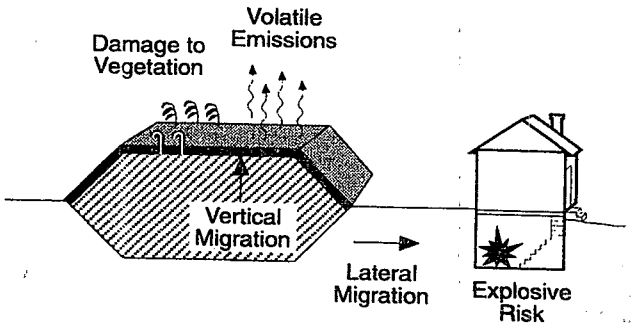

Figure 2. Vertical and lateral migration of generated gas from MSWLF site.

Generation of gas typically results from the biological decomposition of organic material in the wastes. The rate and process of gas generation are dependent on the availability of moisture, temperature, organic content of the waste, waste particle size, and waste compaction.

Data immediately available in the field for assessing gas generation are landfill gas composition and gas pressure. Gas composition in soils usually is evaluated in the field by monitoring or sampling through gas probes using a methane meter, explosimeter, or organic vapor analyzer. Air samples should be analyzed for the presence of volatile organic compounds (VOCs) or semivolatile organic compounds

(SVOCs). Moisture and heat content also can be determined by the laboratory or in the field with hand-held instruments. This information may be necessary to assess possible treatment alternatives for collected gas.

Gas migration is a function of site geology, chemical concentration, and pressure and density gradients. Gases migrate through the path of least resistance (e.g., coarse and porous soils, bedding stone along nearby water and sewer lines). Data for evaluating gas migration control and treatment methods include the composition of any existing landfill liners, soil stratigraphy, depth to water table, proximity of human/ecological receptors, and the locations of buried utilities and other backfilled excavations and structures.

Gas migration pathways may be identified based on knowledge of the site geology, hydrogeology, and surrounding soil characteristics and by review of water and sewer maps. Some of these data may be obtained by collecting and evaluating samples from test pits, borings, or hand-augered holes. Piezocone data also may be cost-effective for characterizing the surrounding subsurface soils at larger MSWLF sites.

Potential receptors of landfill gas emissions may be identified through site reconnaissance, and receptor locations should be monitored to assess possible accumulation of migrant landfill gases. Atmospheric monitoring at receptor locations may be done using a flame ionization detector (FID), a photoionization detector (PID), or a gas monitoring station; however, a PID will not detect methane and thus cannot be used to assess explosion risk. An oxygen meter using the Lower Explosive Limit (LEL) indicator may be used to detect explosive levels of gas.

Gas control is accomplished through either passive or active gas collection. Treatment of collected gas may be required depending on the concentration of hazardous constituents. The gas control system required will depend on the proximity of receptors, permeability of migration pathways, State and Federal regulations and guidelines, and level and rate of gas generation. Effective gas disposal methods include flaring, processing and sale, and/or sorption.

Active gas collection may be necessary to control gas migration when receptors are, or are expected to be, at risk. Active gas collection generally is required when measurements exceed either

- 5% methane at the property line or cap edge, or
- 25% methane LEL in/at on-site structures. (This subject is further addressed in the U.S. EPA Technology Brief: *Data Requirements for Selecting Remedial Action Technology* [U.S. EPA, 1987].)

A gas pumping test can be used to improve the estimate of the gas permeability of the waste materials and unsaturated soils, number of collection wells required, piping size and configuration, and blower requirements. However, gas pumping tests should not be relied on without further measurement and adjustment during construction.

TECHNICAL AREA 4: EXISTING COVER ASSESSMENT

Existing landfill caps should be evaluated to determine whether or not any components can be reused in the construction of a new cap. Use of existing components could save both time and money.

Data on existing components can be readily collected because only materials above the waste need be sampled. Sampling locations and procedures that will minimize damage to geosynthetic materials should be used. Sampling holes should, at a minimum, be refilled with bentonite if the existing cap is composed of clay. Geosynthetics should be patched with materials of equal properties following manufacturer's guidelines.

Additionally, the site reconnaissance should be used to evaluate, in general, the need for regrading the landfill surface to achieve proper side slopes. Appropriate limits to the steepness of slopes can be determined from preliminary slope stability calculations. Excavation into landfill waste materials may be required to reduce slope steepness to acceptable limits.

Table 1 provides recommended guidelines for final cover designs. The assessment of the existing cover should include an evaluation of the potential for any components to meet final cover guidelines.

Table 1. Existing Cover Assessment Data Requirements and Recommended Guidelines

Data Requirements	Recommended Guidelines[a] (for Final Cover)
Slope (top)	3% to 5% minimum for drainage
Cap Area	Covers horizontal waste limits
Vegetative/Soil Layer	Vegetative soil supporting healthy low shrubs or grass, no erosion, gullies or deep-rooted plants, no unacceptable frost heaves or settlement
Drainage Layer	Permeability $>1\times10^{-2}$ cm/s (sand, gravel, or geosynthetic)
Barrier Layer	Two-component (geomembrane atop compacted clay[b]) composite liner below the frost zone
Gas Venting System	Either passive vents located at high points (not clogged, no settlement) or extraction and treatment system working properly

[a] Refer to EPA's Technical Guidance Document: *Final Covers on Hazardous Waste Landfills and Surface Impoundments* (U.S. EPA, 1989).

[b] Clay compacted to a permeability $\leq 1\times10^{-7}$ cm/s, geomembrane thickness $\geq$ 20 mil.

TECHNICAL AREA 5: SURFACE WATER RUN-ON/RUN-OFF MANAGEMENT

The surface area and gradient of landfill slopes will affect surface water control measures. For the protection of both the landfill cap and adjacent areas (see Figure 3), the design of the final remedy should ensure that the site layout will provide adequate space for surface water diversion and containment/retention impoundments.

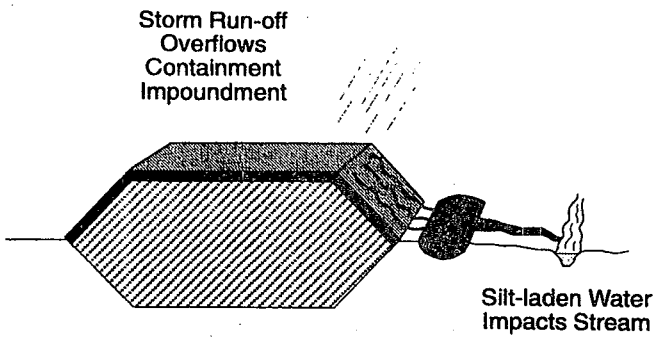

Figure 3. Storm run-off impact from an MSWLF site.

RCRA Subtitle D minimum requirements for MSWLFs (40 CFR Section 258.26) include providing a run-on control system capable of preventing flow onto the active portion of a landfill during the peak discharge from a 25-year rain storm. The regulation also requires providing run-off control systems to collect, at a minimum, the water volume resulting from a 24-hour, 25-year rainstorm. RCRA Subtitle D regulations apply to the closure of active MSWLFs and may be Applicable or Relevant and Appropriate Requirements (ARARs) for certain landfills at CERCLA sites as well.

The method for estimating run-on and run-off design discharges should be based on engineering judgment and on-site conditions (e.g., the Rational Method used by hydrologists to determine overland flow). Detailed storm flow calculations usually are done during the design phase. However, data for preliminary calculations should be collected early enough to prepare an estimate of the cost of run-on/run-off control measures as part of the remedy estimate for the ROD.

Because run-on and run-off control is required for operating landfills, some landfills may already have surface water diversion or containment impoundments that allow sediment to settle out of the run-off and that control discharge for a 25-year storm. Depending on when the landfill was designed (with respect to applicable Federal and State regulations), existing control structures may not have adequate capacity. In addition, the RI/FS should identify areas for temporary surface water controls for use during cap construction activities.

A review of the original design or site records available for a landfill may provide information on design criteria for the surface water control structures. Site reconnaissance should be conducted to evaluate the physical condition of the system. If there are no existing diversion or containment impoundments, adequate space should be located on or off site to accommodate them. Property acquisition may be necessary if on-site space is not available.

Prior to cap installation, collected or diverted run-on surface waters often can be discharged to a nearby surface waterbody or to a recharge basin. Discharge to surface water is considered a point source discharge and must comply with the National Pollution Discharge Elimination System (NPDES) requirements of the Clean Water Act. Because many States have jurisdiction for the discharge of pollutants to surface waters, permit requirements may vary depending on location, although an NPDES permit is always needed. Other factors to consider are the water quality and soil type, which can be determined by analysis of surface water samples, visual and sieve analyses of the soil, and review of NPDES compliance data (if applicable).

After the cover is installed, the collected or diverted surface water is not contaminated; therefore, diversion or containment impoundment maintenance usually is limited to control of vegetation and debris and sediment removal. Discharge to a recharge basin is not considered a point source discharge and, generally, regulators evaluate these basins for permit compliance on a case-by-case basis.

TECHNICAL AREA 6: CLAY SOURCES

A compacted clay layer is normally one of the primary components of an effective cap, provided that sources of clay (low-permeability soil) are available at or near the landfill. Data-gathering activities should include looking for potential on-site/local clay deposits for the cap construction. Manufactured geosynthetic clay liners should be considered if the required volume or physical properties are not available in nearby soils. A comparison of geosynthetic clay liner material cost versus clay excavation and transport cost should be completed before design commences.

Investigation of potential sources for clay should be initiated prior to the preliminary conceptual cap design (which defines the components of the cover). For information on clay deposits, the Soil Conservation Service (SCS) of the U.S. Department of Agriculture (USDA) publishes soil maps and classifications by county. Additional information on the availability of clay soils may be obtained from State natural resource inventory programs; local contractors or engineering firms practicing in the area; State and local highway officials,

shallow borings, test pits, and hand-augered holes; and geotechnical laboratory testing.

After potential sources of clay are identified, a site reconnaissance may be conducted. The site reconnaissance should include sample collection via hand-augered holes or shovels to verify the availability of clay over the site.

Subsurface soil samples of the source area should be collected later to determine resource quality (shear testing of layer interfaces) and quantity. Procedures used to characterize clay sources generally include:

- Excavation of at least one test pit for every 25,000 to 50,000 cubic yards
- Collection of soil samples from test pits for laboratory characterization
- Shallow borings to confirm soil type, volume, and, in certain instances, depth to ground water
- Laboratory testing of samples collected including: grain size analysis, Atterberg limits, permeability testing, moisture content, and compaction testing. Detailed compaction requirements to meet construction quality assurance objectives are provided in *Quality Assurance and Quality Control for Waste Containment Facilities* (U.S. EPA, 1993b).

If sufficient quantities of soil cover materials with appropriate engineering properties are not available within an economically practicable distance from the project site, geosynthetics or processed natural materials should be considered. Geosynthetic clay liners are generally manufactured by either sandwiching bentonitic clays between geotextiles or affixing the bentonitic clay to the bottom surface of a membrane. Thus, if clay is not readily available, low-permeability layers of the cap may be comprised of either available soil that is processed by adding bentonite to reduce the permeability or geosynthetic clay liners. For cap drainage layers, geosynthetic drainage nets may also be used, in lieu of coarse sand and gravel, to meet performance requirements. Information on geosynthetic clay liners and drainage nets can be obtained from manufacturer catalogues.

CONCLUSION

For each MSWLF site where capping is clearly a preferred remedy, the RPM should assemble a technical review team to determine the design data to be collected. This team should include experienced RPMs and technical experts familiar with data collection needs for cap design. The team can help the RPM in defining the field work required and its timing and in reviewing the design data submitted by the contractor. In the event that the contractor is changed (i.e., the RI/FS is Fund-led and the design is switched to Potentially Responsible Party [PRP]-led), the technical review team can assist the RPM in transferring the pertinent collected design data to the new contractor.

Table 2 summarizes the data needs and collection methods presented in this fact sheet. This table should be used as a reference when determining necessary design data collection activities.

Table 2. Data Requirements and Collection Methods

Data Requirements	Data Collection Methods
Waste Area Delineation	
Design/historical information	Historical records, personal interviews
Horizontal extent of waste	Test pits, probes, hand-augered holes, magnetometry, electromagnetic conductivity, ground-penetrating radar, electrical resistivity, seismic refraction
Depth and thickness of waste	Borings, geophysical surveys
Slope Stability and Settlement[a]	
Waste Evaluation	
Slope measurement (A)	Slope inclinometers, topographic survey
Potentiometric surface (A)	Piezometers/monitoring wells
Compressibility characteristics (C)	Preload testing, empirical correlations to published literature
Settlement rate (C)	Survey monuments, settlement plates, topographic survey
Thickness of waste (A,C)	Observation and sampling during test pits, borings, hand-augered holes, historical records, geophysical surveys
General waste composition (A,C)	Observation and sampling during test pits, borings, hand-augered holes, historical records, geophysical surveys
Existing topography (A,C)	Site reconnaissance, topographic survey, historical photographs

(continued)

Table 2 (continued)

Data Requirements	Data Collection Methods
Existing Cover Soil Evaluation[a]	
Slope measurement (A,B)	Topographic survey, slope inclinometers
Soil classification (B)	Grain size analysis, hydrometer analysis, Atterberg limits performed on borings/test pit samples
Potentiometric surface (A,C)	Piezometers/monitoring wells
Shear strength (B)	Fine-grained soil (cohesion): Field and/or lab vane shear test, torvane, pocket penetrometer, piezocone penetrometer, unconfined compressive strength, empirical correlations to Standard Penetration Test (S-P-T) Coarse grained soil (friction angle): Empirical correlations to S-P-T, direct shear test, triaxial shear test, piezocone penetrometer
Compressibility characteristics (C)	Consolidation tests performed on undisturbed tube samples collected from borings. Empirical correlations to index properties (water content, plasticity).
Density (B)	Empirical correlations to S-P-T data, bulk density determination from undisturbed tube samples (fine-grained soils only)
Gas Generation/Migration	
Gas composition and gas pressure	Gas probes, monitoring wells, laboratory samples
Moisture and heat content	Laboratory samples or handheld instruments in the field
Migration pathways	Water and sewer maps, piezocone, test pits, borings, hand-augered holes
Receptors	Site reconnaissance, photoionization detector, flame ionization detector, air monitoring station, oxygen meter
Existing Cover Assessment	
Slope-top	Site reconnaissance, topographic survey
Cap area	Site reconnaissance, borings, test pits, geophysical survey
Vegetative/soil layer	Site reconnaissance, topographic survey, test pits
Drainage layer	Site reconnaissance, borings, test pits, hand-augered holes, field infiltrometer or laboratory samples for hydraulic conductivity
Barrier layer	Test pits, borings, hand-augered holes, Shelby tubes for permeability, laboratory samples/analysis for shear strength, compaction curve, Atterberg limits, freeze/thaw cycling, water content
Gas venting system	Site reconnaissance, gas character sampling, gas pumping tests
Run-on/Run-off Management	
Estimated discharge, size of control structures, treatment requirements	Review of design records, National Pollutant Discharge Elimination System (NPDES) permit, detailed storm flow calculations
Climatic data	National Oceanographic and Atmospheric Administration (NOAA)
Run-on/run-off areas (% vegetated, % paved)	Site reconnaissance, topographic surveys, aerial photographs
Water quality	Surface water sampling and analysis
Soil types	Visual, aerial photographs, and soil maps from the Soil Conservation Service (SCS)
Clay Sources	
Soil properties	Soil maps from the SCS, local contractors or engineering firms, state/local transportation officials, natural resource inventory programs, shallow borings, hand-augered holes, test pits, and geotechnical laboratory testing
Subsurface resource adequacy and quantity (shear testing)	Grain size analysis, Atterberg limits, permeability test, moisture content, compaction test, shallow borings, test pits, laboratory testing
Geosynthetic clay liner properties	Manufacturer catalogs, literature, EPA studies/guidance

[a] The letters following the slope stability and settlement and existing cover soil evaluation data requirements are referenced to the data needed to perform the three separate calculations used to evaluate slope stability and settlement of the landfill cover (see Technical Area 2):

A = Stability of waste. B = Stability of cap components. C = Settlement of waste.

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Superfund

Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites

EPA/540/R-95/128
December 1995

Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites

Office of Emergency and Remedial Response, 5202G
Washington, DC 20460

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INTRODUCTION

Since the enactment of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund), the Superfund remedial and removal programs have found that certain categories of sites have similar characteristics, such as types of contaminants present, disposal practices performed, or environmental media affected. Based on information acquired from evaluating and cleaning up these sites, the Superfund program is undertaking an initiative to develop presumptive remedies to accelerate future cleanups at these types of sites. The presumptive remedy approach is one tool for speeding up cleanups within the ***Superfund Accelerated Cleanup Model (SACM)***. This approach can also be used to streamline remedial decisionmaking for corrective actions conducted under the Resource Conservation and Recovery Act (RCRA).

Presumptive remedies are preferred technologies for common categories of sites, based on EPA's experience and its scientific and engineering evaluation of alternative technologies. The objective of the presumptive remedies initiative is to use the Superfund program's experience to streamline site characterization and speed up the selection of cleanup actions. Over time, presumptive remedies are expected to ensure consistency in remedy selection and reduce the cost and time required to clean up similar types of sites. Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances.

This directive identifies the presumptive remedies for wood treater sites with contaminated soils, sediments, and sludges. EPA has developed guidance on presumptive remedies for municipal landfill sites [33] and sites with volatile organic compounds (VOCs) in soils [32]. EPA is also in the process of developing guidance on presumptive remedies for polychlorinated biphenyl (PCB), grain storage, manufactured gas plant, and contaminated ground-water sites. In addition, EPA has developed a directive entitled Presumptive Remedies: Policy and Procedures [31], which outlines and addresses the issues common to all presumptive remedies (e.g., the role of ***innovative treatment technologies***).

Bold and italicized ***terms*** are defined in the Glossary at the end of this document. The References section at the end of this document provides a list of supporting guidance documents that may be consulted for additional information on relevant topics. Bracketed numbers [#] appear throughout the text to indicate specific references in the References section.

PURPOSE

The purpose of this directive is to provide guidance on selecting a presumptive remedy or combination of presumptive remedies for wood treater sites with contaminated soils, sediments, and sludges. Specifically, this guidance:

- Describes the contaminants generally found at wood treater sites;
- Presents the presumptive remedies for contaminated soils, sediments, and sludges at wood treater sites;
- Describes the presumptive remedy process concerning the site characterization and technology screening steps; and
- Outlines the data that should be used to select a presumptive remedy.

The presumptive remedies for wood treater sites with soils, sediments, and sludges contaminated with organic contaminants are bioremediation, thermal desorption, and incineration. The presumptive remedy for wood treater sites with soils, sediments, and sludges contaminated with inorganic contaminants is immobilization. The section of this document entitled "Presumptive Remedies for Wood Treater Sites" provides a brief description of each of these technologies.

The decision to establish these technologies as presumptive remedies for this site type is based on EPA's accumulated knowledge about site characterization and remedy selection for wood treater sites with contaminated soils, sediments, and sludges, including actual performance at Superfund and RCRA sites. This decision is also based on an analysis conducted by EPA on ***Feasibility Studies (FSs)*** and ***Records of Decision (RODs)*** for sites where wood treating contaminants in soils, sediments, and sludges drove remedy selection. The results of this analysis, which are summarized in Appendix A (Technical Basis for Presumptive Remedies), demonstrate that these four technologies represent approximately 84% of the remedies selected in the FSs and RODs analyzed. The FS/ROD analysis also provides information on why other, non-presumptive technologies generally are not effective and/or appropriate for cleaning up wood

treater sites with contaminated soils, sediments, or sludges.

USE OF THIS DOCUMENT

This directive is designed to assist Superfund site managers (i.e., ***Remedial Project Managers (RPMs)*** and ***On-Scene Coordinators (OSCs)***) and other personnel in selecting remedies for cleaning up soils, sediments, and sludges at wood treater sites that are contaminated primarily with creosote, pentachlorophenol, and/or chromated copper arsenate. Site managers in other programs, such as the RCRA corrective action program or the private sector, may also find this document useful. For example, the information contained in this document could be used to eliminate the need for an alternatives screening step and streamline the detailed analysis of alternatives in the RCRA Corrective Measures Study, which is analogous to the FS under CERCLA.

Wood treater sites that have contaminated soils, sediments, and sludges often have contaminated ground water as well. At some of these sites, the contaminated soils, sediments, or sludges may not require treatment or may only need to be contained, depending on the degree of human health and environmental risk posed by the contaminated soils, sediments, or sludges as determined in the ***removal site evaluation*** and/or ***remedial site evaluation*** (i.e., the preliminary assessment/site inspection (PA/SI)). At some sites, a combination of treatment options may need to be implemented to address the contamination of ground water as well as soils, sediments, and sludges. When addressing contamination at wood treater sites, site managers should consider the impact of contamination across all environmental media. In particular, site managers at wood treater sites should consider the impacts of ground-water contamination. EPA is currently developing guidance on a presumptive remedy approach for responding to contaminated ground-water sites. When available, this guidance should be used to address ground-water contamination at wood treater sites. Site managers should also consult existing guidance on the remediation of contaminated ground water [6, 7, 17, 20, 38]. Box A provides a brief discussion of ground-water considerations for wood treater sites that is consistent with existing guidance and the forthcoming presumptive remedy ground-water approach. In addition, Box D provides background information on non-aqueous phase liquid (NAPL) contaminants, including dense NAPLs (DNAPLs or sinkers) and light NAPLs (LNAPLs or floaters).

The presumptive remedy evaluation and selection process described in this document is consistent with and fits into the more detailed conventional remedy selection process outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300). The Agency believes that the presumptive remedies set out in this document represent appropriate response action alternatives for sites meeting certain criteria and, therefore, generally should be used. However, remedy selection for an individual site may vary because of specific site characteristics or community or state concerns. Although it may still be possible to accelerate remedy selection for non-presumptive technologies, such selection will not be able to take advantage of the generic justification provided by this document. Under these circumstances, a conventional ***Remedial Investigation/Feasibility Study (RI/FS)*** or ***Engineering Evaluation/Cost Analysis (EE/CA)*** should be performed. Guidance on circumstances in which a presumptive remedy might not be appropriate is found in Presumptive Remedies: Policy and Procedures [31]. When determining whether a remedial or removal action is the appropriate method for cleaning up a wood treater site, site managers should consult the NCP and Superfund program guidance. Also, the Agency is currently developing a fact sheet to assist RPMs and OSCs in identifying the factors affecting the site-specific determination of whether a Superfund early action is best accomplished as a non-time-critical removal action or an early remedial action.

This directive is not a stand-alone document. To ensure a full understanding of wood treater site characterization and remedy selection, site managers should refer to the FS/ROD analysis, which is summarized in Appendix A of this document, and the documents cited as references at the end of this document. Site managers unfamiliar with certain complex site conditions at wood treater sites should consult with experienced site managers, the contacts listed in Box B of this document, the Superfund Technical Assistance Response Team (START), or the Environmental Response Team (ERT). EPA is continuing to gather and develop more information on the remedies selected and implemented at wood treater sites.

ANTICIPATED BENEFITS OF PRESUMPTIVE REMEDIES

The use of this document is expected to reduce the costs and time required for remedy selection at wood treater sites. This directive should be used to:

BOX A
Ground-Water Considerations

Wood treater sites typically involve subsurface DNAPL and/or LNAPL contaminants (see Boxes C and D) in addition to contaminated soils, sediments, or sludges. All of these materials are sources of contamination of the underlying ground water and need to be considered when planning an overall site response. A key element of all existing ground-water remediation guidance is that site characterization and response actions should be implemented in a **phased approach.** In a phased approach, site response activities are conducted in a sequence of steps, such that information obtained from earlier steps is used to refine subsequent investigations, objectives, or actions. The recommended strategy for sites with NAPL contamination, such as wood treater sites, includes the following response actions and objectives [17].

Site investigations should be designed to delineate both NAPL zones and aqueous plumes. NAPL zones are those portions of the site where LNAPL or DNAPL contaminants (in the form of immiscible liquids) are suspected in the subsurface, either above, at, or below the water table. Aqueous plumes are portions of the site where contaminants are present in solution and not as immiscible liquids.

Early actions should be used to:

- Prevent exposure, both current and future, to ground-water contaminants;
- Prevent the further spread of the aqueous plume (plume containment);
- Control the further migration of contaminants to ground water from contaminated soils and subsurface NAPLs, where practicable (source containment); and
- Reduce the quantity of source material present in the subsurface (free-phase DNAPL), to the extent practicable (source removal/treatment).

Long-term remedial actions should be used to:

- Attain those objectives listed above that were not accomplished as early actions;
- Minimize further release of contaminants from soils and subsurface NAPLs to the surrounding ground water (source containment);
- Reduce the quantity of source material present in the NAPL zone (free- and residual-phase), to the extent practicable (source removal/treatment); and
- Restore as much of the aqueous plume as possible to cleanup levels (e.g., drinking water standards) appropriate for its beneficial uses. These beneficial uses should take into account anticipated future land use(s) (aquifer restoration).

For more information on NAPL contamination, see Box D.

1. **Identify the presumed or likely remedy options up front and allow for a more focused collection of data on the extent of contamination.**

This presumptive remedy guidance allows for the evaluation of only the primary cleanup alternative or a narrow range of options. The judgment as to whether evaluation of only the primary remedy is appropriate will depend on the degree of complexity and uncertainty at a site. Also, it may be appropriate to collect certain remedial design data before the drafting of the ROD or ***Action Memorandum***, thereby allowing the action to proceed more quickly after signature of the decision document.

BOX B
Contacts for Additional Information

Headquarters Policy Contacts:

Frank Avvisato, Wood Treater Project Manager (703) 603-8949

Scott Fredericks, Presumptive Remedies Team Leader (703) 603-8771

Technical Contacts:

Harry Allen, Environmental Response Team (908) 321-6747

Frank Freestone, Office of Research and Development (908) 321-6632

Regional Contacts:

I	Mike Nalipinski	(617) 223-5503
II	Mel Hauptman	(212) 637-3952
III	Paul Leonard	(215) 597-3163
IV	Felicia Barnett	(404) 347-7791
V	Dion Novak	(312) 886-4737
VI	Cathy Gilmore	(214) 665-6766
VII	Diana Engeman	(913) 551-7746
VIII	Victor Ketellapper	(303) 293-1648
IX	Craig Cooper	(415) 744-2370
X	Eric Winiecki	(206) 553-6904

2. **Eliminate the need for the initial step of screening alternatives during the FS or EE/CA.**

The NCP (section 300.430(e)(1)) states that the lead agency shall include an alternatives screening step *when needed* [emphasis added] to select a reasonable number of alternatives for detailed analysis. The Agency performed an analysis of FSs and RODs on the potentially available technologies for soils, sediments, and sludges at wood treater sites (see Appendix A) and found that certain technologies are appropriately and consistently screened out based on the criteria of effectiveness, implementability, and cost (consistent with section 300.430(e)(7)). Based on this analysis, the Agency has determined that the initial step of identifying and screening alternatives for FSs and EE/CAs for wood treater sites may not be necessary on a site-specific basis; instead, the FS or EE/CA may proceed immediately from the identification of alternatives to the detailed analysis, focusing on the technologies recommended in this directive. This document and the accompanying FS/ROD analysis must be included in the ***Administrative Record*** to provide the basis for streamlining the analysis for wood treater sites in this way.

3. **Streamline the detailed analysis phase of the FS or EE/CA.**

Once cleanup alternatives pass the initial screening step, they must be evaluated against the appropriate criteria defined in the NCP. Appendix A of this document summarizes the analysis EPA conducted on FSs/RODs for wood treater sites with contaminated soils, sediments, or sludges, and Appendix B provides generic evaluations of the different presumptive remedies against seven of the nine remedial criteria (excluding state and community acceptance). Both of these appendices should be used to streamline the detailed analysis phase of the FS. Appendices A and B can also be used to streamline the evaluation of removal action alternatives in an EE/CA. The generic analyses in Appendix B should be supplemented with site-specific information for the final response selection. For a more detailed discussion on preparing an FS or EE/CA, see the references listed at the end of this document [16, 19].

EPA expects that at least one of the presumptive remedies will be suitable for a wood treater site with principal threats that require the treatment of contaminated soils, sediments, or sludges. Circumstances under which other approaches may be appropriate include: unusual site soil characteristics; demonstration of significant advantages of innovative technologies over the presumptive remedies; and extraordinary community and state concerns. If such circumstances are encountered, additional analyses may be necessary or a conventional RI/FS or EE/CA may be performed.

DESCRIPTION OF WOOD TREATER SITES

The wood treating industry has been in existence in the United States for over 100 years. Wood is usually treated in cylinders, under pressure, with one or a combination of the following types of preservatives:

- Pentachlorophenol (PCP) in petroleum or other solvents;
- Creosote (in petroleum or other solvents);
- Aqueous solutions of copper, chromium, and arsenic;
- Copper and arsenic, or copper, arsenic, and zinc solutions in ammonia; and
- Fire retardants (combinations of phosphates, borates, boric acid, and/or zinc compounds).

Older facilities traditionally used oil-based preservatives, while more modern facilities tend to use water-soluble preservatives. Water-soluble processes produce little or no wastewater, except for small amounts of metal-containing sludges. Oil-based processes produce sludge wastes and significant quantities of process wastewater. The processes performed at wood treater sites generally will result in contaminated soils, sediments, and sludges, and/or contaminated surface and ground water.

Box C provides a list of contaminants commonly found at wood treater sites; general chemical categories of contaminants are provided and specific chemicals or substances are identified under each category. As indicated in Box C, most of the organic contaminants found at wood treater sites are NAPLs, either in their pure form or as components of other substances that are NAPLs (e.g., petroleum fuels, creosote). Site managers should refer to Box D for background information on NAPLs and cleanup problems associated with these contaminants.

The three types of contaminants predominantly found at wood treater sites, either alone or in combination with each other -- or with total petroleum hydrocarbon (TPH) carrier oils -- are creosote, PCP, and chromated copper arsenate (CCA). Creosote is an oily, translucent brown to black liquid that is a very complex mixture of organic compounds, containing approximately 85% polynuclear aromatic hydrocarbons (PAHs), 10% phenolic compounds, and 5% nitrogen-, sulfur-, or oxygen-containing heterocycles. PCP is also an organic contaminant. In its pure form, PCP is a DNAPL; however, PCP is commonly found at wood treater sites as an LNAPL mixed into fuel oil or other

BOX C
Contaminants Commonly Found at Wood Treater Sites

ORGANICS

Dioxins/furans[1]
- Dibenzo-p-dioxins
- Dibenzofurans
- Furan

Halogenated phenols[1]
- Pentachlorophenol
- Tetrachlorophenol

Simple non-halogenated aromatics[2]
- Benzene
- Toluene
- Ethylbenzene
- Xylene

Polynuclear aromatic hydrocarbons[1]
- 2-Methylnaphthalene
- Chrysene
- Acenaphthene
- Fluoranthene
- Acenaphthylene
- Fluorene
- Anthracene
- Indeno(1,2,3-cd)pyrene
- Benzo(a)anthracene
- Naphthalene
- Benzo(a)pyrene
- Phenanthrene
- Benzo(b)fluoranthene
- Pyrene
- Benzo(k)fluoranthene

Other polar organic compounds
- 2,4-Dimethylphenol[1]
- 2-Methylphenol[1]
- 4-Methylphenol[1]
- Benzoic acid[1]
- Di-n-octyl phthalate
- N-nitrosodiphenylamine

INORGANICS

Non-volatile metals (compounds of)
- Chromium
- Copper

Volatile metals (compounds of)
- Arsenic
- Cadmium
- Lead
- Zinc

[1] **DNAPL(s) in pure form.**
[2] **LNAPL(s) in pure form.**

light organic substances. If PCP or other chlorinated phenols are present at a site, associated dioxins and/or furans may also be present in the approximate vicinity. If so, these dioxins and/or furans will likely exist in much lower concentrations than the associated chlorinated phenols. This document is not designed to address sites containing high levels of dioxins and/or furans. EPA is currently gathering information on the issue of dioxin/furan contamination; site managers should contact the Headquarters policy contacts listed in Box B for more information on this topic. CCA is an inorganic arsenical wood preservative. Other metal-containing preservatives that may be found at wood treater sites include ammoniacal copper arsenate (ACA) and ammoniacal copper-zinc arsenate (ACZA).

PRESUMPTIVE REMEDIES FOR WOOD TREATER SITES

The presumptive remedies for contaminated soils, sediments, and sludges constituting the principal threats at wood treater sites are described below. Bioremediation is the primary presumptive remedy for treating organic contamination of soils, sediments, and sludges at wood treater sites. Bioremediation has been selected as the primary presumptive remedy for treating organic contamination because it has been selected most frequently to address organic contamination at wood treater Superfund sites, and the Agency believes that it effectively treats wood treating wastes at a relatively low cost. If bioremediation is not feasible, thermal desorption may be the more appropriate response technology. In a limited number of situations (e.g., the treatment of "hot spots" such as sludges), incineration may be the more appropriate remedy. Immobilization is the primary presumptive remedy for treating inorganic contamination of soils, sediments, and sludges at wood treater sites.

An important consideration in determining which presumptive remedy technology is the most appropriate for a particular site is the future land use or uses anticipated for that site (see reference [27] and Box E of this document for more information on land-use considerations). Another important consideration in selecting the most appropriate presumptive remedy technology is determining what are the principal threats and low-level threats (including possible treatment residuals) at a site. Treatment technologies are the preferred remedies for addressing principal threats, while containment technologies in conjunction with institutional and/or engineering controls, are most likely to be appropriate for addressing low-level threats. Table 2 (Comparison of Presumptive Remedy Technologies), which is found at the end of this document, provides detailed information on the advantages, limitations, and costs of each of the presumptive remedies.

At many wood treater sites, it may be necessary to use a combination of control and treatment options as part of an overall treatment train to sufficiently reduce toxicity and immobilize contaminants. Institutional and/or engineering controls can be used in conjunction with one or more of the presumptive remedy technologies to enhance the long-term reliability of the remedy. Site managers should note that all *ex situ* remedy options require measures to protect workers and the community during the excavation, handling, and treatment of contaminants, and may be subject to RCRA land disposal restrictions. Box E (Practical Considerations) provides a discussion of land use, institutional and engineering controls, treatment trains, the remediation of "hot spots," and land disposal restriction issues.

Bioremediation — Bioremediation is the chemical degradation of organic contaminants using microorganisms. Biological activity (i.e., biodegradation) can occur either in the presence (aerobic) or absence (anaerobic) of oxygen. Aerobic biodegradation converts organic contaminants to various intermediate and final decomposition products, which may include various daughter compounds, carbon dioxide, water, humic materials, and microbial cell matter. Aerobic biodegradation may also cause binding of the contaminants to soil components, such as humic materials. Anaerobic biodegradation converts the contaminants to carbon dioxide, methane, and microbial cell matter.

Bioremediation may be an *ex situ* or *in situ* process. *Ex situ* bioremediation refers to the biological treatment of contaminants following excavation of the soil or other media, and includes composting, land treatment in lined treatment cells, treatment in soil piles, or the use of soil slurry reactors. *In situ* bioremediation is the in-place treatment of contaminants, and may involve the addition of nutrients, oxygen, or other enhancements into the subsurface.

EPA has more experience in implementing *ex situ* bioremediation than *in situ* bioremediation. In general, *ex situ* bioremediation is faster than *in situ* bioremediation, although the implementation of either *ex situ* or *in situ* bioremediation typically can require several years, as compared to approximately six months to a year for technologies like thermal desorption or

incineration. *In situ* bioremediation may be less costly than *ex situ* bioremediation. However, at some wood treater sites, *ex situ* bioremediation may be able to achieve higher performance efficiencies than the *in situ* process due to increased access and contact between microorganisms, contaminants, nutrients, water, and electron acceptors.

The effectiveness of bioremediation is site- and contaminant-specific. Careful contaminant and matrix characterization (with particular attention to heterogeneity), coupled with ***treatability studies*** of appropriate scale and duration, are strongly recommended. Bioremediation can successfully treat soils, sediments, and sludges contaminated with organic contaminants, such as halogenated phenols and cresols, other polar organic compounds, non-halogenated aromatics, and PAHs. Studies on the bioremediation of creosote contamination indicate that bioremediation works well on 2-, 3-, and often 4-ring compounds, but generally not as well on 5- or 6-ring compounds.

Bioremediation may not be effective for the treatment of high levels of concentrated residual creosote in soils, sediments, or sludges. It may be necessary to separate this material for disposal or treatment by a different technology (e.g., thermal desorption or incineration) before attempting bioremediation. The remaining soils, sediments, or sludges, with lower levels of contamination, may then be amenable to bioremediation. Bioremediation generally is not appropriate for treating inorganic contamination at wood treater sites. Only limited data on the bioremediation of dioxins or furans are currently available; EPA is currently gathering information on the treatability of dioxins and furans (for more information, contact the individuals listed in Box B).

Thermal Desorption — Thermal desorption physically separates, but does not destroy, volatile and some semi-volatile contaminants from excavated soils, sediments, and sludges. Significant material handling operations may be necessary to sort and size the soils, sediments, or sludges for treatment. Thermal desorption uses heat or mechanical agitation to volatilize contaminants from soils, sediments, or sludges into a gas stream; subsequent treatment must be provided for the concentrated contaminants resulting from the use of this technology. Depending on the process selected, this technology heats contaminated media to varying temperatures, driving off water and volatile and semi-volatile contaminants. Off-gases may be condensed for disposal, captured by carbon adsorption beds, or treated with biofilters.

Treatability studies are recommended before full implementation of the thermal desorption technology. Thermal desorption can successfully treat halogenated phenols and cresols as well as volatile non-halogenated organic compounds at wood treater sites. It cannot, however, effectively separate non-volatile metals (e.g., copper) from the contaminated media. Some desorber units can treat PCBs, pesticides, and dioxins/furans in contaminated soils, sediments, or sludges.

If chlorine is present in the feed material (e.g., as a result of PCP), dioxin and furan formation may occur in the thermal desorber, stack, or air pollution control devices at temperatures of 350 °F and above. Thermal treatment systems can be designed and operated to minimize dioxin and furan formation and to remove these compounds from the stack gases. However, because pilot-scale devices do not always duplicate operating conditions at full scale, bench- or pilot-scale treatability studies alone may not be sufficient to verify dioxin/furan formation or control. A full-scale test, called a "Proof of Performance" test, with analyses for dioxins and furans should be completed. Safe thermal treatment operation should be confirmed prior to the use of thermal desorption.

Compliance with ***Applicable or Relevant and Appropriate Requirements (ARARs)*** and other laws should be considered when determining whether thermal desorption is conducted on- or off-site. On-site thermal desorption may be performed with a mobile unit; however, space availability may make this option infeasible. Thermal desorption may also be conducted off-site; however, the facilities used must be in compliance with the Superfund off-site rule before accepting material from a Superfund site. EPA is currently in the process of completing guidance that provides information on the safe implementation of thermal treatment technologies, including thermal desorption and incineration.

Incineration — Incineration generally treats organic contaminants by subjecting them to temperatures typically greater than 1,000°F in the presence of oxygen and a flame. During incineration, volatilization and combustion convert the organic contaminants to carbon dioxide, water, hydrogen chloride, and sulfur oxides. The incinerator off-gas requires treatment by an air pollution control (APC) system to remove particulates and to neutralize and remove acid gases (e.g., HCl). This technology may generate three residual streams: solids from the incinerator and APC system, water from the APC system, and air emissions from the APC system.

Incineration has consistently been demonstrated to achieve a performance efficiency in the 90 to 99% range. Incineration has successfully treated wood treater soil, sediment, and sludge contamination to cleanup levels that are more stringent than can be consistently attained by the other wood treater presumptive remedies. A substantial body of trial burn results and other quality-assured data verify that incineration can remove and destroy organic contaminants (including dioxins and furans) to the parts per billion or parts per trillion level. Consequently, incineration may be particularly effective in treating "hot spots" at wood treater sites.

Incineration, however, does not destroy metals. Metals will produce different residuals depending on the volatility of the compounds, the presence of certain compounds (e.g., chlorine), and the incinerator operating conditions. Improperly operated incinerators also have the potential to create dioxins and furans. Incineration of large volumes of contaminated media may be prohibitively costly.

Incineration may be performed on- or off-site. There may be significant considerations regarding the compliance of incineration with ARARs and other laws. On-site incineration may be performed with a transportable incineration unit; however, space availability and public opposition may make this option inappropriate. Whenever incineration is considered as an option to fulfill remediation goals, particular efforts should be made to provide the community with good information on incineration and to be responsive to any concerns raised by the community. Commercial incineration facilities (i.e., units permitted for the incineration of hazardous wastes, including incinerators and cement kilns) may be used when off-site incineration is desirable. However, only a limited number of these facilities are available nationwide. Permitting of additional on- and off-site incineration facilities will be affected by EPA's Strategy for Hazardous Waste Minimization and Combustion [37].

Immobilization — Immobilization reduces the mobility of a contaminant, either by physically restricting its contact with a mobile phase (solidification) or by chemically altering/binding the contaminant (stabilization). The most common solidification binders are cementacious materials, including Portland cement, fly ash/lime, and fly ash/kiln dust. These agents form a solid, resistant, aluminosilicate matrix that can occlude waste particles, bind various contaminants, and reduce the permeability of the waste/binder mass. Immobilization is particularly suited to addressing inorganic (e.g., CCA) contamination.

At wood treater sites, inorganic contamination is sometimes commingled with organic contamination. In these situations, a treatment train should be implemented that uses bioremediation, thermal desorption, or incineration to address organic contamination, followed by the immobilization of any significant residual inorganic contamination. There are limited full-scale performance data available on the immobilization of PAHs and PCP, either alone or commingled with inorganic contamination, where the concentration of total petroleum hydrocarbons is significantly more than 1%. Immobilization has been effective in treating soils with commingled organic and inorganic contamination with a total organic content of as much as 20-45%. Immobilization alone is not effective for treating volatile organic contaminants.

Site-specific treatability studies should be conducted to ensure that a solidification/stabilization formulation can be developed that meets site-specific requirements for low leachability and permeability, and high compressive strength. EPA is currently in the process of developing guidance on conducting solidification/stabilization treatability studies.

PRESUMPTIVE REMEDY PROCESS FOR WOOD TREATER SITES

This section and the accompanying "Decision Tree for Technology Selection at Wood Treater Sites" (Figure 1) describe the process for selecting a presumptive remedy or combination of remedies for cleaning up contaminated soils, sediments, and sludges at wood treater sites. This remedy selection process is consistent with and fits into the overall site remediation process outlined in the NCP.

Under the NCP, alternative remedies are to be evaluated and the preferred alternative is to be selected based on nine criteria. Presumptive remedies are technologies that have been found to be generally superior under the nine criteria to other technologies. This generic evaluation makes it unnecessary to conduct a detailed site-specific analysis of the other technologies.

The "decision tree" approach recommended here is a further streamlining of the usual NCP analysis. The decision tree is based on the Agency's findings that,

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among the recommended technologies, a single preferred technology can be identified based on the nine criteria, but that the determination of which technology is preferred will depend on a few key variables such as the types of contaminants present and the feasibility of the technology. Once these factors are determined, the single recommended approach can be identified. This conclusion represents a judgement that, under the circumstances at the site, the preferred technology will be superior under the nine criteria. However, the decision tree avoids the need to go through a full nine-criteria analysis at the site-specific level; in effect, most of that analysis has already been performed and the only information needed to complete the analysis relates to variables specified in the decision tree.

The presumptive remedy process generally begins at the point in the overall NCP process where the removal and/or remedial site evaluation and ***Hazard Ranking System*** scoring steps have been completed and development of the RI/FS or EE/CA is about to begin. The presumptive remedy process streamlines the site characterization, technology assessment, and remedy selection steps.

The decision tree describes a presumptive remedy process that is dynamic, where site characterization, the evaluation of presumptive remedies, and the establishment and refinement of remedial action objectives (including future land use assumptions and ***Preliminary Remediation Goals (PRGs)***) are conducted interactively and concurrently. Site managers should attempt to involve the state, community, and potentially responsible parties (PRPs) in the presumptive remedy process as early as possible.

Presumptive remedy options should be evaluated considering their associated performance efficiencies and the cleanup levels they might achieve, and the future land uses that their implementation may make available. In most cases, treatability studies should be performed for the treatment technologies being considered. As discussed previously, the identification of presumed or likely remedies early in the cleanup process will allow for a more focused collection of data on the extent of contamination, eliminate the need for the initial step of identifying and screening alternatives during the FS or EE/CA, and streamline the detailed analysis phase of the FS or EE/CA.

The numbered steps and decision points in Figure 1, the "Decision Tree for Technology Selection at Wood Treater Sites," correspond to the similarly numbered paragraphs below. These paragraphs provide information and the underlying assumptions for each of the different steps and decision points in the presumptive remedy process. The decision tree should be used as a guide through the specific decision points and considerations that are necessary to choose a presumptive remedy.

1. **Are Creosote, PCP, or CCA Present at the Site?** This document focuses on cleaning up soils, sediments, and sludges at wood treater sites contaminated primarily with creosote, PCP, or CCA; if these contaminants are not present at the site, the presumptive remedy selection process outlined in the document is not appropriate for the site, and the conventional RI/FS or EE/CA process should be followed. Information on contaminants present at the site may be available from data collected during the removal and/or remedial site evaluation. If this information is not available, past chemical use at a particular facility can be ascertained from a number of sources, such as information from facility records, past sampling efforts by state or local agencies, or through information request letters.

2. **Initiate Early PRP, State, and Community Involvement.** Site managers should initiate a dialogue with the community, state representatives, and PRPs early in the process of identifying potential presumptive remedy options for a site. This dialogue should include a discussion of reasonably anticipated future land use. This discussion should be beneficial in establishing remedial action objectives and state ARARs, which, in conjunction with federal requirements, may provide PRGs. In addition, site managers should begin assembling the Administrative Record for the site.

3. **Review Advantages/Limitations Table for Presumptive Remedies.** Using information on the contaminants present at the site, site managers should begin reviewing the presumptive remedies for wood treater sites. Table 1 provides a listing of the presumptive remedies for wood treater sites and the contaminants for which they are applicable. Table 2 provides detailed information on the advantages, limitations, and costs of each of the presumptive remedies.

   Steps 4 and 5 of the decision tree represent separate aspects of initial site cleanup activities. However, these steps should be undertaken concurrently, with each step using information obtained from the other step.

TABLE 1
Evaluation of Presumptive Remedy Technology Options

Contaminants Present at Site	Presumptive Remedy Technology Options	Demonstrated Performance Efficiencies[1]
Organics: Creosote, PCP, or Creosote and PCP	Bioremediation	64-95% for PAHs and 78-98% for chlorophenols (F)[2]
	Thermal Desorption	82-99% (B,P,F)
	Incineration	90-99% (B,P,F)
Inorganics: CCA	Immobilization	80-90% TCLP[3] (B,P,F)
Organics and Inorganics: Creosote and CCA; PCP and CCA; or Creosote, PCP, and CCA	Bioremediation, Thermal Desorption, and/or Incineration, followed by Immobilization	See above

[1] Performance represents a range of treatability data. Percentages may vary depending on the contaminant(s). Bench- (B), pilot- (P), or full-scale (F) demonstration data may not be available for all contaminants. All performance efficiency data are taken from EPA's Contaminants and Remedial Options at Wood Preserving Sites [8], unless noted otherwise.

[2] These data represent current full-scale performance data for *ex situ* bioremediation conducted at three U.S. wood treater sites (all of which are listed on the ***National Priorities List (NPL)***) and one Canadian wood treater site. The use of bioremediation at these four sites achieved remediation goals in all cases. Because the monitoring of biodegradation at these sites stopped after remediation goals were achieved, actual performance efficiencies at these sites may be higher than these numbers indicate. For a more detailed discussion of these performance data, see "Full-Scale Performance Data on the Use of Bioremediation at Wood Treater Sites," a technical background document for the wood treater site presumptive remedy initiative that is available at EPA Headquarters and the Regional Offices. EPA's Contaminants and Remedial Options at Wood Preserving Sites (1992) [8] provides the following pilot-scale performance data for bioremediation: an average of 87% for PAHs and 74% for halogenated phenols and cresols. The effectiveness of bioremediation tends to be highly variable and very site-specific. A significant component of this variability is the range of effectiveness in the remediation of different kinds of PAHs; studies on the bioremediation of creosote contamination indicate that bioremediation works well on 2-, 3-, and often 4-ring PAHs, but generally not as well on 5- or 6-ring PAHs. For example, the use of *ex situ* bioremediation at one of the wood treater NPL sites resulted in 95% removal of 2-ring PAHs, 83% removal of 3-ring PAHs, and 64% removal of 4+-ring PAHs. In practice, *in situ* bioremediation typically results in lower performance efficiencies than the *ex situ* process because *in situ* reactions are less controlled and involve lower mass transfer rates. To obtain additional performance data for bioremediation, contact the U.S. EPA's Center for Environmental Research Information (CERI) at: 26 W. Martin Luther King Drive, Cincinnati, Ohio 45268. CERI maintains a bioremediation data base called "Bioremediation in the Field Search System" (BFSS), which may be accessed electronically through bulletin boards at (301) 589-8366 or (513) 569-7610.

[3] TCLP (toxicity characteristic leaching procedure) is a specific analytical method; this method has been widely used in the past to evaluate the performance of immobilization. However, current information indicates that the SPLP (synthetic precipitation leaching procedure) or other procedures using distilled or site-specific water will produce more accurate results.

4. **Conduct Site Characterization.** Site characterization activities for wood treater sites using the presumptive remedy process should be designed to:

- Positively identify the site type (i.e., a wood treater site with creosote, PCP, or CCA contamination);
- Obtain data to determine whether the presumptive remedies are feasible for the site;
- Focus and streamline the collection of data to support the selection of presumptive remedies only; and
- Collect design data, thereby streamlining the data collection required during the remedial or removal design stage.

The overall site characterization process should proceed using multimedia sampling events whenever possible. Field screening methods should be integrated into the sampling and analysis plan to accelerate information gathering. Data quality objectives must reflect the ultimate use of the results; consequently, all samples taken during a single event may not require the same level of data quality.

Surface lagoons, soil areas, drip pads, and sediments should be sampled in a grid-like manner to determine the horizontal and vertical extent of contamination. Site managers should ensure that sampling for dioxins and furans is conducted at all wood treater sites known to have used chlorinated phenols, such as PCP. Soil, sediment, and sludge characterization relevant to treatment selection should reflect the information needs described in Tables 3A-D.

If a wood treating or other chemical at an abandoned site is still in its original containers, it should be returned to the manufacturer, if possible. Where any of the principal wood treating chemicals (creosote, PCP, or CCA) can be recovered in high enough concentrations to warrant reuse in any process, recycling becomes the preferred technology. The recognized U.S. Waste Exchanges are listed in Appendix A of the Technology Selection Guide for Wood Treater Sites [43].

During site characterization, a site-specific baseline *risk assessment* (or streamlined risk evaluation for a removal action) should be conducted to characterize materials that constitute principal threats (i.e., source materials, including liquids, that are highly toxic or highly mobile wastes that generally cannot be reliably contained or would present a significant risk to human health and the environment should exposure occur). This risk assessment should be conducted to determine whether sufficient threats or potential threats exist to warrant a response action.

The site-specific risk assessment should be used to determine remediation goals for the site. Risk-based remediation goals are often different for soils, sediments, and sludges at different depths. Shallow remediation goals are usually based on direct contact risks, while deeper remediation goals are usually based on ground-water impacts. Site managers should consider the ground-water strategy for the site because remediation goals for soils, sediments, and sludges are often set to protect ground-water quality. As discussed above, existing guidance on the remediation of ground water [6, 7, 17, 20, 38] and the forthcoming guidance on a presumptive ground-water approach, when available, should be consulted.

EPA is currently in the process of developing guidance on soil screening levels [30]; these levels represent contaminant concentrations in soil below which there is generally no need for federal concern for the protection of human health in a residential setting. When the final guidance is available, site managers should use it as a screening tool in determining the need for further assessment of soil contamination during the RI stage of cleanups at National Priorities List sites. For more information on conducting site characterization activities and risk assessments, site managers should refer to the references listed at the end of this document [1, 8, 16, 19, 23, 34 35, 36].

5. **Establish Remedial Action Objectives (Including Land Use Assumptions) and Set PRGs.** Promulgated federal and state standards should be assessed as potential ARARs for the site. As appropriate, other criteria, advisories, or guidance should be assessed as potential *to be considereds (TBCs)*. For a more detailed discussion on identifying ARARs and TBCs, see the references listed at the end of this document [3, 4, 41].

Superfund site managers should also continue to evaluate the presumptive remedies and begin to

develop remedial action objectives for the site. The following steps, as depicted in Figure 1, should be undertaken by site managers.

Review Presumptive Remedies and Associated Performance Efficiencies

Site managers should continue the review of the presumptive remedies that was initiated in Step 3, using additional information on site characteristics obtained under Step 4. Tables 1 and 2 provide data on performance efficiencies for the different presumptive remedy technologies. Information contained in these tables should be used to focus the information gathering activities being conducted under the site characterization step.

Set Preliminary Remediation Goals

As part of the overall remedial action objectives for the site, site managers should set PRGs. Initially, PRGs should be developed based on readily available information, such as ARARs and TBCs. Technical, exposure, and uncertainty factors should also be used to establish PRGs (see section 300.430(e)(2) of the NCP). Site managers should modify PRGs, as necessary, as more information becomes available. When setting PRGs for wood treater sites, site managers should also consider the performance efficiencies of the different presumptive remedies. In most cases, treatability studies will be necessary to determine the site-specific capabilities of a specific presumptive remedy. Reasonably anticipated future land use(s) of the site should also be considered when establishing PRGs. Site managers should consult EPA's guidance on land use in the Superfund remedy selection process [27]. This guidance calls for early interaction with citizens, local governments, and other entities to gather information to develop assumptions regarding anticipated future land use. These assumptions may be used in the baseline risk assessment, the development of alternatives, and remedy selection. Refer to Box E (Practical Considerations) for more information on future land use considerations.

Prepare Information and Present to Public

It is important that site managers involve the public at an early stage in the consideration of the various presumptive remedy options. Site managers should encourage the public to review the advantages and limitations of the presumptive remedies against each other and should consider this public input when selecting a presumptive remedy for a site. In particular, efforts should be made to engage the community and other interested parties in discussions concerning the establishment of PRGs and future land use issues.

Input from the community, state representatives, and PRPs may be obtained through a variety of methods, such as informal contacts or meetings with community leaders or groups. This early input on remedy selection should assist site managers in fostering community acceptance at later stages of the presumptive remedy selection process. Before seeking public input, the site manager should do the following: (1) contact Regional community relations staff for information on community acceptance (if further assistance is necessary, the individuals listed in Box B should be contacted); and (2) prepare a matrix of the applicable presumptive remedy options for the site. This matrix should contain data on the performance efficiencies, advantages, limitations, costs, and implementability of the various options, and should emphasize the full range of trade-offs between the alternatives. This information should be presented to the public to assist them in providing input on the remedy selection process. For a more detailed discussion on holding public meetings and community relations at Superfund sites, see the references listed at the end of this document [5, 42].

Evaluate Public Reaction to the Presumptive Remedy Options

If the public reacts favorably to one or more of the presumptive remedy options, site managers should proceed to the next step of the presumptive remedy process. However, if the public does not react favorably to any of the presumptive remedy options under consideration, site managers may wish to consider reviewing non-presumptive technologies, including innovative technologies, to determine if there are other options that may receive greater community acceptance while providing for sufficient overall protection of human health and the environment. If this is the case, a conventional RI/FS or EE/CA could be performed, or the FS could consider the presumptive remedy plus any specific alternatives believed to warrant consideration to establish a site-specific Administrative Record that supports the selection of a technology that is not specifically identified as a presumptive remedy. Site managers should note that all alternatives should generally be evaluated in a full nine-

criteria analysis, even if objections are raised by members of the community. However, if opposition is intense, it may be justifiable to screen out an alternative early in the process for reasons of implementability.

6. **Conduct Time-Critical Removal Action, if Necessary.** Information from site characterization activities may indicate that the performance of a time-critical removal action is warranted. If so, site managers should conduct the removal action in accordance with the NCP and EPA removal program guidance. If subsequent non-time-critical removal actions or remedial actions are still required at the site, site managers should follow the presumptive remedy process, if appropriate.

7. **Identification of New Contaminants.** Continuing site characterization efforts performed under Step 4 may, at any time, identify new contaminants at the site. Newly identified contaminants should be evaluated to determine if their presence precludes using presumptive remedy technologies or makes the use of these technologies inappropriate. For example, the detection of significant DNAPL contamination of ground water at a site may indicate that contaminated soils, sediments, or sludges do not pose a principal human health and environmental threat and, therefore, may not require treatment or may only need to be contained. In these situations, site managers should follow the presumptive remedy approach for contaminated ground-water sites, when available. If newly identified contaminants do preclude or make inappropriate the use of a presumptive remedy identified in this document, this directive may not be applicable and the conventional RI/FS or EE/CA process may need to be followed.

8. **Refine PRGs. Is There a Need for Further Action?** Using additional information obtained from the site-specific baseline risk assessment, site managers should determine whether the site poses an unacceptable risk to human health or the environment. If the site does not pose an unacceptable risk, no further action is required. However, if it appears that an unacceptable risk does exist, site managers should proceed to the next step in the presumptive remedy process. Information from the baseline risk assessment should be used to refine the PRGs for the site.

9. **Proceed with Technology Assessment and Review "Practical Considerations."** After it has been determined that a cleanup action is warranted at the site, site managers should review the different presumptive remedy options and identify a proposed option. For a remedial action, presumptive remedy options must be evaluated against the nine criteria required by section 300.430(e)(9) of the NCP; this should be documented in the detailed analysis section of an FS or Focused FS. Appendix A of this document summarizes the analysis EPA conducted on FSs/RODs for wood treater sites with contaminated soils, sediments, or sludges, and Appendix B provides generic evaluations of the different presumptive remedies against seven of the nine remedial criteria (excluding state and community acceptance). Both of these appendices should be used to streamline the detailed analysis phase of the FS. Appendices A and B can also be used to streamline the evaluation of removal action alternatives in an EE/CA. The generic analyses in Appendix B should be supplemented with site-specific information for the final response selection. During technology assessment, the factors listed in the "Practical Considerations" section (Box E) of this document should be reviewed to ensure a comprehensive evaluation of response alternatives.

10. **Begin the Technology Selection Process Based on the Types of Contamination Present at the Site.** If the only contaminants present at significant levels (i.e., levels that may justify treatment) are inorganics, site managers should follow Path A in Figure 1 (i.e., proceed to Step 11) and evaluate the feasibility of immobilization. If the only contaminants present at significant levels are organics, site managers should follow Path B in Figure 1 (i.e., proceed to Step 12) and evaluate the feasibility of bioremediation. In situations where significant levels of both inorganic and organic contamination are present at the site, site managers should follow Paths A and B concurrently. In these situations, a treatment train should be implemented that uses bioremediation, thermal desorption, and/or incineration to address the organic contaminants and immobilization to address the inorganic contaminants.

11. **Is Immobilization Feasible?** Immobilization is the primary presumptive remedy for addressing significant levels of inorganic contamination in soils, sediments, and sludges at wood treater sites. If immobilization is not considered feasible for addressing inorganic contaminants present at the site, this document is not applicable and site managers should review other non-presumptive

technologies. If the use of immobilization is feasible, site managers should proceed to Step 15.

12. **Is Bioremediation Feasible?** Bioremediation is the primary presumptive remedy for treating organic contamination of soils, sediments, and sludges at wood treater sites. However, the effectiveness of bioremediation is very site- and contaminant-specific. In addition, implementation of bioremediation remedies requires considerably more time than the implementation of the other presumptive remedies (i.e., several years for bioremediation as compared to approximately six months to a year for thermal desorption and incineration). Bioremediation can successfully treat soils, sediments, and sludges contaminated with organic contaminants such as halogenated phenols and cresols, other polar organic compounds, non-halogenated aromatics, and PAHs (particularly 2- and 3-, and often 4-ring compounds). However, bioremediation may not be feasible if a site exhibits high levels of concentrated residual creosote or dioxins and furans. Pilot/treatability study testing should be conducted to assess the feasibility of using bioremediation at a site. If the use of bioremediation is feasible, site managers should proceed to Step 15. If the use of bioremediation is not feasible, site managers should assess the use of thermal desorption.

13. **Is Thermal Desorption Feasible?** If bioremediation will not be sufficiently effective in achieving PRGs for the site, thermal desorption should be considered as the presumptive remedy for addressing organic contamination. Treatability studies should be conducted (including a Proof of Performance test if dioxin and/or furan formation is a concern) to ensure that thermal desorption is feasible for the site and will achieve the desired PRGs. If the use of thermal desorption is feasible, site managers should proceed to Step 15. If the use of thermal desorption is not feasible, site managers should assess the use of incineration.

14. **Is Incineration Feasible?** If high contaminant concentrations and/or treatability testing indicate that thermal desorption will not achieve the desired PRGs for the site, incineration should be considered as the presumptive remedy. If the use of incineration is feasible for the site, site managers should proceed to Step 15. If none of the three presumptive remedy options for treating organic contaminants are considered feasible for the site, this document is not applicable and site managers should review other non-presumptive technologies.

15. **Proceed with ROD or Action Memorandum.** At this point in the process, site managers should possess sufficient information to set final remediation goals and identify a preferred presumptive remedy option. This preferred option should be presented to the public for review and comment in the proposed plan. Because substantial community input has already been factored into the remedy selection process under Step 5, it is envisioned that significant negative input from the public should not be received at this point.

    The final step in the selection of a presumptive remedy is to document the decision in a ROD for a remedial action or an Action Memorandum for a removal action. As was discussed above, if a presumptive remedy is selected in the ROD or Action Memorandum, a copy of this document and its accompanying attachments must be included in the Administrative Record for the site. These materials will assist in justifying the selection of the presumptive remedy, and will support the elimination of the initial screening step of the FS or EE/CA and the streamlining of the detailed analysis phase of the FS or EE/CA.

CONCLUSION

The presumptive remedies for cleaning up soils, sediments, and sludges at wood treater sites that are contaminated primarily with creosote, PCP, or CCA are bioremediation, thermal desorption, incineration, and immobilization. Bioremediation is the primary presumptive remedy for treating organic contaminants, followed by thermal desorption and incineration, respectively. Immobilization is the primary presumptive remedy for treating inorganic contaminants. Based on site-specific information and remediation goals established for the site, one or more of these treatment technologies should be selected. If a wood treater site does not meet the conditions described in this document, the document is not applicable and the conventional remedy selection process should be followed.

BOX D
Background Information on NAPL Contamination

A non-aqueous phase liquid (NAPL) is a liquid that, in its pure form, does not readily mix with water but slowly partitions into the water phase. Dense NAPLs (DNAPLs) sink in water, while light NAPLs (LNAPLs) float on water. When present in the subsurface, NAPLs slowly release vapor and dissolved phase contaminants, resulting in a zone of contaminant vapors above the water table and a plume of dissolved contaminants below the water table. The term NAPL refers to the undissolved liquid phase of a chemical or mixture of compounds, and not to the vapor or dissolved phases. NAPLs may be present in the subsurface as either "free-phase" or "residual-phase" NAPLs. The free-phase is that portion of the NAPL that can continue to migrate and can flow into a well. The residual-phase is that portion trapped in pore spaces by capillary forces, which cannot generally flow into a well or migrate as a separate liquid. Both residual- and free-phase NAPLs are sources of vapors and dissolved contaminants.

The most common LNAPLs are petroleum fuels, crude oils, and related chemicals, which tend to be associated with facilities that refine, store, or transport these liquids. The following factors tend to make LNAPLs generally easier to locate and clean up than DNAPLs: (1) LNAPL contamination tends to be more shallow than DNAPL contamination; (2) LNAPLs tend to be found at the water table; and (3) LNAPLs are usually associated with specific types of facilities. However, LNAPL contamination that is trapped in soil pores below the water table may not be significantly easier to remediate than DNAPL contamination in the saturated zone.

DNAPLs pose difficult cleanup problems. These contaminants include chemical compounds and mixtures with a wide range of chemical properties, including chlorinated solvents, creosote, coal tars, PCBs, PCP, and some pesticides. Some DNAPLs, such as coal tars, are viscous chemical mixtures that move very slowly in the subsurface. Other DNAPLs, such as some chlorinated solvents, can travel very rapidly in the subsurface because they are heavier and less viscous than water. A large DNAPL spill not only sinks vertically downward under gravity, but can spread laterally with increasing depth as it encounters finer grained layers. These chemicals can also contaminate more than one aquifer by penetrating fractures in the geologic layer that separates a shallow aquifer from a deeper aquifer. Thus, large releases of DNAPLs can penetrate to great depths and can be very difficult to locate and clean up.

The contamination problem at DNAPL sites has two different components: (1) the aqueous contaminant plume, and (2) the DNAPL zone, as shown in Figures D-1 and D-2. The aqueous contaminant plume includes those portions of the site where only dissolved contaminants are present in ground water. The DNAPL zone includes those portions of the site where immiscible liquids are present in the subsurface, either as free-phase or residual-phase compounds. Depending on the volume of the release and the subsurface geology, the DNAPL zone may extend to great depths and over large lateral distances from the entry location.

For a more detailed discussion on DNAPL contamination, see the references listed at the end of this document [7, 10, 11, 12, 13, 15, 17].

BOX D
Background Information on NAPL Contamination
(continued)

FIGURE D-1
Components of DNAPL Sites

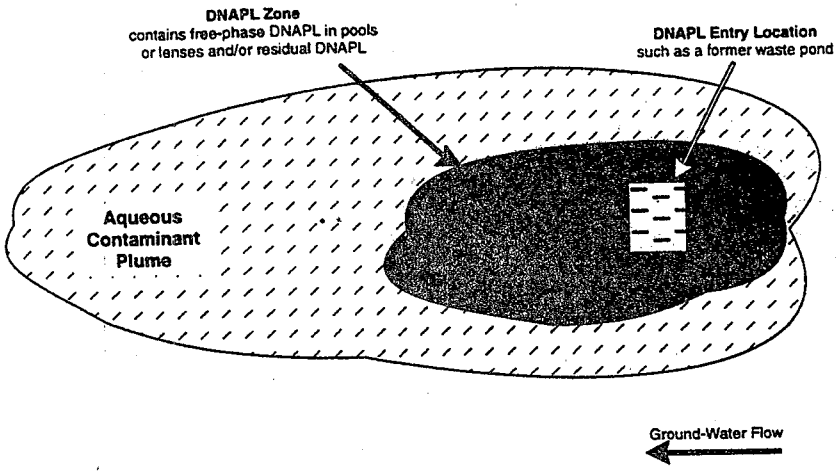
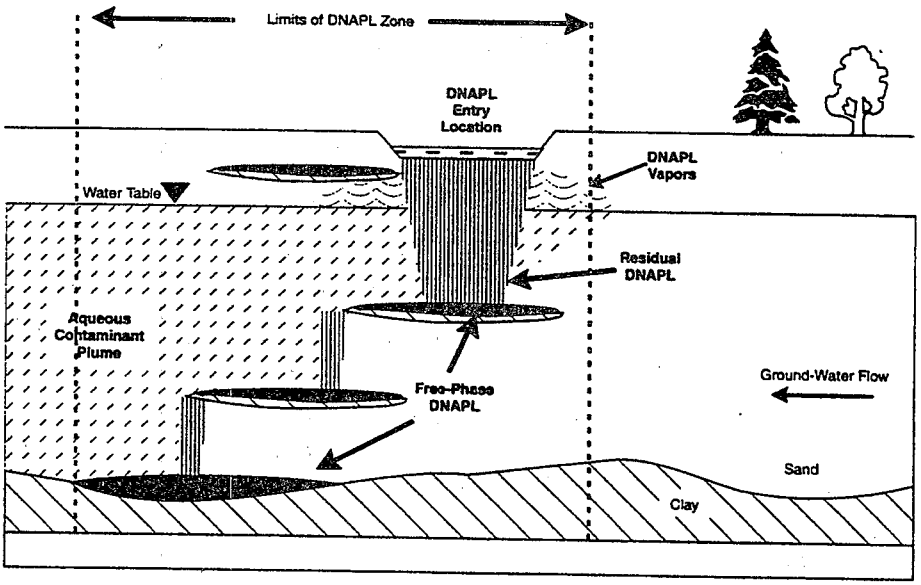


FIGURE D-2
Types of DNAPL Contamination and Contaminant Zones at DNAPL Sites
(Cross-Sectional View)



BOX E
Practical Considerations

Land use: In general, remedial action objectives should be formulated to identify response alternatives that will achieve cleanup levels appropriate for the reasonably anticipated future land use of a site. Early community involvement, with a particular focus on the community's desired future uses of property associated with the site, should result in a more democratic decisionmaking process, greater community support for remedies selected as a result of this process, and, in many cases, more expedited cleanups. Factors to consider may include: any recommendations or views expressed by members of the affected community; the land use history and current uses of the facility and surrounding properties, and recent development patterns where the facility is located; and the proximity of the contamination to residences, sensitive populations or ecosystems, natural resources, or areas of unique historic or cultural significance. For example, if it is anticipated that a site will be used for future industrial/commercial development, it may be appropriate to select a presumptive remedy (e.g., *in situ* bioremediation) that results in higher residual contaminant levels but is less costly than other options. EPA has developed guidance on land use in the Superfund remedy selection process [27].

Institutional and/or engineering controls: It may be appropriate to use institutional and/or engineering controls in conjunction with the presumptive remedy technologies described in this document to reduce current or potential human exposure via direct contact with contaminated soils, sediments, and sludges or through the use of contaminated ground water. Engineering controls are physical systems requiring construction and maintenance, such as soil caps, caps with liners, and vertical barrier walls. Institutional controls include the use of physical barriers, such as fences and warning signs, and the use of administrative restrictions, such as deed or lease restrictions. When vigorously enforced, institutional controls limit direct contact with and ingestion of soils, sediments, and sludges; however, unlike some engineering controls (e.g., caps), institutional controls do not reduce the potential for wind dispersal and inhalation of contaminants. Monitoring is generally needed to determine the effectiveness of institutional and/or engineering controls.

Institutional and/or engineering controls alone do not satisfy CERCLA's preference for achieving reductions of toxicity, mobility, or volume through treatment as a principal element of the remedy. Consequently, they are not generally recommended as the sole response to address contaminants that are deemed a principal threat at wood treater sites. However, the use of institutional and/or engineering controls after the treatment of a principal threat by one or more of the presumptive remedy technologies can enhance the long-term reliability of the remedy.

A cap is an engineering control that may be particularly useful in improving the overall protection of a presumptive remedy. A simple cap may involve only covering the treated area with uncontaminated native soil and/or seeding, fertilizing, and watering the area until vegetation has been established. A simple cap (soil only) may be appropriate for situations where direct contact and/or erosion are the prime threats, and is particularly appropriate following bioremediation because it ensures oxygen availability for continuing biodegradation. Caps that are intended to prevent surface water infiltration are typically comprised of soil and several other components, including a drainage layer, a geomembrane, and a compacted clay layer. Such caps, in addition to being effective in limiting direct contact exposure and reducing erosion, are also effective in limiting surface water infiltration, minimizing the vertical migration of residual contaminants, and minimizing ground-water contamination. However, caps that prevent infiltration will inhibit aerobic biodegradation, which generally makes the use of such caps following bioremediation inappropriate. For a more detailed discussion on the factors affecting the appropriate uses of caps, refer to the references listed at the end of this document [14, 18, 29].

BOX E
Practical Considerations
(continued)

Treatment trains: A single technology may not be sufficient to clean up an entire wood treater site. Remediation of sites often requires a combination of control and treatment options in order to sufficiently reduce toxicity and immobilize contaminants. The treatment train concept combines pretreatment and/or post-treatment activities with treatment technologies to achieve site-specific objectives and acceptable residual contaminant levels. For example, the implementation of a remedy might include institutional controls to control direct contact exposure, bioremediation to treat organic contamination (including excavation, capping, and monitoring activities), and immobilization to treat residual inorganic contamination. The pretreatment and post-treatment portions of the treatment train should be selected based on site-specific considerations.

"Hot spots": Hot spots (e.g., highly contaminated sludges) are generally defined as discrete areas within a site that contain hazardous substances, pollutants, or contaminants that are present in high concentrations, are highly mobile, or cannot be reliably contained, and would present a significant risk to human health or the environment should exposure occur. Hot spots will usually be considered principal threats at a site, as defined by the NCP. Site managers should be aware that the limitations of certain presumptive remedies (e.g., bioremediation) may preclude their use in cleaning up certain hot spots. In addition, responding to hot spots may require additional pretreatment and post-treatment activities, such as the use of institutional controls or capping. (For additional information, see the references listed at the end of this document [23].)

Land disposal restrictions (LDRs): All technologies that treat hazardous waste *ex situ* may cause the waste being treated to be subject to RCRA LDRs. *In situ* treatment of hazardous waste does not trigger LDRs because "placement" of the waste does not occur. LDRs establish treatment standards that must be met before a waste can be land disposed. These treatment standards are either concentration-based (hazardous constituents must be reduced to a set concentration) or, less frequently, technology-based (waste must be treated using a specified technology). EPA has promulgated LDR treatment standards for specific wood preserving wastes (K001 - sediments and sludges from the treatment of wastewaters resulting from processes using creosote or PCP) and anticipates proposing treatment standards for other wood preserving wastewaters in 1995. The Agency has also promulgated LDR treatment standards for RCRA characteristic wastes. If a wood treater waste exhibits one or more of the identified hazardous characteristics, it is subject to RCRA LDRs.

Wood treater wastes that qualify as "remediation wastes" and are placed in a Corrective Action Management Unit (CAMU, see 58 FR 8658-8685), whether at a Superfund site or RCRA corrective action site, do not have to meet LDRs. (Whether LDRs are triggered depends on whether remediation wastes are "placed" in a land-based unit, not on whether they are treated. LDRs do not apply to remediation wastes treated on-site and then placed in a CAMU.) The EPA Region is responsible for setting site-specific requirements for a CAMU, which could include LDRs. The LDR program also provides four exceptions to meeting LDRs that may be applicable to wood treater sites: (1) the treatability variance (see 40 CFR 268.44); (2) equivalent treatment; (3) the no-migration exemption (see 40 CFR 268.6); and (4) de-listing. The treatability variance is anticipated to be the primary route of compliance with LDRs for contaminated soil and debris; for more information, see the references at the end of this document [39, 40]. Site managers should consult with Regional RCRA program staff when addressing LDR issues at specific wood treater sites.

TABLE 2
Comparison of Presumptive Remedy Technologies

Note: Performance represents a range of treatability data. A number of variables, such as concentration and distribution of contaminants, matrix particle size, and moisture content can affect system performance. Bench- (B), pilot- (P), or full-scale (F) performance data may not be available for all contaminants. The performance efficiency data are taken from U.S. EPA's Contaminants and Remedial Options at Wood Preserving Sites [8], unless noted otherwise.

TECHNOLOGY	PERFORMANCE	ADVANTAGES	LIMITATIONS	COST
Bioremediation (*ex situ*)	64 - 95% for PAHs, 78 - 98% for chlorophenols (F)[1]	• More suitable for higher concentrations of organic contaminants than *in situ* processes. • Solid-phase treatment has been successfully demonstrated at wood treater sites. • Generally receives wide community acceptance.	• May require treatability studies due to a scarcity of full-scale performance data. Bench- or pilot-studies may be necessary. • Efficiency limited by lack of indigenous microbes, toxic metals, highly chlorinated organics, pH outside of 4.5 - 8.5 range, limited growth factors, or rainfall/ evapotranspiration rate/percolation rate ratio too high or too low. • Increases the volume of treated materials if bulking agents are added. • Excavation and material handling add to costs. • Land treatment of wastes is subject to land disposal restrictions (LDRs), unless "no-migration" is demonstrated.	$50 - $150 per cubic yard of soil, sediment, or sludge; or approximately $40 - $125 per ton of soil, sediment, or sludge.

[1] These data represent current full-scale performance data for bioremediation conducted at three U.S. wood treater sites (all three of which are listed on the NPL) and one Canadian wood treater site. The use of bioremediation at these four sites achieved remediation goals in all cases. Because the monitoring of biodegradation at these sites stopped after remediation goals were achieved, actual performance efficiencies at these sites may be higher than these numbers indicate. For a more detailed discussion of these performance data, see "Full-Scale Performance Data on the Use of Bioremediation at Wood Treater Sites," a technical background document supporting the wood treater site presumptive remedy initiative that is available at EPA Headquarters and Regional Offices. EPA's Contaminants and Remedial Options at Wood Preserving Sites (1992) [8] provides the following pilot-scale performance data for bioremediation: an average of 87% for PAHs and 74% for halogenated phenols and cresols. The effectiveness of bioremediation tends to be highly variable and very site-specific. A significant component of this variability is the range of effectiveness in the remediation of different kinds of PAHs; studies on the bioremediation of creosote contamination indicate that bioremediation works well on 2-, 3-, and often 4-ring PAHs, but generally not as well on 5- or 6-ring PAHs. For example, the use of *ex situ* bioremediation at one of the wood treater NPL sites resulted in 95% removal of 2-ring PAHs, 83% removal of 3-ring PAHs, and 64% removal of 4+-ring PAHs. To obtain additional performance data for bioremediation, contact the U.S. EPA's Center for Environmental Research Information (CERI) at: 26 W. Martin Luther King Drive, Cincinnati, Ohio 45268. CERI maintains a bioremediation data base called "Bioremediation in the Field Search System" (BFSS), which may be accessed electronically through bulletin boards at (301) 589-8366 or (513) 569-7610.

TABLE 2
Comparison of Presumptive Remedy Technologies
(continued)

TECHNOLOGY	PERFORMANCE	ADVANTAGES	LIMITATIONS	COST
Bioremediation (*in situ*)	51% for PAHs, 72% for PCP (F)[2]	• Suitable for moderate concentrations of organic contaminants. • Can destroy organic contaminants in place without the high costs of excavation and material handling. • Minimizes the release of volatile contaminants into the air. • Generally receives wide community acceptance.	• May require treatability studies due to a scarcity of full-scale performance data. Bench- or pilot-scale studies may be necessary. • Efficiency limited by lack of indigenous microbes, toxic metals, highly chlorinated organics (e.g., even high levels of PCP), pH outside of 4.5 - 8.5 range, limited growth factors, non-uniform contaminant distribution, or rainfall/evapotranspiration rate/percolation rate ratio too high or too low. For example, low-permeability soils can hinder performance; however, hydraulic fracturing or other methods may be used to overcome this problem, at higher operating costs. • Cannot be used to directly destroy concentrated masses of non-aqueous phase liquids (NAPLs).	$50 - $100 per cubic yard of soil, sediment, or sludge.

[2] These data represent current full-scale performance data from a bioremediation demonstration project conducted at a Canadian wood treater site. Because the monitoring of biodegradation at this site stopped after a certain point, actual performance efficiencies at this site may be higher than these numbers indicate. For a more detailed discussion of these performance data, see "Full-Scale Performance Data on the Use of Bioremediation at Wood Treater Sites," a technical background document supporting the wood treater site presumptive remedy initiative that is available at EPA Headquarters and Regional Offices. EPA's Contaminants and Remedial Options at Wood Preserving Sites (1992) [8] provides the following pilot-scale performance data for bioremediation: an average of 87% for PAHs and 74% for halogenated phenols and cresols. The effectiveness of bioremediation tends to be highly variable and very site-specific. A significant component of this variability is the range of effectiveness in the remediation of different kinds of PAHs; studies on the bioremediation of creosote contamination indicate that bioremediation works well on 2-, 3-, and often 4-ring PAHs, but generally not as well on 5- or 6-ring PAHs. In practice, *in situ* bioremediation typically results in lower performance efficiencies than the *ex situ* process because *in situ* reactions are less controlled and involve lower mass transfer rates. To obtain additional performance data for bioremediation, contact the U.S. EPA's Center for Environmental Research Information (CERI) at: 26 W. Martin Luther King Drive, Cincinnati, Ohio 45268. CERI maintains a bioremediation data base called "Bioremediation in the Field Search System" (BFSS), which may be accessed electronically through bulletin boards at (301) 589-8366 or (513) 569-7610.

TABLE 2
Comparison of Presumptive Remedy Technologies
(continued)

TECHNOLOGY	PERFORMANCE	ADVANTAGES	LIMITATIONS	COST
Thermal Desorption	82 - 99% (B,P,F)	• Thermal treatments are well-established technologies for treating organic-contaminated media. • Thermal desorption can often produce a treated waste that meets treatment levels set by the Best Demonstrated Available Technology (BDAT) requirements of the RCRA land disposal ban.	• May warrant treatability studies due to a scarcity of full-scale performance data. Bench- or pilot-studies may be necessary. • Design and operation of unit and associated air pollution control devices must take into account the possible presence of halogenated organics, mercury, or corrosive contaminants. • Inorganic constituents that are not particularly volatile will not be effectively removed by thermal desorption. • If chlorine or chlorinated compounds are present, some volatilization of inorganic constituents in the waste may occur. • The contaminated medium must contain at least 20 - 30% solids in order to facilitate placement of waste material into treatment equipment. • Wastes with high-moisture content may need to be dewatered prior to processing in order to control costs and achieve desired performance. • Material handling of soils, sediments, or sludges that are tightly aggregated or largely clay can result in poor processing performance due to caking.	$150 - $400 per ton of soil, sediment, or sludge, excluding excavation, material handling, or disposal costs.

TABLE 2
Comparison of Presumptive Remedy Technologies
(continued)

TECHNOLOGY	PERFORMANCE	ADVANTAGES	LIMITATIONS	COST
Thermal Desorption (continued)			• If a high fraction of fine silt or clay exists in the matrix, fugitive dusts will be generated and a greater dust loading will be placed on the downstream air pollution control equipment. • The total organic loading is limited by some thermal treatment systems to 10% or less to ensure that Lower Explosive Limits (LELs) are not exceeded. • A medium exhibiting a very high pH (greater than 11) or low pH (less than 5) may corrode thermal system components. • The treatment process may alter the physical properties of the treated material, particularly where waste matrices have a high clay content. The treated product should be evaluated to determine if the product should be mixed with other stabilizing materials or compacted. • Excavation and material handling add to costs. • With chlorinated feed, potential for dioxin and/or furan formation exists. Systems must be designed and operated carefully. • A full-scale Proof of Performance test, with dioxin and furan analysis if chlorinated feed is present, should precede cleanup operations.	

TABLE 2
Comparison of Presumptive Remedy Technologies
(continued)

TECHNOLOGY	PERFORMANCE	ADVANTAGES	LIMITATIONS	COST
Incineration	90 - 99% (B,P,F)	• Ensures that specified cleanup levels can be achieved for a given site. • Can effectively remove nearly all contamination.	• High moisture content reduces capacity of incinerator. • Incineration of large volumes of contaminants may be prohibitively expensive. • Efficiency may be limited by high alkali metals or elevated levels of mercury or organic phosphorous. • If a high fraction of fine silt or clay exists in the matrix, fugitive dusts will be generated and a greater dust loading will be placed on the downstream air pollution control equipment. • A medium exhibiting a very high pH (greater than 11) or low pH (less than 5) may corrode incineration system components. • Excavation and material handling add to costs. • On-site incineration has the potential for community concern/opposition.	$150 - $400 per ton of soil, sediment, or sludge, excluding excavation, material handling, or disposal costs.

TABLE 2
Comparison of Presumptive Remedy Technologies
(continued)

TECHNOLOGY	PERFORMANCE	ADVANTAGES	LIMITATIONS	COST
Immobilization	80 - 90% TCLP[3] (B,P,F)	• Treatability test data indicate that metals in wood preservatives are amenable to solidification/stabilization. • Prevents/mitigates ground-water contamination. • Controls population exposure. • Effectively contains contaminants. • Reduces air emissions.	• High levels of organic compounds can retard or prevent setting of typical solidification/stabilization matrices. • The particular solidification/stabilization system that will perform well on a given contaminated material must be determined by site-specific screening and treatability tests. • Efficiency may be limited by total petroleum hydrocarbon (TPH) content greater than 1%, or humic matter greater than 20%.	$75 - $400 per ton (with landfilling on-site) and $100 - $500 per ton (with landfilling 200 miles off-site).
Capping	N/A (not a treatment technology)	• Capping reduces surface-water infiltration, reduces gas and odor emissions, improves aesthetics, and provides a stable surface over the waste. • Reduces direct contact exposure.	• Capping costs escalate as a function of topographic relief. • Does not treat contamination; contamination is left in place. • May slow down natural bioremediation processes.	$1 - $16 per cubic yard of capping material.

[3] TCLP (toxicity characteristic leaching procedure) is a specific analytical method; this method has been widely used in the past to evaluate the performance of immobilization. However, current information indicates that the SPLP (synthetic precipitation leaching procedure) or other procedures using distilled or site-specific water will produce more accurate results.

TABLE 3-A
Data Requirements for Bioremediation

DATA REQUIREMENT	IMPORTANCE OF INFORMATION
General Data Requirements	
Biochemical oxygen demand (BOD)	Provides estimate of biological treatability of soil, sediment, or sludge.
Chemical oxygen demand (COD)	Another estimate of biological treatability. The measure of the oxygen equivalent of organic content that can be oxidized by a strong chemical oxidant.
Contaminant solubility	Components with low solubility are difficult to remove from soil, sediment, or sludge because of low bioavailability.
Degradation rates of contaminants	Should be determined through treatability studies. Important to determine applicability of remedy.
Indigenous microorganisms	The PAH biodegradation activity of indigenous organisms must be measured to determine if appropriate microorganisms are present in sufficient quantity.
Inorganic contaminants	Important to determine applicability of remedy.
Limiting initial and final concentrations of contaminants	Should be determined through treatability studies with respect to the specific process.
Metals, inorganic salts concentrations	High metal concentrations may inhibit microbial activity. Some inorganic salts are necessary for biological activity.
Moisture content	May inhibit solid-phase aerobic remediation of soils, sediments, or sludges if greater than 80% of field capacity; soil, sediment, and sludge remediation inhibited if less than 40% of field capacity. Soil slurry reactors may operate with 80-90% moisture content (water/weight of soil).
Nutrients	Lack of certain nutrients reduces activity.
Oil and grease content	Oil and grease concentrations may inhibit soil, sediment, and sludge remediation at concentrations greater than 5% by weight, which may result in unacceptable lag times.
Organic content	Important to determine applicability of remedy. Important to determine horizontal and vertical extent of contaminants and to ensure that appropriate detection limits are used.
Particle size	Particle size affects access and contact between microorganisms, contaminants, nutrients, water, and electron acceptors.
Total organic carbon (TOC)	Indicates total organic carbon present and can be used to estimate waste available for biodegradation.

TABLE 3-A
Data Requirements for Bioremediation
(continued)

DATA REQUIREMENT	IMPORTANCE OF INFORMATION
General Data Requirements (continued)	
Variable waste composition	Large variations affect biological activity.
Redox potential (Eh)	Aerobic degradation: oxidation-reduction potential of the soil, sediment, or sludge must be greater than that of the organic contaminant for oxidation to occur.
Specific *In Situ* Data Requirements	
Soil, sediment, or sludge temperature	High or low temperatures affect microbial activity for *in situ* treatment (high temperatures tend to increase activity, low temperatures tend to decrease activity).
Position of water table	Important for remedy selection and implementation.
Site geology	Important to determine mass transfer capability.
Soil, sediment, or sludge permeability	Affects movement of water, oxygen, and nutrients for *in situ* treatment.
Specific *Ex Situ* Data Requirements	
Toxicity Characteristic Leaching Procedure (TCLP) analysis	Needed to determine if the soil, sediment, or sludge is a RCRA hazardous waste.

TABLE 3-B
Data Requirements for Thermal Desorption

DATA REQUIREMENT	IMPORTANCE OF INFORMATION
Bulk density of soil, sediment, or sludge	Used in converting weight to volume in material handling calculations.
Contaminant physical properties	Information on physical properties, such as boiling point, determines the required characteristics of the thermal desorption unit.
Inorganic contaminants	Important to determine applicability of remedy.
Metals content	Metals (As, Cd, Cr, Pb, Zn) can vaporize at high temperatures and must be removed from emissions.
Extent of organic contaminants	Need to determine horizontal and vertical extent of organic contamination to be excavated.
Moisture content	High moisture content increases feed handling and energy requirements.
Sulfur, chlorine, and organic phosphorous content	Contribute to acid gas formations at high concentrations.
Particle size	Oversized debris hinders processing. Fine particles can result in high particulate loading in flue gasses. Clay content will impede material handling and may interfere with waste processing.
pH	Extreme pH may be harmful to equipment.
Salt content	High salt content, depending on temperature, may cause material in the thermal unit to slag.
Soil, sediment, or sludge plasticity	Plastic soil, sediment, or sludge, when subjected to compressive forces, can become molded into large particles that are difficult to heat.
Toxicity Characteristic Leaching Procedure (TCLP) analysis	Needed to determine if the soil, sediment, or sludge is a RCRA hazardous or listed waste.
Flash point of soil, sediment, or sludge	Important to determine safe temperature parameters for the desorber unit.
Total organic carbon (TOC)	Provides estimate of material available for combustion, which may affect the temperature range available for thermal desorption.
Total chloride	Influences metal partitioning to the gas phase.

TABLE 3-C
Data Requirements for Incineration

DATA REQUIREMENT	IMPORTANCE OF INFORMATION
Bulk density of soil, sediment, or sludge	Used in converting weight to volume in material handling calculations.
Contaminant combustion characteristics	Required to determine the incinerator's combustion characteristics.
Heating value	Affects throughput and energy requirements.
Inorganic contaminants	Important to determine applicability of remedy.
Metals content	Metals (As, Cd, Cr, Pb, Zn) can vaporize at high temperatures and are difficult to remove from emissions.
Extent of organic contaminants	Need to determine horizontal and vertical extent of organic contamination to be excavated due to cost concerns.
Moisture content	High moisture content increases feed handling and energy requirements.
Sulfur, chlorine, and organic phosphorous content	Contribute to acid gas formations at high concentrations.
Particle size	Oversized debris hinders processing. Fine particles can result in high particulate loading in flue gasses.
pH	Extreme pH may be harmful to equipment.
Salt content	High salt content will cause material in the incinerator to slag.
Soil, sediment, or sludge plasticity	Plastic soil, sediment, or sludge, when subject to compressive forces, can become molded into large particles that are difficult to heat.
Toxicity Characteristic Leaching Procedure (TCLP) analysis	Needed to determine if soil, sediment, or sludge is a RCRA hazardous or listed waste.
Total organic carbon (TOC)	Provides estimate of material available for combustion.

TABLE 3-D
Data Requirements for Immobilization

DATA REQUIREMENT	IMPORTANCE OF INFORMATION
Coal or lignite content	May affect product quality.
Cyanides content	Affects bonding (greater than 3,000 ppm).
Halide content	Retards setting; leaches easily.
Inorganic salts content	Reduces product strength and affects curing rates (soluble salts of Mn, Sn, Zn, Cu, and Pb).
Metals content	Important for process considerations.
Phosphate concentration	Phosphate is a key reagent in some solidification/stabilization mixes to reduce metals (especially Pb) solubility; in high concentrations, phosphate may cause problems.
Oil and grease content[1]	Affects cementation, mix design, and cost.
Organic content[1]	Affects cementation, mix design, and cost.
Particle size	Affects bonding (if less than 200 mesh or greater than 1/4 inch diameter). Concrete is able to use larger particles.
Phenol concentration	Affects product strength (greater than 5%).
Sodium arsenate, borate, phosphate, iodate, sulfide, sulfate, carbohydrate concentrations	Retards setting and affects product strength.
Solids content	Low solids content indicates that de-watering is needed.
Semi-volatile organics	Requires the use of special mixes, and may inhibit bonding (if greater than 10,000 ppm).
Volatile organic concentrations	Volatiles have not been successfully treated with solidification/stabilization alone; volatiles should be removed or otherwise treated.

[1] Immobilization with lime or proprietary additives has been used to treat oily soils and petroleum sludge at petroleum industry sites; however, the structural properties of the product are poor, even when the material passes the TCLP (Toxicity Characteristic Leaching Procedure). High concentrations (e.g., greater than 20%) of naturally-occurring humic matter may also interfere with cement-based processes, but some success with higher levels of organics has been reported using modified lime products.

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES

This Appendix summarizes the analyses that EPA conducted on Feasibility Study (FS) and Record of Decision (ROD) data from Superfund wood treater sites, which led to establishing bioremediation, thermal desorption, incineration, and immobilization as the presumptive remedies for wood treater sites with contaminated soils, sediments, and sludges. The analyses consisted of the following activities:

- Identifying wood treater sites;
- Determining the frequency of technology selection for wood treater sites;
- Identifying sites for the FS/ROD analysis; and
- Conducting the FS/ROD analysis.

Results of the FS/ROD analysis, along with a technical analysis of performance data on technology application, are part of the Administrative Record for this directive, which is available at EPA Headquarters and the Regional Offices. These analyses provide support for the decision to eliminate the initial alternatives identification and screening step for this site type. These analyses found that certain technologies are appropriately screened out based on effectiveness, implementability, and/or cost. Review of technologies against the nine remedial criteria led to elimination of additional alternatives. A discussion of each of the analyses is provided below.

Identification of the Universe of Wood Treater Sites

EPA identified the universe of wood treater sites listed on the National Priorities List from information contained in the following two sources: (1) *Contaminants and Remedial Options at Wood Preserving Sites*, U.S. EPA, EPA/600/R-92/182, 1992; and (2) *Innovative Treatment Technologies: Annual Status Report (Sixth Edition)*, U.S. EPA, EPA 542-R-94-005, 1994. The first source contained comprehensive lists of NPL and non-NPL wood treater sites prior to 1992. The second source contained information, current as of 1994, on the status of the implementation of innovative treatment technologies at a wide range of sites, including wood treater sites. By cross-checking the information in both of these documents, an overall list of 58 NPL wood treater sites was identified.

Frequency of Technology Selection for Wood Treater Sites

Table A-1 presents the distribution of remedial technologies selected at 52 of the 58 NPL wood treater sites (data on remedy selection were not available for the remaining six sites). These data were obtained from the two sources cited above and EPA's Superfund Records of Decision CD-ROM data base (March 1995). Table A-1 demonstrates that the four wood treater site presumptive remedies (bioremediation, thermal desorption, incineration, and immobilization) together were selected more often (39 out of the 50 sites for which remedy selection information was available, or approximately 78% of the time) than the other applicable technologies. Bioremediation, the primary presumptive remedy for treating organic contamination, was the remedy selected more often than any other technology (18 out of the 50 sites, or approximately 36% of the time).

TABLE A-1
Remedies Selected at NPL Wood Treater Sites

Primary Technologies Selected to Address Contaminated Soils, Sediments, and Sludges at Wood Treater Sites	Total Number of Sites Selecting Technology[1]
Bioremediation	18
Thermal Desorption	3
Incineration	13
Immobilization	13
Dechlorination	2
Solvent Extraction	1
Soil Flushing/Washing	6
Landfilling	4
Institutional Controls/Monitoring	2
To Be Determined[2]	2

[1] The total number of primary technologies selected is greater than the total of 50 sites for which remedy selection data were available because several sites selected more than one primary technology to address the principal threat of contaminated soils, sediments, and sludges (e.g., bioremediation to treat organic contamination and immobilization to treat inorganic contamination). Secondary technologies selected as part of a treatment train are not documented in this table.

[2] Remedial technology for contaminated soils, sediments, and/or sludges not yet selected.

Identification of Sites for the FS/ROD Analysis

The purpose of the FS/ROD analysis was to document the technology screening step and the detailed analysis in the FSs/RODs of wood treater sites, and to identify the principal reasons given for eliminating technologies from further consideration. To achieve a representative sample of FSs/RODs for the analysis, sites were selected according to the following criteria:

- Sites were chosen to ensure a balanced distribution among the primary technologies for addressing contaminated soils, sediments, and sludges at wood treater sites (i.e., bioremediation, thermal desorption, incineration, immobilization, dechlorination, solvent extraction, soil flushing/washing, landfilling, and institutional controls/monitoring); and

- Sites were chosen to ensure an even distribution in geographic location and ROD signature date.

Using these criteria, a set of 25 NPL wood treater sites was chosen for the FS/ROD analysis; this represents approximately 43% of the total universe of NPL wood treater sites.

FS/ROD Analysis

The FS/ROD analysis involved a review of the technology screening phase, including any pre-screening steps, followed by a review of the detailed analysis and comparative analysis phases in each of the 25 FSs and RODs. Information derived from each review was documented on site-specific data collection forms, which are available for evaluation as part of the Administrative Record for this directive (available at EPA Headquarters and the Regional Offices).

For the screening phase, the full range of technologies considered was listed on the data collection forms, along with the key reasons given for eliminating technologies from further consideration. These reasons were categorized according to the three initial screening criteria: cost, effectiveness, and/or implementability. The frequency with which specific reasons were given for eliminating a technology from further consideration was then tallied and compiled into a screening phase summary table (Table A-2).

For the detailed analysis and comparative analysis, information on the relative performance of each technology/alternative with respect to the nine NCP criteria was documented on the site-specific data collection forms. In most cases, several different remedial technologies were combined in the FSs and RODs to form a remedial alternative or cleanup option. The disadvantages of a technology/alternative were then compiled into a detailed analysis/comparative analysis summary table, under the assumption that these disadvantages contributed to non-selection. The advantages and disadvantages associated with each cleanup option were highlighted. Table A-3 provides the summary information for the detailed analysis and comparative analysis phases.

Tables A-2 and A-3 demonstrate that non-presumptive remedy technologies are consistently eliminated from further consideration in the screening phase due to effectiveness, implementability, and/or excessive costs. In addition, the FS/ROD analysis indicates that, although certain technologies routinely passed the screening phase, these technologies were selected infrequently because they did not provide the best overall performance with respect to the nine criteria. This analysis (in addition to the technical background documentation in the Administrative Record) will support a decision by site managers to bypass the technology identification and screening step for a particular wood treater site and select one or more of the presumptive remedies for contaminated soils, sediments, and sludges. As previously discussed, this document and the accompanying FS/ROD analysis should be part of the Administrative Record for the site. Additional supporting materials not found in the Regional files can be provided by Headquarters, as needed.

APPENDIX A
TABLE A-2: SUMMARY OF INITIAL SCREENING PHASE FOR WOOD TREATER SITES

Remedial Technology or Treatment	# of FSs Technology Was Considered[1]	# of FSs Technology Passed Screening	# of FSs Technology Was Screened Out	# of FSs Where Criterion Contributed to Screening Out[2]		
				Cost	Effectiveness	Implementability
I. Institutional Controls						
A. Restrictions/Monitoring	23	22	1		1	
II. Containment						
A. Capping	42	28	14	5	5	9
1. unspecified	5	5	0			
2. asphalt/concrete	10	4	6	2	3	2
3. soil/bentonite/clay	13	8	5	2		5
4. multi-layer cover system	14	11	3	1	2	2
B. Closure-In-Place/On-Site Encapsulation/Vaults	10	4	6	1	3	5
C. Temporary On-Site Storage Pile	9	7	2			
D. Long-Term On-Site Landfill	16	9	7	1	2	5
III. Immobilization						
A. Solidification/Stabilization	23	15	8	2	7	4
IV. Treatment						
A. Biological Treatments	54	18	36	1	28	19
1. *in situ* bioremediation	18	5	13		12	9
2. *ex situ* bioremediation (e.g., lined land treatment units)	15	8	7		6	3

APPENDIX A
TABLE A-2: SUMMARY OF INITIAL SCREENING PHASE FOR WOOD TREATER SITES (continued)

Remedial Technology or Treatment	# of FSs Technology Was Considered[1]	# of FSs Technology Passed Screening	# of FSs Technology Was Screened Out	# of FSs Where Criterion Contributed to Screening Out[2]		
				Cost	Effectiveness	Implementability
3. off-site landfarming	4	0	4	1	2	3
4. soil/slurry bioreactor	12	5	7		3	2
5. anaerobic treatment	4	0	4		4	1
6. other	1	0	1		1	1
B. Other Thermal Treatments	49	9	40	7	23	20
1. thermal desorption	10	5	5	1	3	1
2. pyrolysis	9	0	9		5	5
3. vitrification	14	2	12	4	8	9
4. wet air oxidation	5	0	5		3	2
5. infrared treatment	9	2	7	2	2	1
6. other	2	0	2		2	2
C. Incineration	43	26	17	9	4	11
1. on-site	23	15	8	3	3	5
2. off-site	20	11	9	6	1	6
D. Chemical Treatments	30	9	21	7	13	12
1. dechlorination	12	4	8	3	5	4
2. solvent extraction	14	5	9	4	4	6
3. other	4	0	4		4	2

APPENDIX A
TABLE A-2: SUMMARY OF INITIAL SCREENING PHASE FOR WOOD TREATER SITES (continued)

Remedial Technology or Treatment	# of FSs Technology Was Considered[1]	# of FSs Technology Passed Screening	# of FSs Technology Was Screened Out	# of FSs Where Criterion Contributed to Screening Out[2]		
				Cost	Effectiveness	Implementability
E. Physical Treatments	42	12	30	5	21	13
1. soil flushing (*in situ*)	14	5	9	1	8	5
2. soil washing (*ex situ*)	19	7	12	2	7	3
3. attenuation (mixing with clean soil)	2	0	2	1	1	2
4. aeration/soil venting	5	0	5	1	3	2
5. macro-encapsulation/ overpacking	1	0	1		1	
6. other	1	0	1		1	1
V. Off-Site Options						
A. Off-Site RCRA Facility	23	19	4	3	1	2
B. Off-Site Sanitary Landfill	3	1	2		1	1
C. Off-Site Recycle/Reuse Facility	3	1	2		1	1

[1] Because several specific technologies within a general technology group (e.g., capping: unspecified capping, asphalt/concrete caps, soil/bentonite/clay caps, and multi-layer cover systems) were considered for each site, the total number of FSs in which a technology group was considered may be greater than 25.

[2] FSs may indicate more than one criterion for screening out a technology. Also, some FSs did not fully explain the criteria for screening out a technology. Therefore, the totals for these screening criteria may not be equal to the number of FSs in which a technology was screened out.

APPENDIX A
TABLE A-3: SUMMARY OF DETAILED ANALYSIS PHASE FOR WOOD TREATER SITES

Remedial Technology or Treatment	# of FSs/RODs Technology Was Considered[1]	# of FSs/RODs Technology Was Selected[2]	# of FSs/RODs Technology Was Not Selected	# of FSs/RODs Where Criterion Contributed to Non-Selection[3]						
				Overall Protectiveness	Compliance w/Federal ARARs	Reduction of Toxicity, Mobility, & Volume	Long-Term Effectiveness/ Permanence	Short-Term Effectiveness	Implementability	Cost
I. Institutional Controls										
A. Restrictions/ Monitoring	22	22	0							
II. Containment										
A. Capping	28	13	15	7	3	12	7	1	3	3
1. unspecified	5	2	3	1	1	2	1	1	1	1
2. asphalt/ concrete	4	2	2	1		2	1			
3. soil/bentonite/ clay	8	4	4	2	1	3	2			1
4. multi-layer cover system	11	5	6	3	1	5	3		2	1
B. Closure-In-Place/On-Site Encapsulation/ Vault	4	3	1			1	1		1	
C. Temporary On-Site Storage Pile	7	6	1	1		1				1
D. Long-Term On-Site Landfill	9	1	8	1	2	3	1	1	4	2

APPENDIX A
TABLE A-3: SUMMARY OF DETAILED ANALYSIS PHASE FOR WOOD TREATER SITES
(continued)

Remedial Technology or Treatment	# of FSs/RODs Technology Was Considered[1]	# of FSs/RODs Technology Was Selected[2]	# of FSs/RODs Technology Was Not Selected	# of FSs/RODs Where Criterion Contributed to Non-Selection[3]						
				Overall Protectiveness	Compliance w/Federal ARARs	Reduction of Toxicity, Mobility, & Volume	Long-Term Effectiveness/ Permanence	Short-Term Effectiveness	Implementability	Cost
III. Immobilization										
A. Solidification/ Stabilization	15	11	4			3	1	1	1	1
IV. Treatment										
A. Biological Treatments	18	9	9	1		2	5	3	5	1
1. *in situ* bioremediation	5	2	3	1			3	1	1	
2. *ex situ* bioremediation	8	5	3			1	2	2	2	
3. soil/slurry bioreactor	5	2	3			1			2	1
B. Other Thermal Treatments	9	2	7			2	2	2	4	2
1. thermal desorption	5	2	3					2	1	1
2. vitrification	2	0	2			2	2		2	1
3. infrared treatment	2	0	2						1	

APPENDIX A
TABLE A-3: SUMMARY OF DETAILED ANALYSIS PHASE FOR WOOD TREATER SITES (continued)

Remedial Technology or Treatment	# of FSs/RODs Technology Was Considered[1]	# of FSs/RODs Technology Was Selected[2]	# of FSs/RODs Technology Was Not Selected	# of FSs/RODs Where Criterion Contributed to Non-Selection[3]						
				Overall Protectiveness	Compliance w/Federal ARARs	Reduction of Toxicity, Mobility, & Volume	Long-Term Effectiveness/ Permanence	Short-Term Effectiveness	Implementability	Cost
C. Incineration	26	7	19	1	1	3	4	7	12	14
1. on-site	15	3	12	1	1	2	2	4	6	8
2. off-site	11	4	7			1	2	3	6	6
D. Chemical Treatment	9	4	5			2			2	2
1. solvent extraction	5	1	4			1			2	2
2. dechlorination	4	3	1			1				
E. Physical Treatment	12	6	6	1		1	3		4	1
1. soil flushing (*in situ*)	5	1	4	1			3		3	1
2. soil washing (*ex situ*)	7	5	2			1			1	

APPENDIX A
TABLE A-3: SUMMARY OF DETAILED ANALYSIS PHASE FOR WOOD TREATER SITES
(continued)

Remedial Technology or Treatment	# of FSs/RODs Technology Was Considered[1]	# of FSs/RODs Technology Was Selected[2]	# of FSs/RODs Technology Was Not Selected	# of FSs/RODs Where Criterion Contributed to Non-Selection[3]						
				Overall Protectiveness	Compliance w/Federal ARARs	Reduction of Toxicity, Mobility, & Volume	Long-Term Effectiveness/ Permanence	Short-Term Effectiveness	Implementability	Cost
V. Off-Site Options										
A. Off-Site RCRA Landfill	19	10	9	2	1	1	1		6	2
B. Off-Site Sanitary Landfill	1	0	1							
C. Off-Site Reclamation/ Recycling	1	1	0							

[1] Because several specific technologies within a general technology group (e.g., capping: unspecified capping, asphalt/concrete caps, soil/bentonite/clay caps, and multi-layer cover systems) were considered for each site, the total number of FSs/RODs in which a technology group was considered may be greater than 25.

[2] The total number of remedial technologies selected is greater than 25 because treatment trains consisting of several different technologies were selected at most sites. For example, the selection of an overall remedy may have included the selection of institutional controls to control direct contact exposure, bioremediation to treat organic contamination (including soil washing), and immobilization to address inorganic contamination.

[3] Information on state and community concerns was not included in this analysis because FSs do not contain this information, and RODs generally only reference supporting documentation (i.e., state concurrence letters and responsiveness summaries). FSs and RODs may indicate more than one criterion for non-selection of a technology. Therefore, the totals for these non-selection criteria may not be equal to the number of FSs/RODs in which a technology was not selected.

APPENDIX B
EVALUATION OF SELECTION CRITERIA FOR TECHNOLOGIES USED TO TREAT CONTAMINATED SOILS, SEDIMENTS, AND SLUDGES AT WOOD TREATER SITES:

BIOREMEDIATION

CRITERIA						
Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[1]**
Provides protection by reducing concentrations of organic contaminants in soils, sediments, and sludges. *Ex situ* bioremediation requires measures to protect workers and the community during excavation, handling, and treatment. Does not impact the local environment with the proper implementation of erosion/sediment control measures.	Operation must comply with all federal and state regulations that are identified as ARARs. Requires compliance with RCRA removal, treatment, transportation, and land disposal regulations, if RCRA is determined to be an ARAR. Requires compliance with CERCLA off-site rule (if off-site treatment, storage, or disposal is used).	Residual contamination following treatment may require use of capping and/or institutional controls. Residual contamination may migrate. Hazardous substances left in place will require a five-year review. Bioremediation systems may require lengthy operation, in addition to long-term maintenance of cap integrity (if capping is implemented).	May reduce toxicity, mobility, and volume through degradation of organic contaminants; however, if bulking agents are added, volume may not necessarily be reduced. If used in conjunction with capping, minimizes mobility.	Microbial degradation is a relatively slow process that is highly site-specific and is affected by a multitude of factors. Some of these factors (e.g., electron acceptor and nutrient availability, and pH) may need to be examined in bench-scale studies during the design phase of site remediation to maximize aerobic activity and minimize process interferences. *Ex situ* bioremediation presents potential short-term risks to workers and community from air releases during excavation and treatment; requires air monitoring to address these short-term risks.	Requires relatively simple technologies; easy to construct and operate. May require bench- and/or pilot-scale studies during the design phase. Pilot-scale studies in the field are almost always required before full-scale implementation. Easy to economically maintain treatment until cleanup levels are achieved. Size of site may limit capability to perform some types of *ex situ* bioremediation.	*In situ* $50 - $100 per cubic yard of soil, sediment, or sludge. *Ex situ* $50 - $150 per cubic yard of soil, sediment, or sludge; or $40 - $125 per ton of soil, sediment, or sludge.

[1] Actual cost of a remediation technology is highly site-specific and dependent upon target cleanup levels of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
EVALUATION OF SELECTION CRITERIA FOR TECHNOLOGIES USED TO TREAT CONTAMINATED SOILS, SEDIMENTS, AND SLUDGES AT WOOD TREATER SITES:

BIOREMEDIATION (continued)

CRITERIA						
Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[1]**
In situ bioremediation may not be feasible for the treatment of subsurface soils, sediments, and sludges (depending upon variables such as contaminant type, soil type, depth to contamination, etc.). A simple cap, in conjunction with bioremediation, provides protection by reducing and/or controlling erosion and direct contact exposure to residual contamination.	Requires compliance with Hazardous Materials Transportation Act regulations (if off-site treatment is used). Requires compliance with location-specific ARARs. *Ex situ* bioremediation may need emission controls to ensure compliance with air quality standards during excavation and treatment.	*In situ* process generates little, if any, toxic waste streams that need to be disposed; *ex situ* may generate such streams.		Where it is feasible, *in situ* bioremediation requires the least soil disturbance and, therefore, presents the least short-term risks. Involves potential short-term risks from handling and transporting waste (if off-site treatment is used).		

[1] Actual cost of a remediation technology is highly site-specific and dependent upon target cleanup levels of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
EVALUATION OF SELECTION CRITERIA FOR TECHNOLOGIES USED TO TREAT CONTAMINATED SOILS, SEDIMENTS, AND SLUDGES AT WOOD TREATER SITES:

THERMAL DESORPTION

CRITERIA						
Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[1]**
Provides both short- and long-term protection by eliminating exposure to organic contaminants in soils, sediments, and sludges. Prevents further ground-water contamination and off-site migration. Requires measures to protect workers and the community during excavation, handling, and treatment.	Operation and design must comply with all federal and state ARARs concerning hazardous waste treatment facilities. Requires compliance with RCRA removal, treatment, transportation, and land disposal regulations, if RCRA is determined to be an ARAR. Requires compliance with CERCLA off-site rule (if off-site treatment, storage, or disposal is used).	Effectively removes source of contamination. Has been demonstrated as an effective technique for removing and concentrating organic contaminants in soils, sediments, and sludges. Would involve some treatment or disposal of residuals in addition, generally through use of carbon adsorption/ regeneration or disposal. Eliminates risks associated with direct contact or migration of wastes.	Significantly reduces toxicity, mobility, and volume of contaminants through treatment.	Presents potential short-term risks to workers and community from fugitive emissions during excavation and treatment (if on-site treatment is used). Requires air monitoring to address these short-term risks. Involves potential short-term risks from handling and transporting waste (if off-site treatment is used). Requires relatively short time frame to achieve cleanup levels.	Substantive permit requirements must be addressed. Mobile treatment units are readily available. Limited off-site treatment capacity exists. Used successfully at other Superfund sites to treat organic contaminants in soils, sediments, and sludges. Public may oppose technology, viewing it as similar to incineration.	$150 - $400 per ton of soil, sediment, or sludge, excluding excavation, material handling, or disposal costs.

[1] Actual cost of a remediation technology is highly site-specific and dependent upon target cleanup levels of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
EVALUATION OF SELECTION CRITERIA FOR TECHNOLOGIES USED TO TREAT CONTAMINATED SOILS, SEDIMENTS, AND SLUDGES AT WOOD TREATER SITES:

THERMAL DESORPTION (continued)

CRITERIA						
Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[1]**
	Requires compliance with Hazardous Materials Transportation Act regulations (if off-site treatment is used). Requires compliance with location-specific ARARs. Emission controls may be needed to ensure compliance with air quality standards during excavation and treatment. EPA's Draft Combustion Strategy is a TBC (e.g., for conducting risk assessments, etc.)				Requires engineering measures to control air emissions, fugitive dust, runoff, erosion, and sedimentation.	

[1] Actual cost of a remediation technology is highly site-specific and dependent upon target cleanup levels of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
EVALUATION OF SELECTION CRITERIA FOR TECHNOLOGIES USED TO TREAT CONTAMINATED SOILS, SEDIMENTS, AND SLUDGES AT WOOD TREATER SITES:

INCINERATION

CRITERIA						
Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[1]**
Provides both short- and long-term protection by permanently destroying organic contaminants in soils, sediments, and sludges. Prevents further ground-water contamination and off-site migration. Requires measures to protect workers and the community during excavation, handling, and treatment.	Operation and design must comply with all federal and state ARARs concerning hazardous waste treatment facilities. Requires compliance with RCRA removal, treatment, transportation, and land disposal regulations, if RCRA is determined to be an ARAR. Requires compliance with CERCLA off-site rule (if off-site treatment, storage, or disposal is used). Must meet Boiler and Industrial Furnace (BIF) regulations, which can be more restrictive than RCRA.	Effectively destroys nearly all contamination. Is a well-demonstrated technique for treating organic contaminants in soils, sediments, and sludges. Eliminates risks associated with direct contact or migration of wastes. Generates little, if any, toxic residues.	Significantly reduces toxicity, mobility, and volume of contaminants through treatment.	Presents potential short-term risks to workers and community from fugitive emissions during excavation and treatment (if on-site treatment is used). Requires air monitoring to address these short-term risks. Involves potential short-term risks from handling and transporting waste (if off-site treatment is used). Requires relatively short time frame to achieve cleanup levels.	Construction and substantive permit requirements of on-site incinerators may be somewhat difficult to meet. Mobile incinerators are readily available; these use common procedures and equipment. Limited off-site incineration capacity exists. Used successfully at other Superfund sites to treat organic contaminants in soils, sediments, and sludges.	$150 - $400 per ton of soil, sediment, or sludge, excluding excavation, material handling, or disposal costs.

[1] Actual cost of a remediation technology is highly site-specific and dependent upon target cleanup levels of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
EVALUATION OF SELECTION CRITERIA FOR TECHNOLOGIES USED TO TREAT CONTAMINATED SOILS, SEDIMENTS, AND SLUDGES AT WOOD TREATER SITES:

INCINERATION (continued)

CRITERIA						
Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[1]**
	Requires compliance with Hazardous Materials Transportation Act regulations (if off-site treatment is used). Requires compliance with location-specific ARARs. Emission controls may be needed to ensure compliance with air quality standards during excavation and treatment. EPA's Draft Combustion Strategy is a TBC (e.g., for conducting risk assessments, etc.)				Public opposition may make this technology infeasible. Requires a trial burn to demonstrate destruction efficiency and define operating parameters (if on-site treatment is used). Requires coordination with state and local officials to select transportation routes (if off-site treatment is used).	

[1] Actual cost of a remediation technology is highly site-specific and dependent upon target cleanup levels of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
EVALUATION OF SELECTION CRITERIA FOR TECHNOLOGIES USED TO TREAT CONTAMINATED SOILS, SEDIMENTS, AND SLUDGES AT WOOD TREATER SITES:

IMMOBILIZATION

CRITERIA						
Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[1]**
Provides both short- and long-term protection by containing contaminants in a fixed-soil/sediment/ sludge mass. Reduces the potential for further ground-water contamination and off-site migration. Reduces potential risks associated with inhalation, dermal contact, and ingestion of contaminated soils, sediments, and sludges.	Operation must comply with all federal and state ARARs. Requires compliance with RCRA removal, treatment, transportation, and land disposal regulations, if RCRA is determined to be an ARAR. Requires compliance with CERCLA off-site rule (if off-site treatment, storage, or disposal is used).	Represents a long-term solution that effectively reduces and/or eliminates the mobility of hazardous substances into the environment. Has been demonstrated as an effective technique for treating inorganic contaminants (primarily metals, such as chromium and arsenic) in soils, sediments, and sludges.	Significantly reduces the mobility of inorganic contaminants (and non-volatile organics, to some extent) by chemically binding and encapsulating them. Does not reduce volume or toxicity of contaminants. Volume may increase 30-50% through the mixing of the soil/sediment/ sludge with fixative agents.	Presents potential short-term risks to workers and community from air release during excavation and treatment (if on-site treatment is used). Involves potential short-term risks from handling and transporting waste (if off-site disposal is used). Requires relatively short time frame to achieve cleanup levels.	Requires relatively simple technologies; easy to construct and operate. Requires treatability testing. Used successfully at other Superfund sites to treat inorganic (primarily metals) contaminants in soils, sediments, and sludges.	$75 - $400 per ton of soil, sediment, or sludge (for on-site treatment). $100 - $500 per ton of soil, sediment, or sludge (for off-site disposal).

[1] Actual cost of a remediation technology is highly site-specific and dependent upon target cleanup levels of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
EVALUATION OF SELECTION CRITERIA FOR TECHNOLOGIES USED TO TREAT CONTAMINATED SOILS, SEDIMENTS, AND SLUDGES AT WOOD TREATER SITES:

IMMOBILIZATION (continued)

CRITERIA						
Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Cost[1]**
Requires measures to protect workers and the community during excavation, handling, and treatment. Lower portions of the soil profile are often untreated.	Requires compliance with Hazardous Materials Transportation Act regulations (if off-site disposal is used). Requires compliance with location-specific ARARs. Emission controls may be needed to ensure compliance with air quality standards during excavation and treatment.	Requires air and ground-water monitoring to confirm long-term effectiveness. Requires proper management and/or institutional controls to address any residual risks associated with direct contact.		Short-term effectiveness maintained through strict environmental controls.		

[1] Actual cost of a remediation technology is highly site-specific and dependent upon target cleanup levels of contaminants, soil characteristics, and the design and operation of the remediation technology used.

GLOSSARY

Action Memorandum — A document that provides a concise written record of the decision selecting a removal action. It describes the site's history, current activities, and health and environmental threats; outlines the proposed actions and costs; and documents approval of the proposed action by the proper EPA Headquarters or Regional authority.

Administrative Record — A formal record established by the lead agency, it contains the documents that form the basis for the selection of a response action (e.g., analysis report, Feasibility Study, Record of Decision, Directives, etc.).

Applicable or Relevant and Appropriate Requirements (ARARs) — *Applicable requirements* are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. *Relevant and appropriate requirements* are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site and are well-suited to the particular site.

Engineering Evaluation/Cost Analysis (EE/CA) — Required for non-time-critical removal actions, the EE/CA contains information on site characteristics, removal action objectives, and removal action alternatives. It is intended to identify the objectives of the removal action and to analyze the various alternatives that may be used to satisfy these objectives for cost, effectiveness, and implementability. The EE/CA process includes: conducting a removal site evaluation, notifying PRPs of their liability, preparing an EE/CA approval memorandum, and preparing a study documenting the removal action options. Although an EE/CA is similar to the RI/FS conducted for remedial actions, it is less comprehensive. The EE/CA is part of the Administrative Record file and is subject to the public comment and comment/response requirements for the Administrative Record.

Feasibility Study (FS) — A study undertaken by the lead agency to develop and evaluate options for remedial design. The FS emphasizes data analysis and is generally performed concurrently and in an interactive fashion with the Remedial Investigation (RI), using data gathered during the RI.

Hazard Ranking System (HRS) — The method used by EPA to evaluate the relative potential of hazardous substance releases to cause health or safety problems, or ecological or environmental damage.

Innovative Treatment Technologies — Technologies that have been tested, selected, or used for the treatment of hazardous substances or contaminated materials but lack well-documented cost and performance data under a variety of operating conditions.

National Priorities List (NPL) — The list compiled by EPA, pursuant to CERCLA section 105, of hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response.

On-Scene Coordinator (OSC) — The federal official predesignated by EPA or the U.S. Coast Guard to coordinate and direct federal responses under Subpart D of the NCP, or the official designated by the lead agency to coordinate and direct removal actions under Subpart E of the NCP.

Preliminary Remediation Goals (PRGs) - Initial cleanup goals developed as part of the overall remedial action objectives. PRGs are established and refined based on a variety of information, including ARARs

and TBCs, the baseline risk assessment, anticipated future land use(s) of the site, and technical, exposure, and uncertainty factors.

Principal Threats - Principal threats include liquids, areas contaminated with high concentrations of toxic compounds, and highly mobile materials.

Record of Decision (ROD) — The final remedial action plan for a site or operable unit, which summarizes problems, alternatives, remedies, and the selected remedy. The ROD also includes the rationale for the selection of the final remedy, and explains how the selected remedy meets the nine evaluation criteria stated in the NCP.

Remedial Investigation (RI) — A process undertaken by the lead agency to determine the nature and extent of the problem presented by a release. The RI emphasizes data collection and site characterization, and is generally performed concurrently and in an interactive fashion with the Feasibility Study.

Remedial Project Manager (RPM) — The official designated by the lead agency to coordinate, monitor, or direct a remedial action under Subpart E of the NCP.

Remedial Site Evaluation — A process undertaken by the lead agency to collect data, as required, and evaluate a release or threat of release of hazardous substances, pollutants, or contaminants. The evaluation may consist of two steps: a preliminary assessment (PA) and a site inspection (SI).

Removal Site Evaluation — A process undertaken by the lead agency to identify the source and nature of a release or threat of release; it may include a removal preliminary assessment and, if warranted, a removal site inspection.

Risk Assessment — The qualitative and/or quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by the cumulative presence or potential presence and/or use of specific pollutants.

Superfund Accelerated Cleanup Model (SACM) - The purpose of SACM is to make hazardous waste cleanups more timely and efficient. This will be accomplished through a greater focus on the front end of the process and better integration of all Superfund program components. The approach involves: (1) a continuous process for assessing site-specific conditions and the need for action; (2) cross-program coordination of response planning; (3) prompt risk reduction through early action (removal or remedial); and (4) appropriate cleanup of long-term environmental problems.

To Be Considereds (TBCs) — Non-promulgated advisories or guidance issued by federal or state governments that are not legally binding and do not have the status of potential ARARs. In many circumstances, TBCs will be considered along with ARARs as part of the risk assessment and may be used in determining the necessary level of cleanup for protection of health or the environment.

Treatability Studies — Preliminary studies in which a hazardous waste is subjected to a treatment process to determine if the waste is amenable to the process, what pretreatment activities are necessary, what the optimal process options are, and what is the efficiency of the process.

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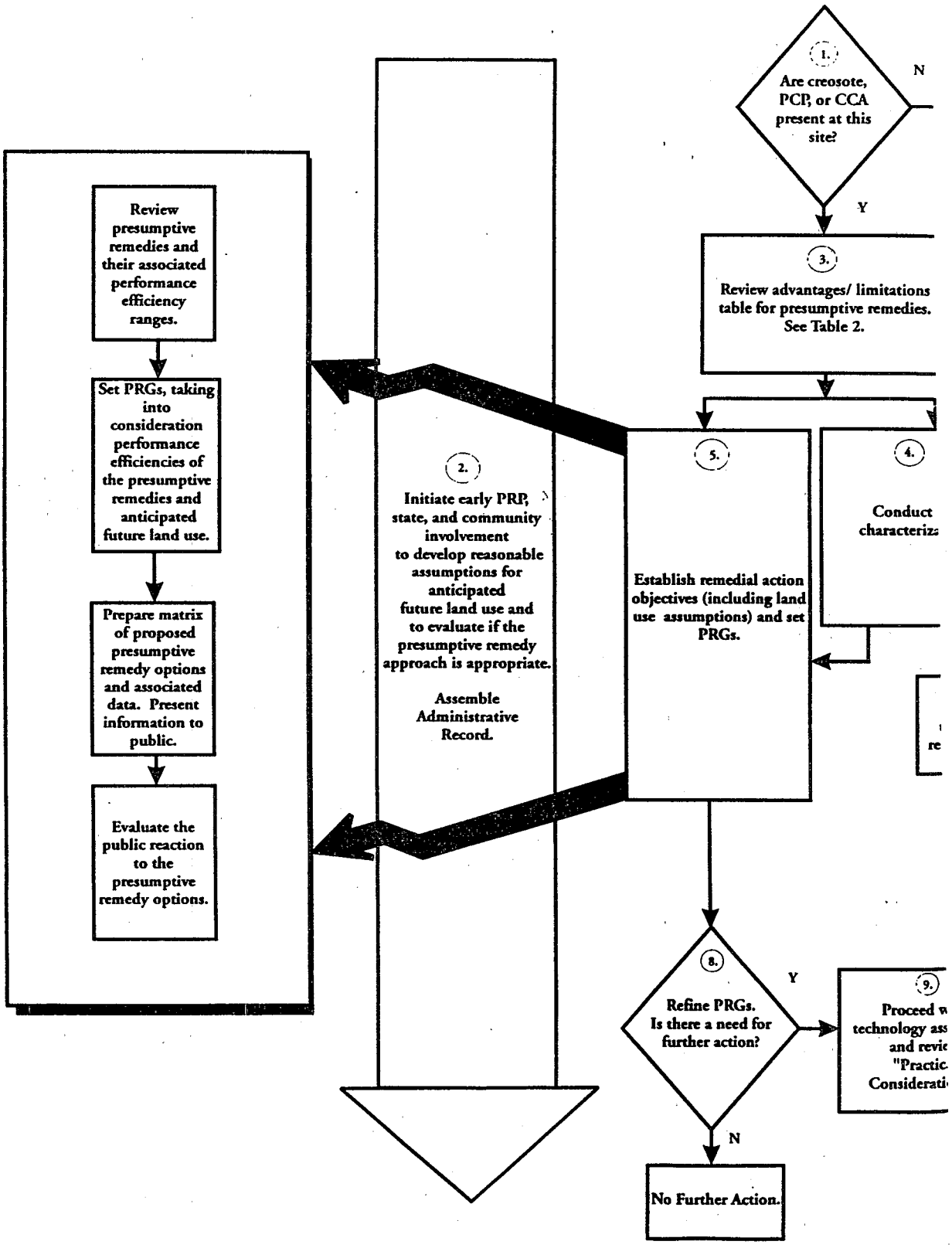
Figure 1: Decision Tree for Techn



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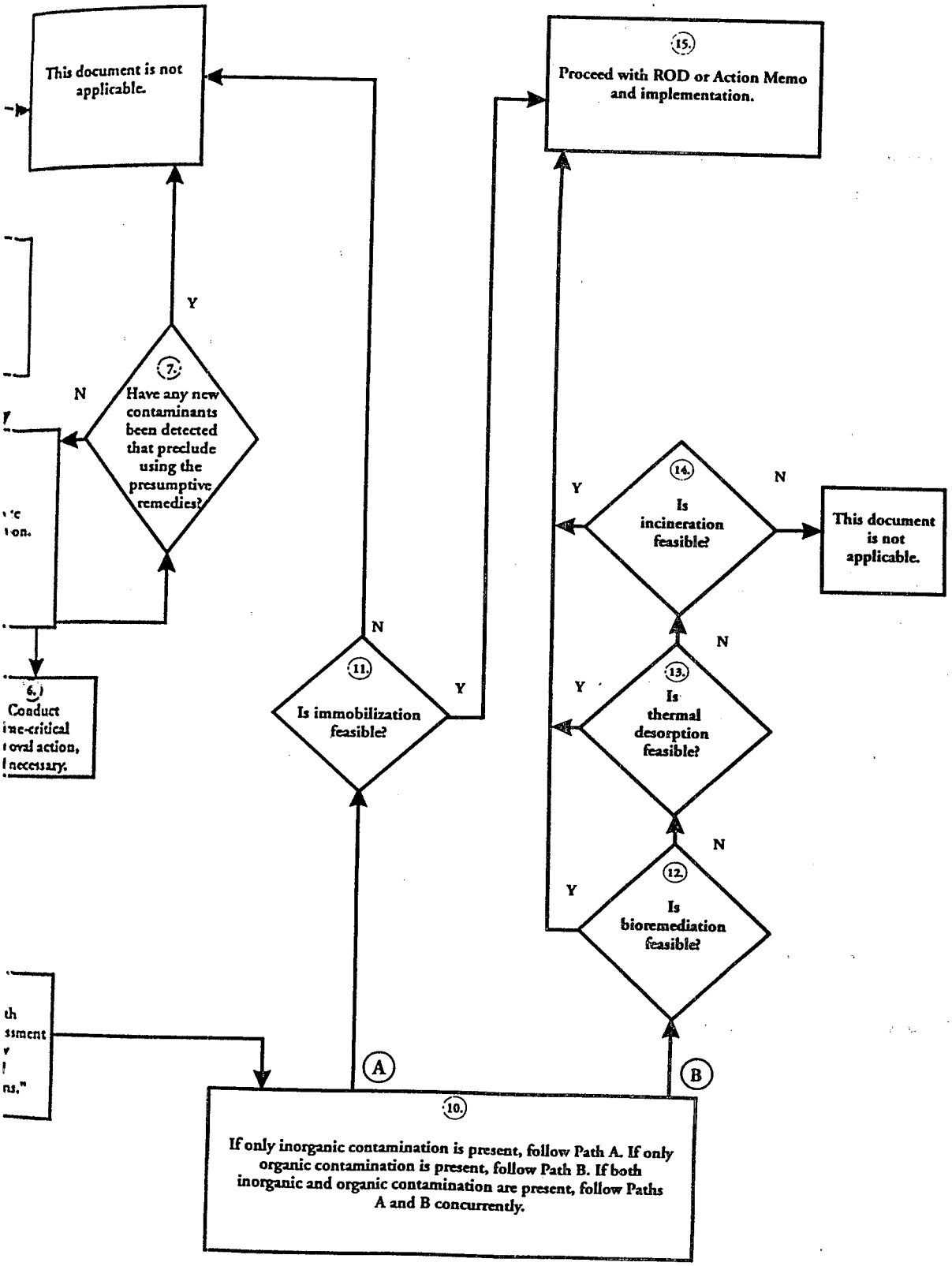

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Volume 1 Number 2

The Presumptive Remedy Selection Initiative

Since Superfund's inception in 1980, the removal and remedial programs have found that certain categories of sites have similar characteristics, such as the types of contaminants present, past industrial use, or the environmental media that are affected. Based on a wealth of information acquired from evaluating and cleaning up these sites, Superfund is undertaking an initiative to develop **presumptive remedies** that are appropriate for specific types of sites, contaminants, or both. This initiative is part of a larger program, known as the **Superfund Accelerated Cleanup Model (SACM)**, which is designed to speed all aspects of the Superfund clean-up process.

The objective of the presumptive remedies initiative is to use clean-up techniques shown to be effective in the past at similar sites in the future. The use of presumptive remedies will streamline site studies and removal and remedial clean-up actions, thereby improving consistency, reducing costs, and increasing the speed with which hazardous waste sites are remediated.

Why Wood Treatment Sites?

Our removal and remedial programs have worked at almost 90 wood-treatment sites, many of them on the National Priorities List (NPL), gaining a great deal of data and experience in the process. Three primary types of contaminants, including dioxin, usually predominate at these sites. The facilities tend to be similar. And EPA knows a great deal about assessing such sites, handling the contaminants, and, ultimately, disposing of wood-treatment waste. The Agency's Office of Research and Development (ORD) has also extensively studied these sites. With all this accumulated experience and information, Superfund is ready to establish presumptive remedies that will standardize remedy selection for contaminated wood-treatment sites.

Superfund Accelerated Clean-up

Faster...Cleaner...Safer

What Are the Components of the Presumptive Remedy Initiative?

The wood-treatment presumptive remedy initiative has five components:

- **Technology Selection Matrix.** This will be a guide to the clean-up technologies known to be appropriate for wood-treatment sites cross-tabulated with the factors to be considered in selecting remedies. The matrix is being developed by the Office of Emergency and Remedial Response's Environmental Response Team.

- **ORD Guidance.** Currently in draft form, this document will evaluate the effectiveness of various technologies on the types of wastes commonly found at wood-treatment sites. The Technology Selection Matrix will complement this guidance.

- **Expert Teams.** The Office of Emergency and Remedial Response (OERR) will establish a team of wood-treatment site experts who can help evaluate sites and aid in making decisions on appropriate clean-up methodologies.

- **Computer-Assisted Remedy Selection.** Currently under development is a computer program that will provide appropriate remedy information based on site characteristics. Although not a substitute for expert decision-making, the program will lead users through the remedy-selection process by narrowing the scope of options, using site characteristics and technology considerations.

- **Pilot Sites.** OERR is looking for wood-treatment sites where it can test its presumptive remedy initiative.

What Will This Initiative Accomplish?

EPA expects the presumptive remedy initiative to reduce the time spent on RI/FSs and to help better integrate the removal and remedial programs.

By being better prepared when the assessment starts—i.e., knowing what contaminants to expect and the best ways to deal with them—and by using a team of experts, we can reduce the time spent on RI/FSs considerably. Currently, individual sites may undergo similar, sequential assessments from the removal program, the site assessment program, the remedial program, and even the Resource Conservation and Recovery Act (RCRA) program. In addition, the U.S. Public Health Service's Agency for Toxic Substances and Disease Registry (ATSDR), State and local agencies, and even private parties may conduct their own studies. A standardized sampling and assessment process may reduce the consecutive studies required at these sites.

We expect to do comprehensive cleanup of hazardous waste sites through Superfund's removal or remedial authority. The team of experts contemplated by the presumptive remedy initiative will cross program lines, as will their participation at individual sites. The presumptive remedies will be applicable regardless of which aspect of Superfund is responsible for the site cleanup.

How Will This Initiative Affect Innovative Technologies?

Innovative technologies will always be important to Superfund, since they can reduce disposal quantities, and save time and money. The team of experts will consider the use of innovative technologies at specific sites. As experience is gained, we will incorporate appropriate innovative technologies into the technology matrix. They may also be incorporated in the computer-assisted remedy selection program.

What Is to Follow?

Similar presumptive remedy initiatives for other types of sites, such as landfills and metal-plating facilities are currently before the presumptive remedy workgroup. The types of contaminates to be addressed include PCBs, asbestos, solvents, pesticides, metals, and dioxin.

Further information on the wood-treatment site initiative is available from Harry Allen of the Environmental Response Team at FTS 340-6740, or (201) 321-6740.

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

Publication 9360.0-46FS
EPA540-F-93-020
May 1993

EPA

Technology Selection Guide for Wood Treater Sites

Office of Emergency and Remedial Response
Emergency Response Division 5202G

Quick Reference Fact Sheet

Since the enactment of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) in 1980, the Superfund remedial and removal programs have found that certain site categories have similar characteristics, such as: types of contaminants present; types of disposal practices; or how environmental media are affected. Based on information acquired from evaluating and cleaning up many of these sites, Superfund is undertaking an initiative to develop presumptive remedies that are appropriate for specific types of sites and that are designed to accelerate the Superfund cleanup process. The objective of the presumptive remedies initiative is to draw upon past experiences to streamline site investigations and the remedy selection process in accordance with the Superfund Accelerated Cleanup Model (SACM). The Agency has developed presumptions that particular technologies are appropriate for certain types of sites by evaluating technologies that have been consistently selected and successfully used for past sites.

The Agency is developing a Generic Presumptive Remedies fact sheet which will outline and address the common issues (e.g., use of risk assessment, innovative technologies, how to rebut the presumptive remedy, etc.) anticipated with the use of a presumptive remedy at any site. In addition, the Agency is developing guidance on presumptive remedies for soils contaminated by volatile organic compounds, municipal landfills, polychlorinated biphenols, grain storage, coal gasification sites, and contaminated ground water.

Information on technology performance for wood treater sites is presented in this **Technology Selection Guide.** This document is intended for use by a decision-making team experienced with wood treater sites; it will be supplemented by additional analyses of previous remedy selection decisions and remedy performance. This additional analyses will be developed into a **Presumptive Remedy Guide.**

BACKGROUND

Abandoned wood treater sites typically contain the following contaminants either alone or in combination with each other or with total petroleum hydrocarbon (TPH) carrier oils: creosote (mainly, polynuclear aromatic hydrocarbons (PAHs)); pentachlorophenol (PCP); and chromated copper arsenate (CCA). These contaminants may be found in pure form (product), or in sludge, soil, sediments, surface waters, or ground water. Light Non-Aqueous Phase Liquids (LNAPLs) and Dense NAPLs (DNAPLs) may also be present in surface or ground water.

Experience at full-scale removal and remedial projects indicates that there are demonstrated treatment technologies capable of achieving stringent clean-up goals at wood treater sites; these technologies are presented in this guide. In addition, other technologies, with more limited performance data, are presented.

IMPLEMENTATION

Choosing among remedies requires care to match treatment requirements with site specific conditions, but the process can be streamlined within the scope of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) remedy selection requirements. A focused site evaluation by experienced personnel with the use of the guide can greatly limit the feasible treatment options, identify early actions, and expedite the clean-up process. This guide provides a selection procedure outline (box below) and practical considerations for the facilitation of remedy selection. In addition, three tables are included in the guide: Table I, Technologies for Treatment of Sludge, Soil, and Sediment; Table II, Technologies for Treatment of Surface Water and Ground Water; and Table III, Information Needs and Process Limitations. Many of the tasks outlined in this guide can and should be conducted simultaneously to accelerate the process and to minimize

cost; however, a sequential process may be necessary at times.

WOOD TREATER TECHNOLOGY SELECTION PROCEDURE OUTLINE

Site Characterization

A. Identify Contaminant
   1. Type (i.e., CCA, PCP, creosote, or TPH)
   2. Alone or mixed (e.g., PCP/creosote/CCA)
B. Establish Site Screening Criteria[1] Based on Actual or Anticipated Land and Water Uses
C. Identify Media and Areas Needing Treatment:
   1. Product (drums, tanks, or recoverable NAPLs)
   2. Sludge (drums, tanks, or open or buried lagoons)
   3. Soil and sediments from:
      a. process areas
      b. drip areas and storage areas
      c. lagoon or drainage areas (on-site/off-site)
   4. Surface Water
      a. ponds/lagoons
      b. runoff or drainage pathways
   5. Ground Water
D. Identify Possible Treatment Options (Tables I and II) (Include treatability studies, particularly for non-demonstrated technologies)
E. Determine Extent, Volume, and Level of Contamination in Each Medium and Area of Concern
F. Characterize Broadly the Physical/Chemical Nature of Each Treatment Medium in View of the Possible Treatments (Table III Identifies Additional Information Needs):
   1. Solids - Particle Size Distribution/ pH/Total Organic Carbon (TOC)/Cation Exchange Capacity/Moisture
   2. Liquids - Phases/pH/TOC
   3. Sludge - TOC/Moisture/Pumping Characteristics
G. Select Final Clean-up Goals[2] Considering Anticipated Land and Water Uses and the Removal Efficiencies Required to Achieve Those Levels

WOOD TREATER TECHNOLOGY SELECTION PROCEDURE OUTLINE (continued)

Treatment Selection

A. Confirm the Volumes, Matrix Homogeneity and Consistency, and Contaminant Concentrations
B. Evaluate On/Off-Site and Pre-Treatment Options
C. Evaluate Capping/Containment Option
D. Assess Excavation, Segregation, and Stockpiling
E. Select Candidate Treatment Options (conduct treatability studies, if needed) (Tables I and II)
F. Evaluate Treatment Limitations and Information Needs Using Table III
G. Select Final Treatments and Perform Site Specific Treatability Studies to Obtain Design Data for Procurement Specification

[1] Site Screening Criteria are operational indicators, such as action levels resulting from an exposure risk assessment for a specific land use; they trigger the need for cleanup. Cleanup Goals reflect projected exposures for particular land uses; these levels describe the suitability of a resource for its intended use.

PRACTICAL CONSIDERATIONS FOR FACILITATING TECHNOLOGY SELECTION

1. If the product is still in original containers it should be returned to the manufacturer, if possible. Reuse of material (i.e., process liquids) and relocation of equipment to other permitted facilities should be considered. Phase separation should be conducted; water and emulsified product could be treated on site. LNAPLs and DNAPLs may or may not be recyclable depending on the purity of the recovered phase.

2. Where any of the principal wood treating chemicals (creosote, PCP, or CCA) can be recovered in high enough concentrations to warrant reuse in any process, recycling becomes the preferred technology. The recognized Waste Exchanges are listed in Appendix A. The alternative to reuse or recycling is to treat the material as waste along with other contaminated liquids or solids.

3. If the product, (e.g., PCP), is in storage tanks, then it should be analyzed for dioxins/furans and cross contaminants. Total pumpable and non-pumpable sludge in tanks and drums should also be determined.

4. Site characterization should proceed as a single, multi-media sampling event whenever possible. Field screening methods should be integrated into the sampling and analysis plan in order to accelerate information gathering. Data quality objectives must reflect the ultimate use of the results, but all samples taken during a single event may not require the same level of data quality.

5. Site preparation and bulk material handling needs require evaluation wherever soil treatment is being considered. Pretreatment renders a material suitable as feed for a treatment process. The technology selection should be evaluated for consistency with the overall remedy for the site. Site preparation and pretreatment activities include but are not limited to the following:

   A. Site Stabilization
      1. Fencing and security
      2. Capture and treatment of runoff
      3. Containment of leaking vessels
      4. Use of liners and covers
      5. Capping and containment
      6. Evaluation of on-site pretreatment for off-site disposal

   B. Material Handling, Waste Segregation, and Pretreatment
      1. Surface material removal (poles, tanks, buildings, product, etc.)
      2. Excavation & stockpiling
      3. Sizing
         a. Screening of inert and oversized materials
         b. Particle fractionation or hydrosieving
         c. Debris handling
      4. Pretreatment

6. In general, other than in processing areas and storage tanks, the highest concentrations of contaminants may be found in surface and buried waste lagoons. Contamination can migrate vertically from these lagoons to significant depths. Hydrogeologic studies may be necessary to discern such contamination and additional technologies for remediation may have to be considered.

7. Surface lagoons, soil areas, drip pads, and sediments should be gridded and sampled to determine the horizontal and vertical extent of contamination. Soil and sludge characterization relevant to treatment selection should reflect the information needs detailed in Table III.

8. Excavation of contaminated soil should generally not be done until the final treatment technology has been selected, except where it is deemed necessary to reduce an imminent hazard or to control migration. Where possible, excavated organic and inorganic contaminants, and high and low concentration materials should be staged separately.

9. It is usually too expensive to ship quantities of greater than 5,000 cubic yards of contaminated soil off-site for disposal. Pretreatment of soil and water may be required prior to shipment or discharge to another treatment facility.

10. Circumstances may arise where capping and containment of material with relatively low toxicity and mobility is an appropriate remedy. Such instances will require careful evaluation.

11. Verification of expected treatment efficiencies should be consistent with accepted Superfund quality assurance/quality control guidance.

12. Health and safety considerations enter into the technology selection process as described in the Health and Safety Plan (HASP). Air monitoring to support the HASP may include on-site or off-site components.

<u>For Additional Information Contact:</u>

John Harris
Response Standards and Criteria Branch
Emergency Response Division (5202G)
U.S.E.P.A.
401 M. St. S.W., Washington D.C. 20460
(703) 603-8780

TABLE I

Technologies for Treatment of Sludge, Soil, and Sediment

Contaminant	Treatment Technologies	Treatability (RREL Database)[4]	Treatment Trains[5]
CCA	Immobilization[1,2]	80 - 90% TCLP (B,P,F)	Soil Washing/ Immob[3]
PCP	Incineration[2] Other Thermal Treatment[3] Biotreatment3[3] Dechlorination[3]	90 - 99% (B,P,F) --- --- ---	--- Soil Washing/Bio[3] --- ---
Creosote	Incineration[2] Other Thermal Treatment[3] Biotreatment3[3]	90 - 99% (B,P,F) --- ---	--- Soil Washing/Bio[3]
PCP + Creosote	Incineration[2] Other Thermal Treatment[3] Biotreatment3[3]	95 - 99% (B,P,F) --- ---	--- Soil Washing/Bio[3]
Creosote + CCA	NA	4	Incin/Immob Ash[2] Soil Washing/Bio/ Immob[3]
PCP + CCA	NA	4	Incin/Immob/Ash2[2] Soil Washing/Bio/ Immob[3] Dechlorin/Immob3[3]

1. Arsenical compounds are often problematic for stabilization; however, the levels of arsenical compounds typically found at wood treater sites is low enough to not present concerns.

2. These technology recommendations assume that no site-specific constraints exist. Technology selection should ensure that the specified treatment efficiencies will meet established cleanup goals.

3. These other technologies may warrant site-specific evaluations, RI/FSs, focused feasibility studies (FFSs), or engineering evaluations/cost analyses (EE/CAs) because they lack full-scale performance data. Site-specific conditions also may favor a subset of the major technology. Bench-scale and/or pilot studies may be necessary to refine the selection of the most appropriate specific treatment method.

4. Performance data are from the Risk Reduction Engineering Laboratory (RREL). The database is derived from bench scale (B), pilot scale (P), or full scale (F) demonstration projects. Dashes indicate insufficient data. The RREL is updated on a regular basis and is available through the Alternative Treatment Technology Information Center (ATTIC). The numbers represent total treatment efficiency, not DRE. Additional technologies and their treatment efficiencies will be added as more information becomes available.

5. Performance efficiency for treatment trains is a function of contaminant concentration, matrix and volume. It can generally be presumed that the performance of treatment trains will equal or exceed that of the individual treatment technologies.

TABLE II

Technologies for Treatment of Surface Water and Ground Water

Contaminant	Treatment Technologies	Treatability (RREL Database)*	Treatment Trains
CCA	Precipitation Reverse Osmosis Ion Exchange	97 - 99% (B,P,F) 99% (P) ---	Precip/Immob Precip/RO/Immob Precip/Ion Ex/Immob
PCP	Carbon Treatment Biotreatment Oxidation	95 - 99% (P) 99% (B,P,F) 99% (B,P)	Phase Sep/Carb Phase Sep/Bio Phase Sep/Oxidation
Creosote	Carbon Treatment Biotreatment Oxidation	82 - 99% (P,F) 99% (P,F) 99% (B,P)	Phase Sep/Carb Phase Sep/Bio Phase Sep/Oxidation
Creosote + PCP	Carbon Treatment Biotreatment Oxidation	82 - 99% (P,F) 99% (B,P,F) 99% (B,P)	Phase Sep/Carb Phase Sep/Bio Phase Sep/Oxidation
Creosote + CCA	Carbon Treatment Oxidation Precipitation	---	Phase Sep/Treat Organic/Treat Metals
PCP + CCA	Carbon Treatment Oxidation Precipitation	---	Phase Sep/Treat Organic/Treat Metals

KEY: Treat Organic = Carbon Treatment or Chemical (O_3, ClO_2, H_2O_2) or Ultraviolet Oxidation

Treat Metals = Reverse Osmosis or Ion Exchange or Chemical Precipitation and Immobilization of Residues

* Performance data from the RREL (Risk Reduction Engineering Laboratory). Database is derived from bench scale (B), pilot scale (P), or full scale (F) demonstration projects. Dashes in the table indicate insufficient data.

TABLE III

Information Needs and Process Limitations

Treatment Technology	Information Needs	Process Constraints and Limitations
Thermal Treatment - Incineration	i) BTU value ii) Volatile metals concs. iii) Alkali metals (Na,K) concs. iv) Elemental analysis (N,S,P,Cl,etc.) v) Moisture content vi) Pumping chars. and viscosity	i) High moisture content ii) High alkali metals soil iii) Elevated levels of mercury, organic phosphorus iv) Volume <3000-5000 cu. yds.
Thermal Treatment - Desorption	i) Melting and boiling points ii) Volatile metals concs. iii) Flash points iv) Elemental analysis (N,S,P,Cl,etc.) v) Vapor pressures vi) Optimum desorption and destruction temperatures vii) Moisture content	i) Elevated levels of halogenated organics ii) Presence of mercury iii) Corrosivity
Immobilization	i) TOC (oils, TPH, humic material, etc.) ii) Grain size distribution iii) Soluble salts iv) Cation Exchange Capacity (CEC)	i) TPH >1% ii) Humic matter <20%
Biotreatment - In-situ	i) Indigenous microorganisms ii) Degradation rates iii) Solubility iv) Nutrient requirements and existing conditions of pH, temp., oxygen, moisture, etc. v) Depth to ground water and thickness of contaminated zone vi) Permeability of the soil	i) Toxic metals, chlorinated organics, pH outside 4.5-9, limiting growth factors ii) Ambient temp. below 15°C iii) Short time/growth season iv) Rainfall/evapotranspiration rate/percolation rate ratios too high or too low v) Limiting initial and final concs.
Biotreatment - Ex-situ	i) Indigenous microorganisms ii) Degradation rates iii) Solubility iv) Nutrient requirements and existing conditions of pH, temp., oxygen, moisture, etc.	i) Lack of indigenous microbes ii) Toxic metals, highly chlorinated organics, pH outside 4.5-9, limiting growth factors iii) See also "In-situ", above
Base-Catalyzed Dechlorination	i) Heavy metals conc. ii) Reactivity at high pH iii) Elemental analysis (N,P,S,Cl, etc.) iv) Redox potential v) TOC, humic material and clay content	i) Heavy metals and excess soil moisture (>20%) may require special treatment ii) High organic and clay content may extend reaction time
Soil Washing	i) Solubilities and partition coefficients ii) Grain size distribution iii) TOC and humic material content iv) Cation Exchange Capacity (CEC)	i) High hydrophobic TOC and humic material content inhibits detergency ii) >30% silt and clay particles cancels out volume reduction benefit of process iii) Surfactant solutions may cause operating problems

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APPENDIX A - U.S. Waste Exchanges

CALIFORNIA WASTE EXCHANGE
Robert McCormick
Department of Health Services
Toxic Substances Control Division
400 P Street
Sacramento, CA 95812
(916) 324-1807

INDIANA WASTE EXCHANGE
Environmental Quality Control
1220 Waterway Boulevard
P.O. Box 1220
Indianapolis, IN 46206
(317) 232-8188

INDUSTRIAL MATERIAL EXCHANGE SERVICE
Diane Shockey
2200 Churchill Road, #31
Springfield, IL 62794-9276
(217) 782-0450
FAX: (217) 782-9142

INDUSTRIAL MATERIALS EXCHANGE
Bill Lawrence
172 20th Avenue
Seattle, WA 98122
(206) 296-4899
FAX: (206) 296-0188

PACIFIC MATERIALS EXCHANGE
Bob Smee
1522 No. Washington St.
Suite 202
Spokane, WA 99205
(509) 325-0551
FAX: (509) 325-2086
NATIONAL WASTE EXCHANGE NETWORK
1-800-858-6625

RENEW
Hope Castillo
Texas Water Commission
P.O. Box 13087
Austin, TX 78711
(512) 463-7773
FAX: (512) 463-8317

INDUSTRIAL WASTE INFORMATION EXCHANGE
William E. Payne
New Jersey Chamber of Commerce
5 Commerce Street
Newark, NJ 07102
(201) 623-7070

MONTANA INDUSTRIAL WASTE EXCHANGE
Don Ingles
Montana Chamber of Commerce
P.O. Box 1730
Helena, MT 59624
(406) 442-2405

NORTHEAST INDUSTRIAL WASTE EXCHANGE
Lewis M. Cutler
90 Presidential Plaza
Suite 122
Syracuse, NY 13202
(315) 422-6572
FAX: (315) 422-9051

SOUTHEAST WASTE EXCHANGE
Maxi May
Urban Institute
Dept. of Civil Engineering
Univ. of North Carolina
Charlotte, NC 28223
(704) 547-2307

SOUTHERN WASTE INFORMATION EXCHANGE
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Tallahassee, FL 32313
(904) 644-5516
FAX: (904) 574-6704

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 24 1997

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Feasibility Study Analysis and Administrative Record for Woodtreater Presumptive Remedy

FROM: Thomas Sheckells, Center Director
Region 3/8 Accelerated Response Center
Office of Emergency and Remedial Response

TO: Director, Office of Site Remediation and Restoration
Region I
Director, Emergency and Remedial Response Division
Region II
Director, Hazardous Waste Management Division
Regions III, IX
Director, Waste Management Division
Region IV
Director, Superfund Division
Regions V, VI, VII
Assistant Regional Administrator, Office of Ecosystem Protection & Remediation
Region VIII
Director, Environmental Cleanup Office
Region X

PURPOSE

The purpose of this memorandum is to transmit for Regional use the Administrative Record documents supporting the policy directive entitled "Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites." This directive was forwarded to the Regions in December, 1995, and the enclosed materials should be placed with this directive in the Regional Administrative Record center to justify the presumptive remedy approach at Woodtreater sites. The actual administrative record is fairly large and is being forwarded to the list of individuals provided in **Attachment A.** The list of the presumptive remedy workgroup members is included in **Attachment B.** The contents along with a general guide on the presumptive remedies Administrative Record is provided to you in **Attachment C.**

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BACKGROUND

Presumptive remedies are preferred technologies for a common category of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The use of presumptive remedies will improve the effiency of the Superfund program by building on past experience. The directive, along with the supporting documentation, will provide practical tools to the Regions for streamlining and accelerating remedy selection in accordance with the Superfund Accelerated Cleanup Model (SACM).

Through this effort, seven site categories have been identified for presumptive remedy guidance development. The supporting documentation to the Soils, Sediments, and Sludges at Woodtreating Sites is presently being forwarded to the Regions. Others include directives addressing volatile organic compounds (VOCs), municipal landfills, and groundwater response strategy which have already been issued and additional directives on polychlorinated biphenyls (PCBs), manufactured gas plants (MGPs), and grain storage.

IMPLEMENTATION

The attached documents along with the above cited presumptive remedy directives, are key elements of the administrative record for Soils, Sediments, and Sludges at Woodtreating Sites where the "presumptive remedy" approach is being used. Under the presumptive remedy approach, the Feasibility Study (FS) or Engineering Evaluation/Cost Analysis (EE/CA) is limited to considering only those technologies identified by EPA as presumptively appropriate for the specific site.

The attached documents in essence serve as a generic FS establishing the preferred technologies and screening out all other technologies. The documents should be placed in the administrative record, along with the appropriate directive, at the time the decision is made to use the presumptive remedy approach.

Regional personnel involved with woodtreater presumptive remedies sites should familiarize themselves with all the contents of the directive and the administrative record for this site type. A brief summary of how to use the administrative record along with the associated directive is presented in **Attachment C.** The guide is available electronically on the Superfund homepage under the "Technical Resources" section. The internet address is: **www.epa.gov/superfund/oerr/techres/index.htm.** For further information, please contact Frank Avvisato of my staff at 703-603-8949.

Attachments

cc: Stephen Luftig
George Wyeth

ATTACHMENT A

PRESUMPTIVE REMEDIES ADMINISTRATIVE RECORDS CONTACTS

REGION	CONTACT	PHONE
I	Margaret Meehan	617-573-9647
II	Jennie Delcimento	212-637-4296
III	Anna M. Butch	215-566-3157
IV	Debbie Jourdan	404-347-5059
V	Janet Pfundheller	312-353-5821
VI	Nancy G. Yarberry	214-665-6537
VII	Barry Thierer	913-551-7515
VIII	Carole Macy	303-312-6551
IX	Craig Cooper	415-744-2370
X	Bob Phillips	206-553-1751

ATTACHMENT B

Presumptive Remedies Workgroup Members

George Wyeth, OGC
Frank Avvisato, OERR
Scott Fredericks, OERR
Bruce Means, OERR
Harry Allen, ERT
Frank Freestone, ORD
Fran Kremer, ORD
Jim Cummings, TIO
Mike Nalipinski, Region I
Mel Hauptman, Region II
Paul Leonard, Region III
Felicia Barnett, Region IV
Dion Novak, Region V
Cathy Gilmore, Region VI
Diana Engeman, Region VII
Victor Kettelapper, Region VIII
Craig Cooper, Region IX
Eric Winiecki, Region X

ATTACHMENT C

PRESUMPTIVE REMEDY ADMINISTRATIVE RECORD CONTENTS AND GUIDE

PURPOSE

This guide is intended to assist the U.S. Environmental Protection Agency (EPA) Regional staff and the public in understanding the administrative record documents and site-type directives for supporting presumptive remedies at individual sites. These documents and directives in essence serve as a generic FS establishing the preferred technologies as presumptive, and screening out all other technologies. Using this information will potentially streamline and accelerate the remedy selection process. In general, the administrative record for a site using presumptive remedies will consist of site-specific information (e.g., technical, administrative, legal) and the presumptive remedies administrative record components highlighted in the section below.

Note: As mentioned earlier, the guide is available electronically on the Superfund homepage under the "Technical Resources" section. The internet address is: **www.epa.gov/superfund/oerr/techres/index.htm.**

CONTENTS OF ADMINISTRATIVE RECORD

This section highlights and provides a brief discussion of the primary components of the administrative record for a site where the presumptive remedy approach is being used. The contents of the Record include:

I. Presumptive Remedies Directives

II. Feasibility Study Analysis Report (FSAR) and Supporting Technical Background Documents

III. Feasibility Studies for sites supporting FSAR

IV. Records of Decision for sites supporting FSAR

V. Other Reference Documents

A general discussion on the Presumptive Remedies Directives and the FSAR is provided below.

I. Directives:

The appropriate site-type directives (e.g., Presumptive Remedy for CERCLA Municipal Landfill sites) together with the General Policy and Procedure directive must be included in the Administrative Record. The policy and procedures directive addresses overall policy and programmatic issues associated with presumptive remedies. The site-type directive's text and

associated tables provide information on the technologies that were selected as presumptive remedies and provides the justification for such a selection. Appendix A to the site-type directive provides a statistical summary (drawn from the Feasibility Study Analysis for the site category) of the technologies screened out from further consideration. Appendix B contains a "nine criteria" analysis of the recommended technology or technologies. (NOTE: only seven criteria are addressed, because state and local acceptance can only be evaluated site specifically.) Appendix C contains the site-specific data collection forms which presents the site specific information from the FSs and RODs concerning remedy selection.

II. FS Analysis Reports

Another key component of the Administrative Record is the FS Analysis Report for the particular category of site. The FS Analysis Report provides information on the technologies that were screened from further consideration in site universe of FSs analyzed. This report in essence provides the justification for not considering these technologies in site-specific FSs when the presumptive remedy approach is being implemented. The report describes each technology, and the strengths and weaknesses of each, including factors that tend to limit each technology's usefulness. For each technology considered, the FS Analysis contains a conclusion explaining why that technology is not generally suitable for such sites. Finally, each document contains tables analyzing the technologies in terms of the remedy selection criteria.

The conclusions in the FS Analyses often contain some caveats because the suitability of a given technology may vary depending on site specific conditions. While the technology may be generally unsuitable for the particular type of site, it may be suitable for further consideration in exceptional cases.

The information in the FS Analyses is drawn in part from prior feasibility studies, and partly from other sources (e.g., technical resource documents). In some cases, either to respond to comments or for other reasons, users may wish to review the underlying documentation used in developing the FS analysis.

Finally, the appendices the FS Analysis contain useful supporting information. Appendix A to the FS Analyses provides a statistical summary of the rationale or basis used for screening out the non-recommended technologies as cited in past feasibility studies (similar to Appendix A in directive). Appendix B describes in greater detail the reasons given in past feasibility studies for screening each technology out where it was excluded at the preliminary screening phase. Appendix C summarizes the findings of each feasibility study analyzed as part of this study, on a site by site basis.

III. Technical Background Documents, Feasibility Studies, Records of Decision, and Other Reference Materials

The directives and the FS Analyses discussed above are documents that were based on various technical literature, site-specific FS Reports and Records of Decisions and other reference materials. As such, this material is also an integral part of the administrative record

and should be placed with the other materials to support presumptive remedies at a particular site.

IMPLEMENTATION

The user should be aware that both the directives and FS analyses present statistical information on the conclusions drawn in past feasibility studies including the number of times each technology was rejected at the preliminary screening phase, the number of times each was rejected at the detailed analysis phase, and the number of times each was selected. While such statistical analysis does not provide reasons for such decisions (and the reasons may have differed from site to site), it can be valuable as a reflection of the agency's past experience.

Before choosing the presumptive remedy approach, Agency personnel should review the FS Analysis to determine whether unusual site conditions exist that warrant further consideration of non-presumptive remedy technologies. Additionally, the use of this approach should be discussed early and often with the community, state, and the potentially responsible parties (PRPs). Further assistance on the implementation of this initiative is available through the Headquarters and Regional Presumptive Remedies contacts (highlighted in Appendix C).

Additionally, the user should note that these documents are meant to provide a basic level of justification for the presumptive remedy, not to answer all possible questions or comments about the selection of the presumptive remedy. In some cases, outside parties may submit comments supporting technologies other than those recommended. A decision will have to be made in each such case as to whether the material provided here adequately addresses the comment, or whether additional record support is needed.

For example, if a commenter contends that unusual site conditions warrant considering a different technology, the FS analysis should be reviewed to determine whether it adequately addresses that argument. If a comment supports a technology not discussed in the FS analysis at all (e.g., an innovative technology), a site specific response will have to be provided. In such cases a decision might be made to consider the innovative technology along with the recommended technologies. A case-by-case decision will have to be made based on the information available on the technology and best engineering judgement.

Finally, if all parties have agreed to this approach, the administrative and technical documents (e.g., Work Plan, FSs, EE/CAs, Proposed Plans, RODs, etc.) for the site should indicate that the site followed the presumptive remedy approach and is supported by the documentation provided in the administrative record.

United States
Environmental Protection
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Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites

Final Guidance

NOTICE

This document provides guidance to EPA staff. It also provides guidance to the public and to the regulated community on how EPA intends to exercise its discretion in implementing the National Contingency Plan. The guidance is designed to implement national policy on these issues. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus, it cannot impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA may change this guidance in the future, as appropriate.

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ACRONYMS USED IN THIS GUIDANCE

ACL	Alternate Concentration Limit
ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by SARA
CERI	Center for Environmental Research Information
CFR	Code of Federal Regulations
CSGWPP	Comprehensive State Ground Water Protection Program
DNAPL	Dense Nonaqueous Phase Liquids
EPA	Environmental Protection Agency
ESD	Explanation of Significant Differences
FS	Feasibility Study
GAC	Granular Activated Carbon
LNAPL	Light Nonaqueous Phase Liquids
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NAPL	Nonaqueous Phase Liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OERR	Office of Emergency and Remedial Response
ORD	Office of Research and Development
OSWER	Office of Solid Waste and Emergency Response
PCB	Polychlorinated Biphenyl Compounds
POTW	Publicly Owned Treatment Works
RARA	Resource Conservation and Recovery Act
RD	Remedial Design
RD/RA	Remedial Design/Remedial Action
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SACM	Superfund Accelerated Cleanup Model
SARA	Superfund Amendments and Reauthorization Act of 1986
UV	Ultra Violet (light)
VOC	Volatile Organic Compound

PREFACE

Presumptive Remedies Initiative. The objective of the presumptive remedies initiative is to use the Superfund program's past experience to streamline site investigations and speed up selection of cleanup actions. Presumptive remedies are expected to increase consistency in remedy selection and implementation, and reduce the cost and time required to clean up similar types of sites. The presumptive remedies approach is one tool within the Superfund Accelerated Cleanup Model (SACM) (EPA, 1992d).

Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. Refer to EPA Directive, *Presumptive Remedies: Policy and Procedures* (EPA, 1993d) for general information on the presumptive remedy process and issues common to all presumptive remedies. This directive should be reviewed before utilizing a presumptive remedy and for further information on EPA expectations concerning the use of presumptive remedies. **"Presumptive remedies are expected to be used at all appropriate sites,"** except under unusual site-specific circumstances (EPA, 1993d).

Other Presumptive Remedy Guidance. Previous fact sheets from EPA's Office of Solid Waste and Emergency Response (OSWER) have established presumptive remedies for municipal landfill sites (EPA, 1993f), for sites with volatile organic compounds in soils (EPA, 1993e) and for wood treater sites (EPA, 1995g). A presumptive response selection strategy for manufactured gas plant sites is under development. Additional fact sheets are in progress for sites contaminated with polychlorinated biphenyl compounds (PCBs), metals in soils and for grain storage sites.

Relation of this Guidance to Other Presumptive Remedies. The fact sheets mentioned above provide presumptive remedies (or a strategy for selecting remedies) for "source control" at specific types of sites. With respect to ground-water response, source control refers to containment or treatment of materials that may leach contaminants to ground water, or a combination of these approaches. In general, treatment is expected for materials comprising the principal threats posed by a site, while containment is preferred for low level threats (EPA, 1991c). Where contaminants have reached ground water and pose an unacceptable risk to human health or the environment, a ground-water remedy will generally be required in addition to the source control remedy and this guidance should be consulted.

Instead of establishing one or more presumptive remedies, this guidance defines a **presumptive response strategy**. EPA expects that some elements of this strategy will be appropriate for **all** sites with contaminated ground water and all elements of the strategy will be appropriate for many of these sites. In addition, this guidance identifies **presumptive technologies** for the ex-situ treatment component of a ground-water remedy, that are expected to be used for sites where extraction and treatment is part of the remedy. (The term presumptive technology is used in this guidance to denote only the ex-situ treatment component of a ground-water remedy.) Other remedy components could include methods for extracting ground water, enhancing contaminant recovery or degradation of contaminants in the subsurface, discharging treated water, preventing contaminant migration, and institutional or engineering controls to prevent exposure to contaminants.

Applicability to RCRA Corrective Action Program. EPA continues to seek consistency between cleanup programs, especially in the process of selecting response actions for sites regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund program) and corrective measures for facilities regulated under the Resource Conservation and Recovery Act (RCRA). In general,

even though the Agency's presumptive remedy guidances were developed for CERCLA sites, they should also be used at RCRA Corrective Action sites to focus RCRA Facility Investigations, simplify evaluation of remedial alternatives in the Corrective Measures Study, and influence remedy selection in the Statement of Basis. For more information refer to the RCRA Corrective Action Plan (EPA, 1994c), the proposed Subpart S regulations (Federal Register, 1990b), and the May 1, 1996 RCRA Corrective Action Advance Notice of Proposed Rulemaking (Federal Register, 1996).

Use of this Guidance. The **presumptive response strategy**, described in Section 2.1, integrates site characterization, early actions, remedy selection, performance monitoring, remedial design and remedy implementation activities into a comprehensive, overall response strategy for sites with contaminated ground water. By integrating these response activities, the presumptive strategy illustrates how the Superfund Accelerated Cleanup Model (SACM) can be applied to ground-water cleanup. Although this response strategy will not necessarily streamline the remedial investigation/feasibility study (RI/FS) phase, EPA expects that use of the presumptive strategy will result in significant time and cost savings for the overall response to contaminated ground water. By providing a mechanism for selecting achievable remediation objectives, the presumptive strategy will minimize the need for changing these objectives during remedy implementation. By optimizing the remedy for actual site conditions during implementation, the effectiveness of the selected remedy can be greatly increased, which will reduce the time and cost required to achieve remediation objectives.

The **presumptive technologies** for treating extracted ground water, identified in Section 3.1, are the technologies that should generally be retained for further consideration in the Detailed Analysis portion of the feasibility study (or in the remedial design as explained in Section 3.3.3). This guidance and its associated Administrative Record will generally constitute the Development and Screening of Alternatives portion of the feasibility study (FS) for the ex-situ treatment component of a ground-water remedy (see Section 3.3.2). In this respect, the presumptive technologies will streamline the FS for this component of a ground-water remedy in the same way that other "presumptive remedies" streamline the FS for the overall remedy for their respective site types (see EPA, 1993d).

1.0 INTRODUCTION

In implementing the Superfund and other remediation programs, cleanup of contaminated ground water has proven to be more difficult than anticipated. For many sites, the program expectation of returning ground waters to their beneficial uses (see Section 1.2.1) often requires very long time periods and may not be practicable for all or portions of the site. Thus, the ultimate cleanup goal for ground water may need to be different over different areas of the site (see Section 1.3.1). For sites where achieving the ultimate goal will require a long time period, interim remediation objectives will generally be appropriate, such as preventing further plume migration. **Therefore, a critical first step in the remedy selection process is to determine the full range of remedial objectives that are appropriate for a particular site.**

This guidance is intended to emphasize the importance of using site-specific remedial objectives as the focus of the remedy selection process for contaminated ground water. Those remedy components that influence attainment of remedial objectives should receive the greatest attention. For example if restoring the aquifer to beneficial use is the ultimate objective, remedy components that influence attainment of cleanup levels in the aquifer include: methods for extracting ground water, enhancing contaminant recovery, controlling subsurface contaminant sources (e.g., nonaqueous phase liquids or NAPLs, discussed in Appendix A1) or in-situ treatment of contaminants. **Some or all of these remedy components should be included in remedial alternatives that are developed and evaluated in detail in the feasibility study (FS) when aquifer restoration is a remedial objective.**

Although the technologies employed for treating extracted ground water and the types of discharge for the treated effluent are important aspects of a remedy, they have little influence on reducing contaminant levels or minimizing contaminant migration in the aquifer. In developing this guidance, historical patterns of remedy selection and available technical information were reviewed in order to identify presumptive technologies for ex-situ treatment of ground water. **By providing presumptive technologies, this guidance attempts to streamline selection of these technologies and shift the time and resources employed in remedy selection to other, more fundamental aspects of the ground-water remedy.**

Although extraction and treatment has been and will continue to be used as part of the remedy for many sites with contaminated ground water, it may **not** be the most appropriate remediation method for all sites or for all portions of a given contaminant plume. Also, remedial alternatives that combine extraction and treatment with other methods, such as natural attenuation (defined in Section 2.6.5) or in-situ treatment, may have several advantages over alternatives that utilize extraction and treatment alone (see Section 2.4.2). (Remedial alternatives are evaluated against remedy selection criteria defined in the National Contingency Plan at §300.430(e)(9)(iii) (Federal Register, 1990a).) In general, the remedy selection process should consider whether extraction and treatment can achieve remedial objectives appropriate for the site and how this approach can be most effectively utilized to achieve these objectives. **This guidance also describes a presumptive response strategy which facilitates selection of both short and long-term remediation objectives during remedy selection, and allows the effectiveness of the remedy to be improved during implementation.**

1.1 Purpose of Guidance

In summary, this guidance is intended to:

- **Describe a presumptive response strategy**, at least some elements of which are expected to be appropriate for **all** sites with contaminated ground water;

- **Identify presumptive technologies** for treatment of extracted ground water (ex-situ treatment) that are expected to be used (see EPA,1993d) for sites where extraction and treatment is part of the remedy;

- **Simplify the selection** of technologies for the ex-situ treatment component of a ground-water remedy, and improve the technical basis for these selections; and

- **Shift the time and resources** employed in remedy selection from ex-situ treatment to other, more fundamental aspects of the ground-water remedy, as discussed above.

1.2 Expectations and Objectives for Ground-Water Cleanup

Careful consideration should be given to national program expectations as well as site-specific conditions when determining cleanup objectives that are appropriate for a given site.

1.2.1 Program Expectations. Expectations for contaminated ground water are stated in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), as follows:

> "EPA expects to return usable ground waters to their **beneficial uses** wherever practicable, within a **timeframe** that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is **not practicable**, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction." (Federal Register, 1990a; §300.430 (a)(1)(iii)(F), emphasis added.)

The Preamble to the NCP explains that the program expectations are not "binding requirements." "Rather, the expectations are intended to share collected experience to guide those developing cleanup options" (Federal Register, 1990a; at 8702).

1.2.2 Objectives for Site Response Actions. The program expectations can be used to define the following overall objectives for site response actions, which are generally applicable for **all** sites with contaminated ground water:

- Prevent exposure to contaminated ground water, above acceptable risk levels;

- Prevent or minimize further migration of the contaminant plume (plume containment);

- Prevent or minimize further migration of contaminants from source materials to ground water (source control); and

- Return ground waters to their expected beneficial uses wherever practicable (aquifer restoration).

In this guidance the term "response action" is used to indicate an action initiated under either CERCLA removal or remedial authority. "Response objective" is the general description of what a response action is intended to accomplish. Source control is included as an objective because the NCP expectation of aquifer restoration will not be possible unless further leaching of contaminants to ground water is controlled, from both surface and subsurface sources. **The objectives, given above, are listed in the sequence in which they should generally be addressed at sites.**

Monitoring of ground-water contamination is not a separate response objective, but is necessary to verify that one or more of the above objectives has been attained, or will likely be attained (see Section 2.1.3). Other response objectives may also be appropriate for some sites, depending on the type of action being considered and site conditions (e.g., maximizing the reuse of extracted ground water may be an appropriate objective for some sites). **Response objectives may be**

different over different portions of the contaminant plume, as discussed in Section 1.3.1.

1.3 Lessons Learned

The most important lesson learned during implementation of Superfund and other remediation programs is that complex site conditions are more common than previously anticipated, including those related to the source and type of contaminants as well as site hydrogeology. As a result of these site complexities, restoring all or portions of the contaminant plume to drinking water or similar standards may not be possible at many sites using currently available technologies.

1.3.1 Sources and Types of Contaminants. Approximately 85 percent of sites on the CERCLA National Priorities List (NPL sites) have some degree of ground-water contamination. Contaminants have been released to ground water at a wide variety of site types and can include a variety of contaminants and contaminant mixtures. **Sources** of contaminants to ground water not only include facilities from which the original release occurred (e.g., landfills, disposal wells or lagoons, storage tanks and others) but also include contaminated soils or other subsurface zones where contaminants have come to be located and can continue to leach into ground water (e.g., NAPLs, see Appendix A1). Thus, the plume of contaminated ground water may encompass NAPLs in the subsurface (sources of contamination) as well as dissolved contaminants. In this case, different response objectives may be appropriate for different portions of the plume. For example, source control (e.g., containment) may be the most appropriate response objective for portions of the plume where NAPLs are present and can not practicably be removed, while aquifer restoration may be appropriate only for the remaining portions of the plume (see Section 2.5.3).

Although originating from a variety of sources, contaminants which reach ground water tend to be those that are relatively mobile and chemically stable in the subsurface environment (e.g., less likely to sorb to soil particles or degrade above the water table). Organic and inorganic contaminants most frequently found in ground water at CERCLA sites are listed in Appendix A2. Sixteen of the 20 most common organic contaminants are volatile organic compounds (VOCs). Of the 16 VOCs, 12 are chlorinated solvents and four are chemicals found in petroleum fuels. Petroleum fuels are **light** nonaqueous phase liquids (LNAPLs, with a density lighter than water); while most chlorinated solvents are **dense** nonaqueous phase liquids (DNAPLs) in pure form (see Appendix A1).

1.3.2 Factors Limiting Restoration Potential. At many sites, restoration of ground water to cleanup levels defined by applicable or relevant and appropriate requirements (ARARs) or risk-based levels may not be possible over all or portions of the plume using currently available technologies. Two types of **site conditions** inhibit the ability to restore ground water:

- Hydrogeologic factors, and
- Contaminant-related factors.

Recent studies by EPA and others have concluded that complex site conditions related to these factors are more common at hazardous waste sites than originally expected (EPA, 1989a, 1992b, 1992g, and 1993b; and the National Research Council, 1994). Examples of hydrogeologic or contaminant-related factors affecting the difficulty of restoring ground water are given in Figure 1. These types of site conditions should be considered in the **site conceptual model**, which is an interpretive summary of the site information obtained to date (**not** a computer model). Refer to EPA, 1993b and 1988a for additional information concerning the site conceptual model. **For every site, data should be reviewed or new data should be collected to identify factors that could increase (or decrease) the difficulty of restoring ground water.**

Figure 1. Examples of Factors Affecting Ground-Water Restoration Potential

Certain site characteristics may limit the effectiveness of subsurface remediation. The examples listed below are highly generalized. The particular factor or combination of factors that may critically limit restoration potential will be site specific. (Figure 1 is taken from EPA, 1993b with minor modifications.)

Site/Contaminant Characteristics		Generalized Remediation Difficulty Scale (Increasing difficulty →)	
Site Use	Nature of Release	Small Volume Short Duration Slug Release	Large Volume Long Duration Continual Release
Chemical Properties	Biotic/Aboitic Decay Potential	High	Low
	Volatility	High	Low
	Contaminant Retardation (Sorption) Potential	Low	High
Contaminant Distribution	Contaminant Phase	Aqueous, Gaseous → Sorbed → LNAPLs	DNAPLs
	Volume of Contaminated Media	Small	Large
	Contaminant Depth	Shallow	Deep
Hydrogeologic Characteristics			
Geology	Stratigraphy	Simple Geology, e.g., Planar Bedding Strata	Complex Geology, e.g., Interbedded and Discontinuous
	Texture of Unconsolidated Deposits	Sand	Clay
	Degree of Heterogeneity	Homogeneous e.g., well-sorted sand	Heterogeneous e.g., interbedded sand and silts, clays, fractured media, karst
Hydraulics/Flow	Hydraulic Conductivity of Aquifer	High (>10^{-2} cm/sec)	Low (< 10^{-6} cm/sec)
	Temporal Variation of Flow Regime	Little/None	High
	Vertical Flow	Little Component	Large Downward Flow

1.3.3 Assessing Restoration Potential. Characterizing **all** site conditions that could increase the difficulty of restoring ground water is often not possible. As a result, the likelihood that ARAR or risk-based cleanup levels can be achieved (**restoration potential**) is somewhat to highly uncertain for many sites, even after a relatively complete remedial investigation. This uncertainty can be reduced by using remedy performance in combination with site characterization data to assess the restoration potential. By implementing a ground-water remedy in more than one step or phase (as two separate actions or phasing of a single action as described in Section 2.2), performance data from an initial phase can be used to assess the restoration potential and may indicate that additional site characterization is needed. In addition to providing valuable data, the initial remedy phase can be used to attain short-term response objectives, such as preventing further plume migration. Phased implementation of response actions also allows realistic long-term remedial objectives to be determined prior to installation of the comprehensive or "final" remedy.

A detailed discussion of factors to consider for assessing restoration potential is provided in *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration* (EPA, 1993b; Section 4.4.4). An especially important tool for this evaluation is the site conceptual model, which should integrate data from site history, characterization and response actions. This assessment could provide justification for waiving ARARs due to technical impracticability from an engineering perspective over all or portions of a site (EPA, 1993b). It is recommended that technical assistance be enlisted from regional technical support staff or the Technical Support Project (EPA, 1994d) when evaluating technical impracticability.

Data from remedy performance are not always necessary to justify an ARAR waiver due to technical impracticability (see Section 2.6.3). At the completion of the remedial investigation (RI), site conditions may have been characterized to the extent needed for EPA (or the lead agency) to determine that ground-water restoration is technically impracticable from an engineering perspective (EPA, 1993b; EPA 1995b). For this case, an ARAR waiver request can be submitted to EPA (or the lead agency), and if approved, included in the Record of Decision (ROD). It will often be appropriate to include an ARAR waiver in the ROD for portions of a site where DNAPLs have been confirmed in the aquifer (see Section 2.5.3).

2.0 PRESUMPTIVE RESPONSE STRATEGY

2.1 Definition and Basis for Strategy

Key elements of the presumptive strategy are summarized in Highlight 1. In the presumptive response strategy, site characterization and response actions are implemented in a several steps, or in a **phased approach**. In a phased response approach, site response activities are implemented in a sequence of steps, or phases, such that information gained from earlier phases is used to refine subsequent investigations, objectives or actions (EPA, 1989a, 1992b, 1993b).

In general for sites with contaminated ground water, <u>site characterization</u> should be coordinated with <u>response actions</u> and <u>both</u> should be implemented in a step-by-step or phased approach.

Performance data from an initial response action are also used to assess the likelihood that ARAR or risk-based cleanup levels can be attained by later, more comprehensive actions. Although it is recognized that phased implementation may not be appropriate for all ground-water remedies, EPA expects that some elements of this strategy will be appropriate for **all** sites with contaminated ground water and that all elements will be appropriate for many of these sites. **For this reason, the response approach given in Highlight 1 is a**

Highlight 1. Presumptive Response Strategy

- For sites with contaminated ground water, **site characterization should be coordinated with response actions** and both should be implemented in a phased approach (Sections 1.3.3 and 2.1).
- **Early or interim actions** should be used to reduce site risks (by preventing exposure to and further migration of contaminants) and to provide additional site data (Section 2.1.2).
- Site characterization and performance data from early or interim ground-water actions should be used to **assess the likelihood of restoring ground water** to ARAR or risk-based cleanup levels (restoration potential). (Sections 1.3.3 and 2.1.2.)
- The restoration potential should be assessed **prior to establishing objectives for the long-term remedy** (Sections 1.3.3 and 2.1.2).
- All ground-water actions should include provisions for **monitoring and evaluating their performance** (Section 2.1.3).
- Ground-water response actions, especially those using extraction and treatment, should generally be **implemented in more than one phase** -- either as two separate actions or phasing of a single action (Sections 2.2.1 and 2.2.2).
- In addition to phasing, **post-construction refinements** will generally be needed for **long-term** remedies, especially those using extraction and treatment (Section 2.3.1).

presumptive strategy for contaminated ground water.

Also, this response strategy is considered presumptive because the **basic elements were included in all previous policy directives** concerning ground-water remediation from EPA's Office of Solid Waste and Emergency recommended use of a phased approach for site characterization and response actions, and more frequent use of early actions to reduce site risks. Better integration of site activities and more frequent use of early actions are also essential components of the Superfund Accelerated Cleanup Model (SACM), defined in EPA, 1992d.

2.1.1 Benefits of Phased Approach. Implementing investigations and actions in phases provides the following major **benefits**:

- Data from earlier response actions are used to further characterize the site and assess restoration potential;
- Attainable objectives can be set for each response phase;
- Flexibility is provided to adjust the remedy in response to unexpected site conditions;
- Remedy performance is increased, decreasing remediation timeframe and cost; and
- Likely remedy refinements are built into the selected remedy, better defining the potential scope and minimizing the need for additional decision documents.

2.1.2 Early Actions. "Early" refers to the timing of the start of an action with respect to other response actions at a given site. For Superfund sites, early actions could include removal actions, interim remedial actions, or early final remedial actions (EPA, 1992b and EPA, 1991b). Although initiated prior to other actions, some early ground-water actions may need to operate over a long time

period (e.g., hydraulic containment actions). In this guidance the later, more comprehensive ground-water action is called the "long-term remedy, " consistent with SACM terminology (EPA, 1992e). Early actions that should be considered in response to contaminated ground water are listed in Highlight 2, categorized by response objective. **Early or interim actions should be used to reduce site risks (by preventing exposure to contaminated ground water and further migration of contaminants) and to provide additional site data.**

Factors for determining which response components are suitable for early or interim actions include: the timeframe needed to attain specific objectives, the relative urgency posed by potential or actual exposure to contaminated ground water (e.g., likelihood that contaminants will reach drinking water wells), the degree to which an action will reduce site risks, usefulness of information to be gained from the action, site data needed to design the action, and compatibility with likely long-term actions (EPA, 1992e). Whether to implement early response actions and whether to use removal or remedial authority for such actions should be determined by the "Regional Decision Team" defined under SACM (EPA, 1992f) or similar decision-making body for the site.

Early or interim actions should be integrated as much as possible with site characterization and with subsequent actions in a phased approach. Once implemented, early actions will often provide additional site characterization information, which should be used to update the site conceptual model. Also, treatability studies (see Section 3.4.5) needed for selection or design of the long-term remedy should be combined with early actions whenever practical. Site characterization and performance data from early or interim ground-water actions should be used to assess the likelihood of restoring ground water to ARAR or risk-based cleanup levels (restoration potential). **The restoration potential should be assessed prior to establishing objectives for the long-term remedy** (see Section 1.3.3).

Highlight 2. Early Actions That Should Be Considered

Prevent exposure to contaminated ground water:

- Plume containment
- Alternate water supply
- Well head treatment
- Use restrictions

Prevent further migration of **contaminant plume:**

- Plume containment
- Contain (and/or treat) plume "hot spots"

Prevent further migration of contaminants **from sources:**

- Source removal and/or treatment
  - Excavate wastes or soils and remove from site
  - Excavate soils and treat ex-situ
  - Treat soils in-situ
  - Extract **free-phase NAPLs** (see Appendix A1)
- Source containment
  - Contain wastes or soils
  - Contain subsurface **NAPLs**

Provide additional site data:

- Assess restoration potential
- Combine actions with treatability studies

2.1.3 Monitoring. Monitoring is needed to evaluate whether the ground-water action is achieving, or will achieve, the intended response objectives for the site (see Section 1.3.1) and other performance objectives for the action (e.g., discharge requirements). **All ground-water actions should include provisions for monitoring and evaluating their performance.** A monitoring plan should be developed for both early and long-term actions. In general, the monitoring plan should include:

- Response objectives and performance requirements for the ground-water action;
- Specific monitoring data to be collected;
- Data quality objectives;
- Methods for collecting, evaluating and reporting the performance monitoring data; and
- Criteria for demonstrating that response objectives and performance requirements have been attained.

Flexibility for adjusting certain aspects of monitoring during the life of the remedy should be included in the monitoring plan, such as changes in the monitoring frequency as the remedy progresses or other changes in response to remedy refinements (see Section 2.3.1). A detailed discussion of the data quality objectives process is provided in EPA, 1993j. Methods for monitoring the performance of extraction and treatment actions are discussed in EPA, 1994e.

2.2 Phased Response Actions

In general, ground-water response actions, especially those using extraction and treatment, should be implemented in more than one phase. There are two options for phasing response actions - implementation of two separate actions, or implementation of a single action in more than one phase. It is recognized that phased implementation may not be appropriate for all ground-water remedies. In some cases, it may be more appropriate to install the entire remedy and then remove from service those components that later prove to be unneeded.

2.2.1 Two Separate Actions. In this approach an early or interim ground-water action is followed by a later, more comprehensive action (the long-term remedy). A flow chart of this approach is given in Figure 2. Earlier ground-water actions are used to mitigate more immediate threats, such as preventing further plume migration. Response objectives for the long-term remedy are not established until after performance of the earlier action is evaluated and used to assess the likelihood that ground-water restoration (or other appropriate objectives) can be attained. Two separate decision documents are used, in which response objectives are specified that are appropriate for each action. The earlier decision document could be an Action Memorandum or an Interim Record of Decision (Interim ROD), since the early action could be initiated under either CERCLA removal or remedial authority. **This approach should be used when site characterization data are not sufficient to determine the likelihood of attaining long-term objectives (e.g., restoring ground water) over all or portions of the plume, which will be the case for many sites.** In order to provide sufficient data for assessing the restoration potential, the early or interim action may need to operate for several years.

2.2.2 Phasing of a Single Action. In this approach the long-term remedy for ground water is implemented in more than one design and construction phase. A flow chart of this approach is given in Figure 3. Response objectives for the long-term remedy are specified in a single Record of Decision (ROD) prior to implementing the remedy. Provisions for assessing the attainability of these objectives using performance data from an initial remedy phase are also included in the ROD. Thus, phased remedy implementation and assessment of remedy performance are specified in one ROD. A second decision document could still be required if evaluation of the first phase

Figure 2. Phased Ground-Water Actions: Early Action Followed by Long-Term Remedy

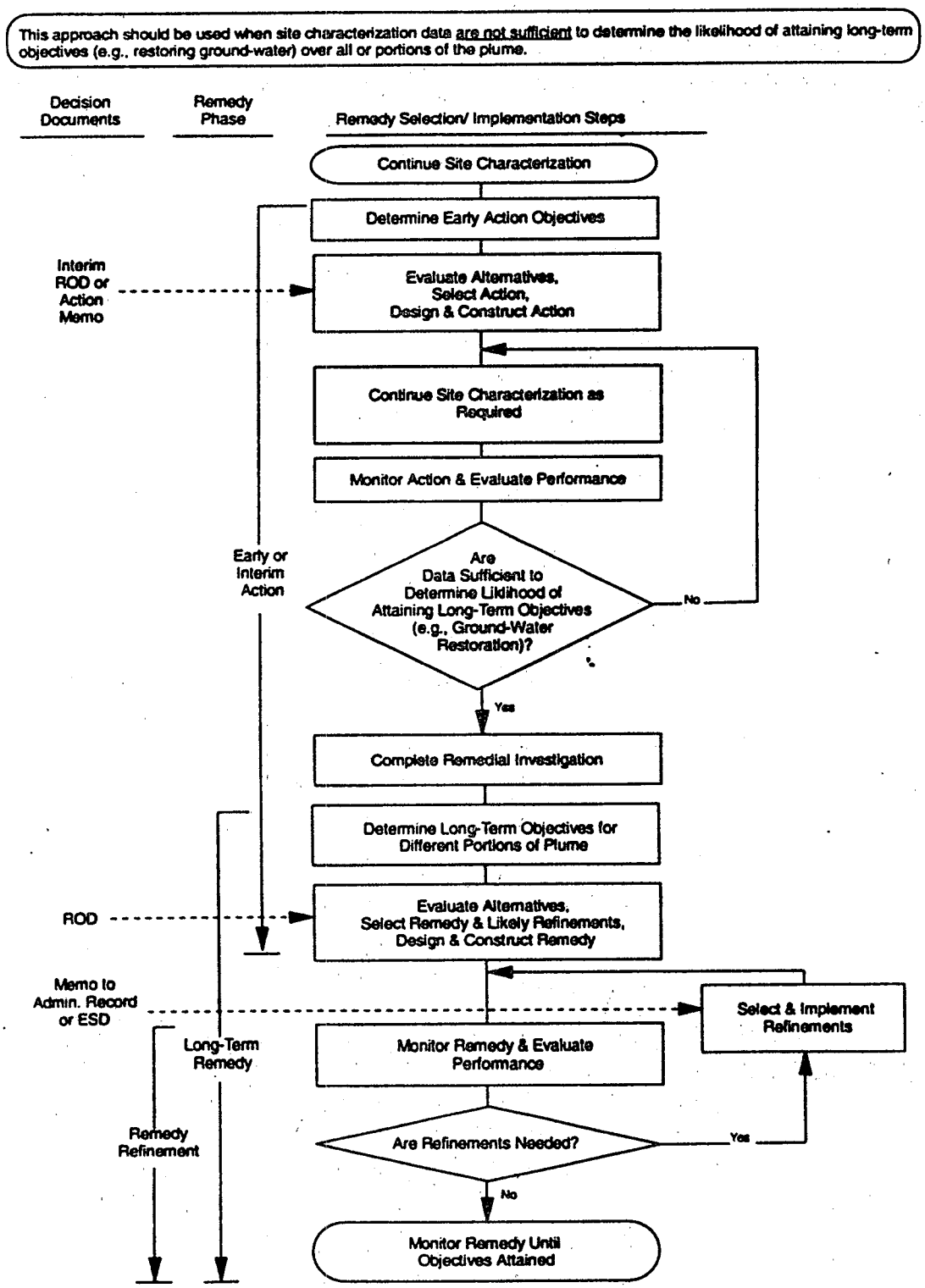
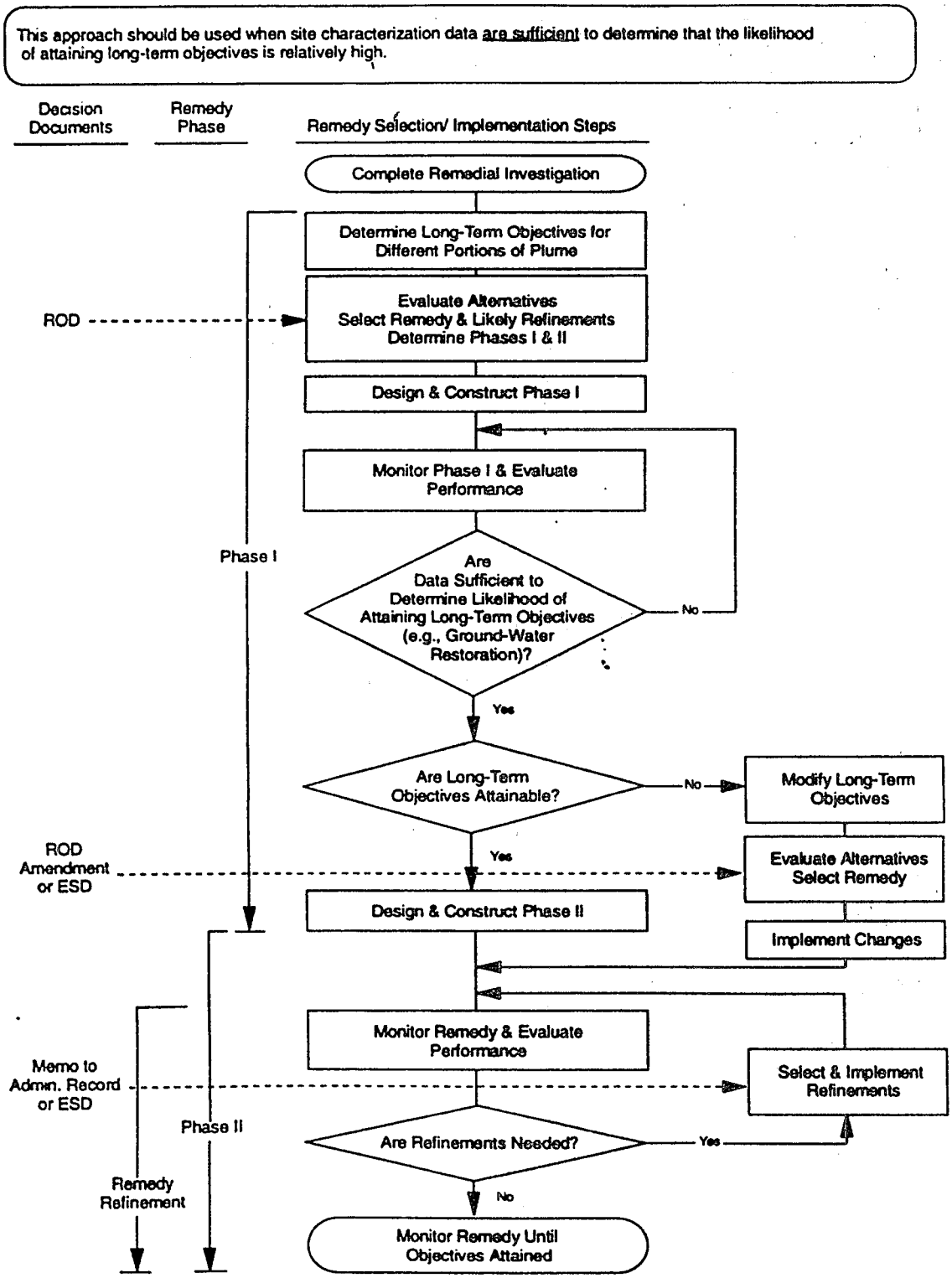


Figure 3. Phased Ground-Water Actions: Long-Term Remedy Implemented in Phases



indicates that long-term objectives or other aspects of the remedy require modification, and the modified remedy differs significantly from the selected remedy in terms of scope, performance or cost (EPA, 1991a). **This approach should be used when site characterization data indicate that the likelihood of attaining long-term objectives is relatively high.**

When phased remedy implementation is specified in a ROD, the Agency should ensure that the proposed plan contains sufficient information regarding the nature, scope timing and basis of future decision points and alternatives that the public is able to evaluate and comment on the proposed remedy. Example language illustrating how such an approach can be specified in the selected remedy portion of the ROD is included in Appendices B1 and B2 for hypothetical sites. These examples follow the suggested ROD language given in EPA, 1990b, although the wording has been updated to reflect this and other recent guidance (EPA, 1993b). For comparison, suggested ROD language from the EPA, 1990b is included as Appendix B4.

Phased implementation of a remedy can often be beneficial even for relatively simple ground-water actions. For example, one extraction well could be installed as the initial phase and the performance of this well would be used to determine whether any additional wells are needed and whether long-term objectives need to be re-evaluated.

Phased implementation of an extraction and treatment remedy will require that the treatment system be designed to accommodate phased installation of the extraction system. Presumptive technologies for the treatment system and other design considerations are discussed in Section 3. Use of modular treatment components, which can be easily added or removed from the treatment system, may facilitate phased implementation or other changes in flow or contaminant concentration that may occur during the life of a remedy. Another approach is to design the treatment system for the higher flows expected from all phases of the extraction system. Some components of the remedy, such as buried portions of the piping distribution system, are difficult to install in phases and should be designed to carry the highest expected flows.

2.3 Post-Construction Refinements

Even after phased implementation of a ground-water remedy, post-construction refinements will generally be needed because of the long time period over which the remedy will operate, especially for extraction and treatment remedies. The refinement portion of the long-term remedy, after phased design and construction, is shown in both Figures 2 and 3.

2.3.1 Types of Refinements. Post-construction refinements that should be considered for extraction and treatment remedies are given in Highlight 3. These refinements are intended to be relatively minor changes to the remedy (i.e., for which an Explanation of Significant Differences (ESD) or ROD Amendment would generally **not** be required). For example, adding a new extraction or reinjection well, or a few additional monitoring wells should be considered a minor modification to a remedy that includes a relatively large number of such wells, because the overall scope, performance and cost of the remedy are not significantly changed (EPA, 1991a). One or more such refinements should generally be implemented when the results of a remedy evaluation indicate that they are needed to increase the performance of the remedy or to decrease the remediation timeframe.

2.3.2 Documenting Refinements. Potential post-construction refinements should be included in the ROD as part of the selected remedy. Listing specific remedy refinements in the ROD serves to communicate the anticipated full scope of the remedy to all concerned parties at an early date, and also minimizes the likelihood that a subsequent **ESD or ROD Amendment will be needed.** When remedy refinements are specified in a ROD, the Agency should ensure that the

Highlight 3. Remedy Refinements for Extraction/Treatment Remedies

- Change the extraction rate in some or all wells.
- Cease extraction from some wells.
- Initiate "pulsed pumping" (see Appendix A4).
- Add or remove extraction or reinjection wells, or drains.
- Add or remove monitoring wells.
- Refine source control components of remedy.
- Refine enhanced recovery or in-situ degradation components of remedy (see Note).
- Refine ex-situ treatment components

NOTE: A ground-water remedy could include both extraction and treatment and in-situ treatment methods.

proposed plan contains sufficient information regarding the nature, scope timing and basis of future decision points and alternatives that the public is able to evaluate and comment on the proposed remedy. Example ROD language specifying likely post-construction refinements for the extraction portion of the selected remedy is given in Appendices B1 and B2. Even if an ESD is not required, a letter or memorandum should be included in the post-ROD portion of the Administrative Record explaining the minor remedy modifications and the reasons for them. Additional information concerning documentation of remedy modifications can be found in the EPA fact sheet entitled *Guide to Addressing Pre-ROD and Post-ROD Changes* (EPA, 1991a).

2.4 Integrating Response Actions

In general, actions in response to contaminated ground water should be planned and implemented as part of an overall strategy. Earlier actions (see Highlight 2 for examples) should be compatible with and not preclude implementation of later actions. For example, permanent facilities should not be constructed which could interfere with possible later actions (e.g., structures that would interfere with later construction of extraction wells or of a cap).

2.4.1 Integrating Source Control and Ground-Water Actions. Restoration of contaminated ground water generally will not be possible unless contaminant sources have been controlled in some manner. Source control is a critical component for active restoration remedies (e.g., extraction and treatment and in-situ methods) as well as for natural attenuation (defined in Section 2.6.5). Selection of appropriate source control actions should consider whether other contaminant sources (i.e., NAPLs) are likely to be present in addition to contaminated soils. If NAPLs are present, the vast majority of contaminant mass will likely reside in the subsurface NAPLs rather than in the surficial soils. Therefore, for this case source control actions that are intended to minimize further contamination of ground water should focus on controlling migration of contaminants from the subsurface NAPLs. Also, capping or treatment of surficial soils may be needed to prevent exposure to contaminants from direct soil contact or inhalation, but these actions alone would be ineffective in preventing further contamination of ground water at sites where NAPLs are present.

2.4.2 Combining Ground-Water Restoration Methods. A remedy could include more than one method for restoring ground water to its beneficial uses, such as combining extraction and treatment with natural attenuation or in-situ-treatment with extraction and treatment. Extraction and treatment is especially useful for providing hydraulic containment of those portions of the

plume where contaminant sources are present (e.g., subsurface NAPLs or contaminated soils), or for containing or restoring those plume areas with relatively high concentrations of dissolved contamination ("hot spots"). However, extraction and treatment may not be the best method for restoring large areas of the plume with low contaminant levels.

Once source areas are controlled, natural attenuation may be able to restore large portions of the plume to desired cleanup levels in a timeframe that is reasonable (see Section 2.6.2) when compared with the timeframe and cost of other restoration methods. Thus, natural attenuation of some plume areas combined with extraction and treatment to contain source areas and/or plume "hot spots" may be the most appropriate restoration approach for many sites with relatively large, dilute plumes. Whether or not natural attenuation is used alone or combined with other remediation methods, the Agency should have sufficient information to demonstrate that natural processes are capable of achieving the remediation objectives for the site. EPA is currently preparing a directive that will provide more detailed discussion of EPA policy regarding the use of natural attenuation for remediation of contaminated ground water (EPA, 1996c).

By combining in-situ treatment and extraction and treatment methods it may be possible to significantly increase the effectiveness with which contaminants are removed from the aquifer. In this guidance, in-situ treatment methods for ground water are divided into two types:

- Methods that can be used to **enhance contaminant recovery** during extraction and treatment (e.g., water, steam or chemical flooding; hydraulic or pneumatic fracturing); and

- Methods for **in-situ degradation of contaminants** generally involve adding agents to the subsurface (i.e., via wells or treatment walls) which facilitate chemical or biological destruction, and have the potential to be used as an alternative to extraction and treatment for long-term restoration of ground water.

Examples of both types of in-situ treatment methods are given in Appendix A3. Reinjection of treated ground water can be used as a method for enhancing contaminant recovery as well as a discharge method, if the reinjection is designed for this purpose as part of an extraction and treatment remedy. When considering enhanced recovery methods for sites with subsurface NAPLs, potential risks of increasing the mobility of NAPLs should be evaluated. Methods of in-situ degradation of contaminants most frequently used at Superfund sites include air sparging, various types of in-situ biological treatment and permeable treatment walls or gates (EPA, 1995e). Additional information concerning air sparging and permeable treatment walls is available in EPA, 1995f and EPA, 1995d, respectively. EPA encourages the consideration, testing and use of in-situ technologies for ground-water remediation when appropriate for the site.

2.5 Strategy for DNAPL Sites

Dense nonaqueous phase liquids (DNAPLs) pose special cleanup difficulties because they can sink to great depths in the subsurface, continue to release dissolved contaminants to the surrounding ground water for very long time periods, and can be difficult to locate. Due to the complex nature of DNAPL contamination, a phased approach to characterization and response actions is especially important for sites where DNAPLs are confirmed or suspected. A recent EPA study concluded that subsurface DNAPLs may be present at up to 60 percent of CERCLA National Priorities List sites (EPA, 1993c). Refer to Appendix A1 for additional background information on DNAPLs.

Two types of subsurface contamination can be defined at DNAPL sites, the:

- DNAPL zone, and the

- Aqueous contaminant plume.

The **DNAPL zone** is that portion of the subsurface where immiscible liquids (free-phase or residual DNAPL) are present either above or below the water table. Also in the DNAPL zone, vapor phase DNAPL contaminants are present above the water table and dissolved phase below the water table. The **aqueous contaminant plume** is that portion of the contaminated ground water surrounding the DNAPL zone where aqueous contaminants derived from DNAPLs are dissolved in ground water (or sorbed to aquifer solids) and immiscible liquids are not present.

2.5.1 Site Characterization. If DNAPLs are confirmed or suspected, the remedial investigation (RI) should be designed to delineate the:

- Extent of aqueous contaminant plumes, and the
- Potential extent of DNAPL zones.

Methods and strategies for characterizing DNAPL sites as well as suggested precautions are discussed in other guidance (EPA, 1992a and 1994b) and by Cohen and Mercer, 1993. The reason for delineating these areas of the site is that response objectives and actions should generally be different for the DNAPL zone than for the aqueous contaminant plume. It is recognized that for some sites complete delineation of the DNAPL-zone may not be possible.

2.5.2 Early Actions. The early actions listed in Highlight 2 should be considered. Also, the following early actions are specifically recommended for DNAPL sites (EPA 1992b, 1993b):

- Prevent further spread of the aqueous plume (plume containment);
- Prevent further spread of hot spots in the aqueous plume (hot spot containment);
- Control further migration of contaminants from subsurface DNAPLs to the surrounding ground water (source control); and
- Reduce the quantity of source material (**free-phase DNAPL**) present in the DNAPL zone, to the extent practicable (source removal and/or treatment).

At DNAPL sites, hot spots in the aqueous plume often are associated with subsurface DNAPLs. Therefore, the second and third actions listed above are essentially the same.

2.5.3 Long-Term Remedy. The long-term remedy should attain those objectives listed above for the **DNAPL zone**, by continuing early actions or by initiating additional actions. Although contaminated ground waters generally are not considered **principal threat** wastes, DNAPLs may be viewed as a principal threat because they are sources of toxic contaminants to ground water (EPA, 1991c). For this reason EPA expects to remove or treat DNAPLs to the extent practicable in accordance with the NCP expectation to "use treatment to address the principal threats posed by a site, wherever practicable" (Federal Register, 1990a; §300.430 (a)(1)(iii)(A)). However, program experience has shown that removal of DNAPLs from the subsurface is often not practicable, and no treatment technologies are currently available which can attain ARAR or risk-based cleanup levels where subsurface DNAPLs are present. **Therefore, EPA generally expects that the long-term remedy will control further migration of contaminants from subsurface DNAPLs to the surrounding ground water and reduce the quantity of DNAPL to the extent practicable.**

For the **aqueous plume**, the long-term remedy should:

- Prevent further spread of the aqueous plume (plume containment);

- Restore the maximum areal extent of the aquifer to those cleanup levels appropriate for its beneficial uses (aquifer restoration).

In general, restoration of the aquifer to ARAR or risk-based cleanup levels in a reasonable timeframe will not be attainable in the DNAPL zone unless the DNAPLs are removed. For this reason, it is expected that ARAR waivers due to technical impracticability will be appropriate for many DNAPL sites, over portions of sites where non-recoverable DNAPLs are present (EPA, 1995c). Also, EPA generally prefers to utilize ARAR waivers rather than ARAR compliance boundaries for such portions of DNAPL sites (see Section 2.6.4). A waiver determination can be made after construction and operation of the remedy or at the time of remedy selection (i.e., in the ROD), whenever a sufficient technical justification can be demonstrated (EPA, 1993b; EPA 1995b). For further information refer to Section 2.6.3 of this guidance and EPA's *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration* (EPA, 1993b). Restoration of the aqueous plume may also be difficult due to hydrogeologic factors, such as sorption of dissolved contaminants to solids in finer grained strata. For some sites, ARAR waivers may also be appropriate for all or portions of the aqueous plume when supported by adequate justification.

2.6 Areas of Flexibility in Cleanup Approach

The current response approach to contaminated ground water, as defined in the NCP and other guidance, includes several areas of flexibility in which response objectives and the timeframe in which to meet them can be adjusted to meet site specific conditions. These are briefly discussed below.

2.6.1 Beneficial Uses and ARARs. Since EPA generally expects to return contaminated ground waters to their beneficial uses wherever practicable, the required cleanup levels for a given site should be determined from applicable or relevant and appropriate requirements (ARARs) based on the current and expected future beneficial uses of the ground water at that site. Depending on state requirements and water quantity or quality characteristics, some ground waters are not expected to provide a future source of drinking water (e.g., EPA Class III ground waters (EPA, 1986) or similar state designations). In general, drinking water standards are relevant and appropriate cleanup levels for ground waters that are a current or future source of drinking water, but are not relevant and appropriate for ground waters that are not expected to be a future source of drinking water (Federal Register, 1990a; Preamble at 8732). (Drinking water standards include federal maximum contaminant levels (MCLs) and/or non-zero maximum contaminant level goals (MCLGs) established under the Safe Drinking Water Act, or more stringent state drinking water standards.) Ground waters may have other beneficial uses, such as providing base flow to surface waters or recharging other aquifers. For contaminated ground waters that discharge to surface water, water quality criteria established under the Clean Water Act, or more stringent state surface water requirements, may also be cleanup level ARARs (Federal Register, 1990a; Preamble at 8754). Thus, the beneficial uses of contaminated ground water at a particular site will generally provide the basis for determining which federal or state environmental requirements are applicable or relevant and appropriate cleanup levels. For additional information on the determination of cleanup levels, refer to EPA, 1988b, Chapter 4.

Determination of current and expected future beneficial uses should consider state ground-water classifications or similar designations. Several states have developed ground-water use or priority designations as part of a Comprehensive State Ground Water Protection Program (CSGWPP), defined in EPA, 1992h. EPA is currently developing a directive (EPA, 1996a) which will recommend that EPA remediation programs should generally defer to state determinations of future ground-water use -- even when this determination differs from the use that would

otherwise have been determined by EPA -- when such determinations are:

- Developed as part of an CSGWPP that is endorsed by EPA, and
- Based on CSGWPP provisions that can be applied at specific sites (EPA, 1996a).

This provision of the directive, when final, is intended to supersede previous guidance contained in the Preamble to the NCP (Federal Register, 1990a; at 8733). Refer to EPA, 1996a for additional information concerning the role of CSGWPPs in the selection of ground-water remedies. When information concerning beneficial uses is not available from a CSGWPP, ground-water classifications defined in EPA, 1986 (i.e., EPA Classes I, II or III) or "more stringent" state ground-water classifications (or similar state designations) should generally be used to determine the potential future use, in accordance with the NCP Preamble (Federal Register, 1990a; at 8732-8733). **Regardless of the ground-water use determination, remedies selected under CERCLA authority must protect human health and the environment and meet ARARs (or invoke an ARAR waiver).**

Many states have **antidegradation** or similar regulations or requirements that may be potential ARARs. Such requirements typically focus on 1) prohibiting certain discharges, 2) maintaining ground-water quality consistent with its beneficial uses, or 3) maintaining naturally occurring (background) ground-water quality. Regulations of the third type do not involve determination of future ground-water use, and often result in cleanup levels that are more stringent than the drinking water standard for a particular chemical. Such requirements are potential ARARs if they are directive in nature and intent and established through a promulgated statute or regulation that is legally enforceable (see Federal Register, 1990a; Preamble at 8746). For further information concerning issues related to state ground-water antidegradation requirements, refer to EPA, 1990a.

2.6.2 Remediation Timeframe. "Remediation timeframes will be developed based on the specific site conditions" (Federal Register, 1990a; Preamble at 8732). Even though restoration to beneficial uses generally is the ultimate objective, a relatively long time period to attain this objective may be appropriate for some sites. For example, an extended remediation timeframe generally is appropriate where contaminated ground waters are not expected to be used in the near term, and where alternative sources are available. In contrast, a more aggressive remedy with a correspondingly shorter remediation timeframe should generally be used for contaminated ground waters that are currently used as sources of drinking water or are expected to be utilized for this purpose in the near future (Federal Register, 1990a; at 8732). A state's CSGWPP may include information helpful in determining whether an extended remediation timeframe is appropriate for a given site, such as the expected timeframe of use, or the relative priority or value of ground-water resources in different geographic areas.

A **reasonable timeframe** for restoring ground waters to beneficial uses depends on the particular circumstances of the site and the restoration method employed. The most appropriate timeframe must be determined through an analysis of alternatives (Federal Register, 1990a; Preamble at 8732). The NCP also specifies that:

> "For ground-water response actions, the lead agency shall develop a limited number of remedial alternatives that attain site-specific remediation levels within different restoration time periods utilizing one or more different technologies." (Federal Register, 1990a; §300.430(e)(4).)

Thus, a comparison of restoration alternatives from most aggressive to passive (i.e., natural attenuation) will provide information concerning the approximate range of time periods needed to attain ground-water cleanup levels. An excessively long restoration timeframe, even with

the most aggressive restoration methods, may indicate that ground-water restoration is technically impracticable from an engineering perspective (see Section 2.6.3). Where restoration is feasible using both aggressive and passive methods, the longer restoration timeframe required by a passive alternative may be reasonable in comparison with the timeframe needed for more aggressive restoration alternatives. The most appropriate remedial option should be determined based on the nine remedy selection factors defined in the NCP (Federal Register, 1990a; §300.430 (e)(9)(iii)). Although restoration timeframe is an important consideration in evaluating whether restoration of ground water is technically impracticable, no single time period can be specified which would be considered excessively long for all site conditions (EPA, 1993b). For example, a restoration timeframe of 100 years may be reasonable for some sites and excessively long for others.

2.6.3 Technical Impracticability. Where restoration of ground water to its beneficial uses is not practicable from an engineering perspective, one or more ARARs may be waived by EPA (or the lead agency) under the provisions defined in CERCLA §121(d)(4)(C)). The types of data used to make such a determination are discussed in *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration* (EPA, 1993b). Alternative remedial strategies, to be considered when restoration ARARs are waived, are also discussed in EPA, 1993b. A finding of technical impracticability may be made in the Record of Decision (ROD) prior to remedy implementation, or in a subsequent decision document after implementation and monitoring of remedy performance.

2.6.4 Point of Compliance. The area over which ARAR or risk-based cleanup levels are to be attained is defined in the NCP as follows:

> "For ground water, remediation levels should generally be attained throughout the contaminated plume, or at and beyond the edge of the waste management area when waste is left in place" (Federal Register, 1990a; Preamble at 8713).

Thus, the edge of the waste management area can be considered as the point of compliance, because ARAR or risk-based cleanup levels are not expected to be attained in ground water within the waste management area. In general, the term "waste left in place" is used in the NCP to refer to landfill wastes that, at the completion of the remedy, will be contained or otherwise controlled within a waste management area.

For the purposes of ARAR compliance, EPA generally does not consider DNAPLs as "waste left in place." DNAPLs are typically not located in a waste management area, as envisioned in the NCP. This is because the full extent of DNAPL contamination is often not known, DNAPLs can continue to migrate in the subsurface, and measures for controlling their migration are either unavailable or have uncertain long-term reliability. Also, as discussed in Section 2.5.3, restoration of the aquifer to ARAR or risk-based cleanup levels generally will not be attainable in a reasonable timeframe unless the DNAPLs are removed. **For these reasons, EPA generally prefers to utilize ARAR waivers rather than an alternate point of compliance over portions of sites where non-recoverable DNAPLs are present in the subsurface** (EPA, 1995c).

The NCP Preamble also acknowledges that "an alternative point of compliance may also be protective of public health and the environment under site-specific circumstances" (Federal Register, 1990a; at 8753). For example, where the contamination plume is "caused by releases from several distinct sources that are in close geographical proximity...the most feasible and effective cleanup strategy may be to address the problem as a whole, rather than source by source, and to draw the point of compliance to encompass the sources of release" (Federal Register, 1990a; at 8753). The NCP Preamble goes on to say that "...where there would be little likelihood of exposure due to the remoteness of the site,

alternate points of compliance may be considered, provided contamination in the aquifer is controlled from further migration" (Federal Register, 1990a; at 8734). The Agency has not developed additional guidance on the use of alternate points of compliance at Superfund sites.

2.6.5 Natural Attenuation. Natural attenuation is defined in the NCP as "biodegradation, dispersion, dilution, and adsorption" of contaminants in ground water (Federal Register, 1990a; Preamble at 8734). The NCP goes on to explain that natural attenuation may be a useful remedial approach if site-specific data indicate that these processes "will effectively reduce contaminants in the ground water to concentrations protective of human health [and the environment] in a timeframe comparable to that which could be achieved through active restoration." This approach differs from the "no action" alternative because natural attenuation is expected to attain cleanup levels in a reasonable timeframe (discussed in Section 2.6.2). The NCP recommends use of natural attenuation where it is "expected to reduce the concentration of contaminants in the ground water to the remediation goals [ARAR or risk-based cleanup levels] in a reasonable timeframe."

Natural attenuation may be an appropriate remedial approach for portions of the contaminant plume when **combined with other remedial measures** needed to control sources and/or remediate "hot spots" (also see Section 2.4.2). Whether or not natural attenuation is used alone or combined with other remediation methods, the Agency should have sufficient information to demonstrate that natural processes are capable of achieving the remediation objectives for the site. One caution is that natural attenuation may not be appropriate for sites where contaminants biodegrade to intermediate compounds that are more toxic and degrade more slowly.

Additional EPA policy considerations regarding the use of natural attenuation for remediation of contaminated ground water are provided in EPA, 1996c. Although currently in draft, this EPA directive recommends that remedies utilizing natural attenuation should generally include: 1) **detailed site characterization** to show that this approach will be effective; 2) **source control measures** to prevent further release of contaminants to ground water; 3) **performance monitoring** to assure that natural attenuation is occurring as expected; and 4) **institutional controls** and other methods to ensure that contaminated ground waters are not used before protective concentrations are reached. Also, **contingency measures** may be needed in the event that natural attenuation does not progress as expected.

2.6.6 Alternate Concentration Limits. Alternate concentration limits (ACLs) are intended to provide flexibility in establishing ground-water cleanup levels under certain circumstances. In the Superfund program, EPA may establish ACLs as cleanup levels in lieu of drinking water standards (e.g., MCLs) in certain cases where contaminated ground water discharges to surface water. The circumstances under which ACLs may be established at Superfund sites are specified in CERCLA §121(d)(2)(B)(ii), and can be summarized as follows:

- The contaminated ground water must have "known or projected" points of entry to a surface water body;
- There must be no "statistically significant increases" of contaminant concentrations in the surface water body at those points of entry, or at points downstream; and
- It must be possible to reliably prevent human exposure to the contaminated ground water through the use of institutional controls.

Each of these criteria must be met and must be supported by site-specific information. Such information also must be incorporated into the appropriate portions of the Administrative Record (e.g., the RI/FS and ROD).

The NCP Preamble also advises that ACLs not be used in every situation in which the above conditions are met, but only where active restoration of the ground water is "deemed not to be practicable" (Federal Register, 1990a; at 8754). This caveat in the Preamble signals that EPA is committed to the program goal of restoring contaminated ground water to its beneficial uses, except in limited cases. In the context of determining whether ACLs could or should be used for a given site, the term "practicability" refers to an overall finding of the appropriateness of ground-water restoration, based on an analysis of remedial alternatives using the Superfund remedy selection criteria, especially the "balancing" and "modifying" criteria (EPA, 1993b). (These criteria are defined in part §300.430(e)(9)(iii) of the NCP (Federal Register, 1990a.) This is distinct from a finding of "technical impracticability from an engineering perspective," which refers specifically to an ARAR waiver and is based on the narrower grounds of engineering feasibility and reliability with cost generally not a major factor, unless ARAR compliance would be inordinately costly (see Section 2.6.3 and EPA, 1993b). Where an ACL is established, such an ARAR waiver is not necessary. Conversely, where an ARAR is waived due to technical impracticability, there is no need to establish CERCLA ACLs, as defined above. When establishing an ACL, a detailed site-specific justification should be provided in the Administrative Record which documents that the above three conditions for use of ACLs are met, and that restoration to ARAR or risk-based levels is "not practicable" as discussed above.

Although alternate concentration limits are also defined in the RCRA program, users of this guidance should be aware of **several important differences in the use of ACLs by the RCRA and Superfund programs**. For "regulated units" (defined in 40 CFR 264.90) ACLs are one of the three possible approaches for establishing concentrations limits of hazardous constituents in ground water. Those options are described in 40 CFR 294.94(a). Factors considered when determining whether an ACL is appropriate for a particular facility are provided in 40 CFR 264.94(b). The use of RCRA ACLs is not strictly limited to cases where contaminated ground water discharges to surface water, or to cases where ground-water restoration is considered "not practicable" (as is the case in Superfund). However, the factors considered in the RCRA ACL decision are meant to ensure that establishment of ACLs will be protective of human health and the environment.

A specific reference to ACLs is not made in the existing framework for implementing RCRA Corrective Action at "non-regulated units" (Federal Register, 1990b and 1996). However, the Corrective Action framework recommends flexibility for the development and use of risk-based cleanup standards, based on considerations similar to those used for establishing ACLs under 40 CFR 264.94.

3.0 PRESUMPTIVE TECHNOLOGIES

3.1 Presumptive Technologies for Ex-Situ Treatment

Presumptive technologies for the treatment portion of an extraction and treatment remedy (ex-situ treatment) are identified in Highlight 4. Descriptions of each of the presumptive technologies are presented in Appendices D1 through D8. These technologies are presumptive for treatment of **contaminants dissolved** in ground water that has been extracted from the subsurface, and are expected to be used for this purpose at "all appropriate sites." (Refer to the Preface of this guidance and EPA, 1993d for further information concerning the Agency's expectations concerning the use of presumptive treatment technologies.)

Highlight 4. Presumptive Technologies For Treatment Of Extracted Ground Water

For treatment of dissolved **organic contaminants**, volatiles, semivolatiles and others (see Note):

- Air stripping
- Granular activated carbon (GAC)
- Chemical/UV oxidation (for cyanides also)
- Aerobic biological reactors

For treatment of dissolved **metals**:

- Chemical precipitation
- Ion exchange/adsorption
- Electrochemical methods (when only metals are present)
- Aeration of background metals

For treatment of **both organic and inorganic constituents**:

- A combination of the technologies listed above

NOTE: A given treatment train could include a combination of one or more of the presumptive technologies for treatment of **dissolved** contaminants as well as other technologies for other purposes (e.g., separation of solids) as indicated in Appendix C2.

3.1.1 Design Styles within Presumptive Technologies. The presumptive technologies identified in Highlight 4 refer to technology types rather than specific designs (design styles). Each presumptive technology represents a single process falls within one of these technology types (e.g., innovative air stripper designs, or innovative media for ion exchange/adsorption of metals). A listing of design styles of the presumptive technologies typically considered during Superfund remedy selection are listed in Appendix C1.

3.1.2 Benefits of Presumptive Technologies. Use of the presumptive technologies identified in this guidance will simplify and streamline the remedy selection process for the ex-situ treatment portion of a ground-water remedy by:

- Simplifying the overall selection process, since the large number and diverse assortment of these technologies have been reduced to relatively few technology types;
- Eliminating the need to perform the technology screening portion of the feasibility study (FS), beyond the analysis contained in this guidance and its associated Administrative Record. (See Section 3.3.2);
- Allowing, in some cases, further consideration and selection among the presumptive technologies to be deferred from the FS and ROD to the remedial design (RD), which prevents duplication of effort and allows selection to be based on additional data collected during the RD (see Section 3.3.3);
- Shifting the time and resources employed in remedy selection from ex-situ treatment to other, more fundamental aspects of the ground-water remedy (see Section 1.0); and
- Facilitating the use of extraction and treatment for early actions, where appropriate, since selection of the treatment component is simplified.

3.1.3 Consideration of Innovative Technologies. Use of presumptive technologies for treatment of extracted ground water is intended to simplify the remedy selection process,

but does not preclude the consideration of innovative technologies for this purpose in the FS or RD. Refer to the EPA fact sheet, *Presumptive Remedies: Policy and Procedures* (EPA, 1993d), for additional information. Many innovative or emerging technologies for ex-situ treatment are actually design variations of one of the presumptive technology types, as discussed above, and others may be considered on a site-specific basis. In addition, EPA encourages consideration of in-situ treatment technologies for ground-water remedies, either when combined with extraction and treatment or as an alternative to such methods (see Section 2.4.2).

3.2 Basis for Presumptive Technologies

3.2.1 Sources of Information. Three sources of information were used to determine which technologies should be identified as presumptive for ex-situ treatment of ground water:

- Review of the technologies selected in **all RODs** signed from fiscal years 1982 through 1992;
- Review of capabilities and limitations of ex-situ treatment technologies from engineering and other technical literature; and
- Detailed evaluation of the technologies considered in the FS and selected in the ROD or RD for a sample of 25 sites for which at least one ex-situ treatment technology was selected.

The above information is summarized in a separate report entitled *Analysis of Remedy Selection Results for Ground-Water Treatment Technologies at CERCLA Sites* (EPA, 1996b). A total of 427 RODs selected at least one ex-situ technology for treatment of ground water, as of September 30, 1992. From these RODs, a sample of 25 sites were selected for detailed evaluation of the rationale used to select these technologies as part of the ground-water remedy.

3.2.2 Rationale for Indentifying Presumptive Technologies. At least one of the eight presumptive technologies, identified in Highlight 4, was selected as part of the ground-water remedy in 425 of 427 RODs, or **99.5 percent** of the time. In only five RODs were technologies other than the presumptive technologies selected as part of the treatment train. Therefore, presumptive technologies were the **only** technologies selected for ex-situ treatment of dissolved ground-water contaminants in 420 of the 427 RODs.

More importantly, all the presumptive technologies are well understood methods that have been used for many years in the treatment of drinking water and/or municipal or industrial wastewater. Engineering Bulletins or Technical Data Sheets have been developed by EPA and the Naval Energy and Environmental Support Activity, respectively, for five of the eight presumptive technologies. These publications generally include site specific performance examples, and are included as references, along with other publications, with the description of each technology in Appendix D.

In the 25 site sample, the presumptive technologies, identified in Highlight 4, were the **only** technologies selected in the ROD for **all** sites and the only technologies implemented in the RD for 24 sites. Other technologies were consistently eliminated from further consideration, usually in the technology screening step, based on technical limitations which were verified by the engineering literature. As part of this evaluation the large number and diverse assortment of technologies considered for ex-situ treatment of ground water were categorized according to the underlying treatment process. A complete listing of the technologies considered in the FS, ROD or RD for the 25 sites is given in Appendix C1, categorized by process type and with the presumptive technologies identified.

Some technologies are identified as presumptive even though they were selected in relatively few RODs. **Aeration of background metals** was identified as presumptive because this technology

is often used for removal of iron and manganese, and was considered and selected for this purpose at two of the 25 sample sites. **Electrochemical methods** for metals removal were also identified as presumptive because these methods were considered at all three sample sites where metals were the only contaminants of concern, and were selected at two of these sites. **Chemical/UV oxidation** and **aerobic biological reactors** were identified as presumptive technologies for treating organic contaminants for the following technical reasons:

- A range of chemical, physical and biological treatment methods should be included in the presumptive technologies, because air stripping and granular activated carbon, alone or combined, may not provide cost effective treatment (see Section 3.4.5) for all organic contaminants.

- These methods destroy organic contaminants as part of the treatment process instead of transferring them to other media, which reduces the quantity of hazardous treatment residuals (e.g., spent carbon) that will require further treatment.

- Ongoing research and development efforts, by EPA and others, are expected to increase the cost effectiveness of these treatment methods.

3.3 Remedy Selection Using Presumptive Technologies

Selection of technologies for long-term treatment of extracted ground water requires an understanding of the types of technologies that will be needed, how they will be used in the treatment system and site-specific information for determining the most appropriate and cost-effective technologies. **The presumptive technologies for treating dissolved contaminants in extracted ground water, identified in Highlight 4, are the technologies that should be retained for further consideration in the Detailed Analysis portion of the feasibility study (FS).** This guidance and its associated Administrative Record will generally constitute the Development and Screening of Alternatives portion of the FS for the ex-situ treatment component of a ground-water remedy, as discussed in Section 3.3.2.

Site information needed to select cost-effective treatment technologies (see Section 3..4) is often not collected until the remedial design (RD) phase. **In such cases, it will generally be appropriate to specify performance requirements for the treatment system in the ROD, but defer selection of specific technologies until the RD,** as discussed in Section 3.3.3.

3.3.1 Use of Technologies in Treatment Systems. Complete treatment of extracted ground water generally requires that units of more than one technology, or multiple units of a single technology (unit processes), be linked together in a treatment train. A given treatment train could include some combination of treatment technologies for the following purposes:

1. Separation of mineral solids and/or immiscible liquids from the extracted ground water during initial treatment (pretreatment);

2. Treatment of **dissolved contaminants**;

3. Treatment of vapor phase contaminants from the extracted ground water or those generated during treatment;

4. Separation of solids generated during treatment;

5. Final treatment of **dissolved contaminants** prior to discharge (polishing); and

6. Treatment of solids generated during treatment.

Presumptive technologies for treatment of **dissolved contaminants** in extracted ground water (No. 2 and 5, above) are identified in Highlight 4. Examples of the types of technologies used for other purposes are given in Appendix C2, along with a listing of the general sequence of unit processes used in a treatment train. Solid residuals (such as sludges from chemical or biological processes, or spent carbon media) will generally require additional treatment or disposal, either as part of the treatment train or at a separate facility. Presumptive technologies for purposes other than for treatment of dissolved contaminants have **not** been identified in this guidance.

Use of modular treatment components, which can be easily added or removed from the treatment system, may facilitate phased implementation or other changes that may occur during the life of a remedy. Phased implementation of the extraction portion of a remedy may require that some components of the treatment system also be installed in stages. Also, modification of the treatment system over time may be needed in response to changes in the inflow rate or contaminant loadings, or to increase the effectiveness or efficiency of the treatment system.

3.3.2 This Guidance Constitutes the FS Screening Step. This guidance and its associated Administrative Record will generally constitute the "development and screening of alternatives" portion of the feasibility study (FS), for the ex-situ treatment component of a ground-water remedy. When using presumptive technologies, the FS should contain a brief description of this approach (see fact sheet entitled *Presumptive Remedies: Policy and Procedures* (EPA, 1993d)), and refer to this guidance and its associated Administrative Record. Such a brief description should fulfill the need for the development and screening of technologies portion of the FS for the ex-situ treatment component of the remedy.

3.3.3 Deferral of Final Technology Selection to RD. Although EPA prefers to collect the site information needed for technology selection prior to the ROD, it is sometimes impracticable to collect some of the necessary information until the remedial design (RD) phase. (See Section 3.4 for a summary of site information generally needed for selection of these technologies.) In reviewing remedy selection experience for a sample of sites, EPA found that at seven of 25 sites (28 percent) the type of technology selected in the ROD for treatment of extracted ground water was later changed in the RD because of additional site information obtained during the design phase (EPA, 1996b). Where EPA lacks important information at the ROD stage, it may be appropriate to defer final selection among the presumptive ex-situ treatment technologies (as well as selection of specific design styles) to the RD phase.

In this approach, EPA would identify and evaluate the technologies and provide an analysis of alternative technologies in the FS (this guidance and its associated administrative record will generally constitute that discussion). The proposed plan would identify the technologies that may be finally selected and specify the timing of and criteria for the future technology selection in sufficient detail that the public can evaluate and comment on the proposal. The ROD would also identify all ARARs and other performance specifications and information associated with discharge and treatment of the extracted ground water, including the types of discharge, effluent requirements, and specifications developed in response to community preferences. Specifying the performance criteria and other requirements in the ROD (using a type of "performance based approach") ensures that the remedy will be protective and meet ARARs. Overall, the ROD should be drafted so that the final selection of technologies at the RD phase follows directly from the application of criteria and judgments included in the ROD to facts collected during the RD phase. If the ROD is drafted in this fashion, documenting the final technology selection can generally be accomplished by including a

document in the post-ROD portion of the Administrative Record, which explains the basis of technology selection (e.g., Basis of Design Report, or memorandum to the RD file).

Advantages of deferring selection of ex-situ treatment technologies to the RD include:

- The remedy selection process is further streamlined, since final selection and the accompanying detailed analysis for these technologies is performed only in the RD not in both the FS and the RD, minimizing duplication of effort;

- Site information collected during the RD can be used to make final technology selections as well as to design the treatment train, which facilitates selection of the most cost effective technologies (see Section 3.4.5);

- The likelihood that changes in the treatment train will be made during the RD is explicitly recognized in the ROD; and

- The time and resources employed in the FS can focus on other components of the ground-water remedy that have more direct influence on attainment of **remedial objectives** for contaminated ground water (see Section 1.0).

Cost estimates for remedial alternatives, including the ex-situ treatment component, will need to be included in the FS regardless of whether or not technology selection is deferred to the RD. For cost estimating purposes when deferring technology selection to the RD, reasonable assumptions should be made concerning the treatment system, including assumptions concerning the presumptive technologies and likely design styles to be used. To assist in making such assumptions, advantages and limitations for the presumptive technologies are summarized in Appendix C4. Also, brief descriptions of the presumptive technologies and references for additional information are provided in Appendix D. Assumptions used for estimating treatment costs should be consistent across all remedial alternatives. All assumptions should be clearly stated as such in the FS and ROD.

Example ROD language for deferring technology selection to the RD is given in Appendix B3 for a hypothetical site. This language is only for the ex-situ treatment portion of an extraction and treatment remedy and should appear in the selected remedy portion of the ROD when following this approach.

3.4 Information Needed for Selecting Technologies

The site information listed in Highlight 5 is generally needed to determine the treatment components of a complete treatment train for extracted ground water and to select the most appropriate technology type and design style for each component. Further detail regarding site data needed and the purpose of this information is provided in Appendix C3. Much of this information is also needed for design of the extraction component of an extraction and treatment remedy.

3.4.1 When Should this Information be Collected? The information listed in Highlight 5 is needed for design of the treatment train. Therefore, it must be collected prior to or during the design phase, for either an early action or long-term remedy. Much of this information should also be available for selecting among the presumptive technologies, since it is generally needed to determine the technologies most appropriate for site conditions. The timing of information needed during remedy selection is different when deferring technology selection to the RD than when selecting technologies in the ROD, as discussed in Section 3.3.3. However, much of this information can be collected along with similar data gathered during the remedial investigation (RI). In general, it is recommended that as much of this information as possible be obtained prior to the RD in order to minimize the

Highlight 5. Summary of Site Information Needed For Treatment Train Design

- Total extraction flow rate
- Discharge options and requirements
  - Target effluent concentrations
    - Contaminants
    - Degradation products
    - Treatment additives
    - Natural constituents
  - Other requirements
    - Regulatory
    - Operational
  - Community concerns or preferences
- Water quality of treatment influent
  - Contaminant types and concentrations
  - Naturally occurring constituents
  - Other water quality parameters
- Treatability information

NOTE: Further detail is provided in Appendix C3.

need for additional site investigations during the RD and to accelerate the RD phase.
much of this information can be collected along with similar data gathered during the remedial investigation (RI). In general, it is recommended that as much of this information as possible be obtained prior to the RD in order to minimize the need for additional site investigations during the RD and to accelerate the RD phase.

3.4.2 Extraction Flow Rate. Inflow to the treatment system is the total flow from all extraction wells or drains. Estimates of total extraction flow rate often have a **high degree of uncertainty** (i.e., one or more orders of magnitude), depending on type of data and estimation method used. Expected flow rates from extraction wells are typically estimated from hydraulic properties of the aquifer. Aquifer hydraulic properties may have considerable natural variation over the site and accurate measurement of these properties is often difficult. In order to reduce uncertainty during design of the treatment system, **aquifer properties used in estimating the inflow should generally be obtained from pumping-type aquifer tests** and not from "slug tests," laboratory measurements on borehole samples or values estimated from the literature.

Pumping-type aquifer tests provide a much better estimate of average aquifer properties than other methods, because a much larger volume of aquifer is tested. For the same reason, ground water extracted during pumping tests is more representative of that which will enter the treatment system, and should generally be used for treatability studies of ex-situ treatment technologies instead of samples obtained from monitoring wells. Suggested procedures for conducting pumping-type aquifer tests are given in EPA, 1993i. Methods for treatment of contaminated ground water extracted during pumping-type aquifer tests are discussed in Section 3.5.

The likely variability in the total extraction rate during the life of the remedy should also be estimated. Variability in the extraction rate could result from addition or removal of extraction wells, short-term operational changes in the system (e.g., changing the pumping rates) or seasonal fluctuations in the water table. The number of extraction wells could change as a result of implementing the remedy in phases or from post-construction refinement of the remedy (see Section 2.3.1).

3.4.3 Discharge Options and ARARs. All options for discharge of ground water after extraction and treatment should be identified and considered in the FS, especially options that include re-use or recycling of the extracted ground water. Water quality requirements for the treated effluent (i.e., effluent ARARs) may be different for each discharge option. Examples of regulatory requirements include those promulgated under the federal Safe Drinking Water Act and Clean Water Act, which would apply to discharges to a drinking water system or to surface waters, respectively; and state requirements for these types of discharge. Effluent requirements could also include those for chemicals added during treatment, contaminant degradation products, and naturally occurring constituents (e.g., arsenic), in addition to those for contaminants of concern. **In general, one or more types of discharge for extraction and treatment remedies should be selected in the ROD, not deferred to the RD.** ARARs for the treated effluent will determine the overall level of treatment needed, which in turn determines the type of components needed in the treatment train (see Section 3.3.1) and is a critical factor in selecting appropriate treatment technologies.

In some cases it may be appropriate to select more than one type of discharge for the selected remedy. One type of discharge may be preferred, but may not be capable of accepting the entire flow of treated effluent. For example, it may be possible to re-use or recycle a portion but not all of the discharge. It may also be desirable to reinject a portion of the treated effluent for enhanced recovery of contaminants (aquifer flushing) but prohibitively costly to reinject the entire discharge.

In addition to the types of discharge, ARARs and other specifications related to technology selection or operating performance of the treatment system should be specified in the ROD. Regulatory requirements for all waste streams from the treatment system should be specified, including those for the treated effluent; releases to the air; and those for handling, treatment and disposal of solid and liquid treatment residuals. Other specifications could include those preferred by the affected community, such as requirements to capture and treat contaminant vapors (even though not required by ARARs) or limits on operating noise. Other specifications may also be needed to maintain continued operation of the system, such as water quality conditions necessary to minimize chemical and/or biological clogging of injection wells or drains.

3.4.4 Water Quality of Treatment Influent. In order to design the treatment system, contaminant types and concentrations and other water quality parameters must be estimated for the total flow entering the system. Since some technologies are more effective than others in removing certain contaminant types, this is an important technology selection factor. Concentrations of naturally occurring constituents as well as background and site-related contaminants in the extracted ground water should also be measured, as discussed in Appendix C3.

3.4.5 Treatability Studies. Treatability studies involve testing one or more technologies in the laboratory or field to assess their performance on the actual contaminated media to be treated from a specific site. These studies may be needed during the RI/FS to provide qualitative and/or quantitative information to aid in selection of the remedy, or during the RD to aid in design or implementation of the selected remedy. Three tiers of testing may be undertaken: 1) laboratory screening, 2) bench-scale testing, or 3) pilot-scale testing. Treatability studies may begin with any tier and may skip tiers that are not needed (EPA, 1989c).

For treatment of extracted ground water, treatability studies are generally needed to accurately predict the effectiveness and total cost of a technology for a given site, including construction and operating costs; and the costs of other components that may be needed in the treatment train (see Section 3.3.1). Optimizing the cost effectiveness of the treatment train is especially important for systems designed to

operate over a long time period. (In this guidance, optimizing the cost effectiveness of the treatment system is defined as meeting all treatment and other performance requirements while minimizing total costs per unit volume of water treated.) Treatability studies may also indicate that some technologies provide cost effective treatment when all of the above factors are considered, even though these technologies were infrequently selected in past RODs (e.g., chemical/UV oxidation or aerobic biological reactors). For these reasons treatability studies will be helpful in selecting among the presumptive technologies. Similarly, a presumptive treatment technology should not be eliminated from further consideration in the FS or RD simply because a treatability study is required to determine its applicability for a given site. In general, some type of treatability study should be performed prior to or during the design of any system expected to provide long-term treatment of extracted ground water, including systems using presumptive technologies.

3.5 Treatment Technologies for Aquifer Tests

Although pumping-type aquifer tests are the preferred method of determining average aquifer properties (see Section 3.4.2) and this information is useful for remedy selection, such testing is often deferred to the RD phase because of the need to determine how to treat and/or dispose of the extracted ground water. To facilitate use of such tests earlier in the site response, ex-situ treatment technologies most suitable for this application are discussed below.

3.5.1 Treatment Needs during Aquifer Tests. In comparison to an extraction and treatment remedy, pumping-type aquifer tests (see Section 3.4.2) generate relatively small flows of contaminated ground water over a short period of time. At the time of such tests, the estimated pumping rates and contaminant loadings generally have a high degree of uncertainty. Often the total volume of ground water extracted during testing is held in storage tanks or lined ponds to prevent the discharge from affecting water levels in observation wells and interfering with the test. Storage of the extracted ground water also allows subsequent flow to a treatment system to be controlled and optimized. For example, if storage vessels are used for both the untreated and treated water, the extracted water can be routed through the treatment system as many times as necessary to meet discharge and/or disposal requirements. Therefore, the cost effectiveness of treatment technologies (see Section 3.4.5) is less important for aquifer testing than for the long-term remedy, because of the much smaller volume of ground water to be treated and the much shorter period of operation.

3.5.2 Treatment Technologies for Aquifer Tests. Technologies for treating ground water extracted during aquifer tests should be able to treat a wide range of contaminant types, be available in off-the-shelf versions (short lead time for procurement), have a short on-site startup time, be relatively simple to operate, and be available in easily transportable units. Of the presumptive technologies identified above, the three most suitable for this application are:

- Granular activated carbon,
- Air stripping, and
- Ion exchange/adsorption.

Granular activated carbon can effectively remove most dissolved organic contaminants and low concentrations of some inorganic compounds. Ion exchange/adsorption can remove most metals. Air stripping may be applicable for volatile organic contaminants (VOCs) and generally is more cost effective than granular activated carbon for treating VOCs when flow rates are greater than about three gallons per minute (Long, 1993). Granular activated carbon may still be needed in conjunction with air stripping, for treating dissolved semivolatile organic contaminants, or for reaching stringent effluent requirements for VOCs. Granular activated carbon may also be needed for treatment of vapor phase contaminants separated by an air stripper. Also, treatability

studies generally are not required for the above three technologies, especially for **short-term** applications. Additional information regarding the availability and field installation of skid or trailer mounted treatment units (package plants) is available in EPA, 1995a.

Other presumptive ex-situ treatment technologies (chemical/UV oxidation, aerobic biological reactors, chemical precipitation, and electrochemical methods) generally are less suitable for aquifer testing purposes. In general, these other technologies require longer lead times for procurement and longer time on-site for startup; and have more complex operating requirements and higher capital costs.

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APPENDIX A

Additional Background Information

Appendix A1: Background on **DNAPL** Contamination

Appendix A2: **Contaminants** Most Frequently Reported in Ground Water at CERCLA NPL Sites

Appendix A3: Examples of **In-Situ** Treatment Technologies

Appendix A4: Definition and Discussion of **Pulsed Pumping**

Appendix A1: Background on DNAPL Contamination

DNAPL Background

A **nonaqueous phase liquid (NAPL)** is a chemical that is a liquid in its pure form, which does not readily mix with water but does slowly dissolve in water. **Dense NAPLs (DNAPLs)** sink while **light NAPLs (LNAPLs)** float in water. When present in the subsurface NAPLs slowly release vapor and dissolved phase contaminants, resulting in a zone of contaminant vapors above the water table and a plume of dissolved contaminants below the water table. The term NAPL refers to the undissolved liquid phase of a chemical or mixture of compounds and not to the vapor or dissolved phases. NAPLs may be present in the subsurface as either **"free-phase"** or as **"residual-phase."** The free-phase is that portion of NAPL that can continue to migrate and which can flow into a well. The residual-phase is that portion trapped in pore spaces by capillary forces, which can **not** generally flow into a well or migrate as a separate liquid. Both residual and free-phase NAPLs are sources of vapors and dissolved contaminants.

LNAPLs tend to pose less of a cleanup problem than DNAPLs. The most common LNAPLs are petroleum fuels, crude oils and related chemicals, which tend to be associated with facilities that refine, store or transport these liquids. Since LNAPLs tend to be shallower, are found at the water table and are associated with certain facilities, they are generally easier to locate and clean up from the subsurface than DNAPLs.

DNAPLs pose much more difficult cleanup problems. These contaminants include chemical compounds and mixtures with a wide range of chemical properties, including chlorinated solvents, creosote, coal tars, PCBs, and some pesticides. Some DNAPLs, such as coal tars, are viscous chemical mixtures that move very slowly in the subsurface. Other DNAPLs, such as some chlorinated solvents, can travel very rapidly in the subsurface because they are heavier and less viscous than water. A large DNAPL spill not only sinks vertically downward under gravity, but can spread laterally with increasing depth as it encounters finer grained layers. These chemicals can also contaminate more than one aquifer by penetrating fractures in the geologic layer which separates a shallower from a deeper aquifer. Thus, large releases of DNAPLs can penetrate to great depths and can be very difficult to locate and clean up.

The contamination problem at DNAPL sites has two different components, as shown in **Figures A1-1 and A1-2**, the:

- DNAPL zone, and the
- Aqueous contaminant plume.

The **DNAPL zone** is that portion of the subsurface where immiscible liquids (free-phase or residual DNAPL) are present either above or below the water table. Also in the DNAPL zone, vapor phase DNAPL contaminants are present above water table and dissolved phase below water table. The **aqueous contaminant plume** is that portion of the contaminated ground water surrounding the DNAPL zone where aqueous contaminants derived from DNAPLs are dissolved in ground water (or sorbed to aquifer solids) but immiscible liquids are **not** present. Depending on the volume of the release and subsurface geology, the DNAPL zone may extend to great depths and over large lateral distances from the entry location, as discussed above.

Figure A1-1: Components of DNAPL Sites

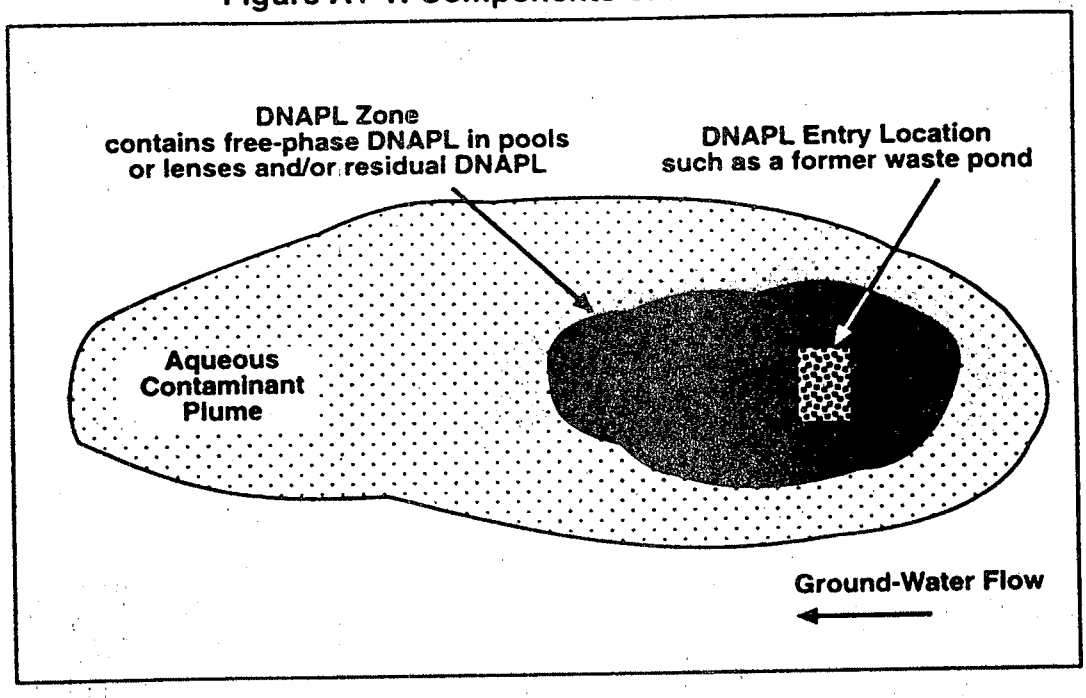
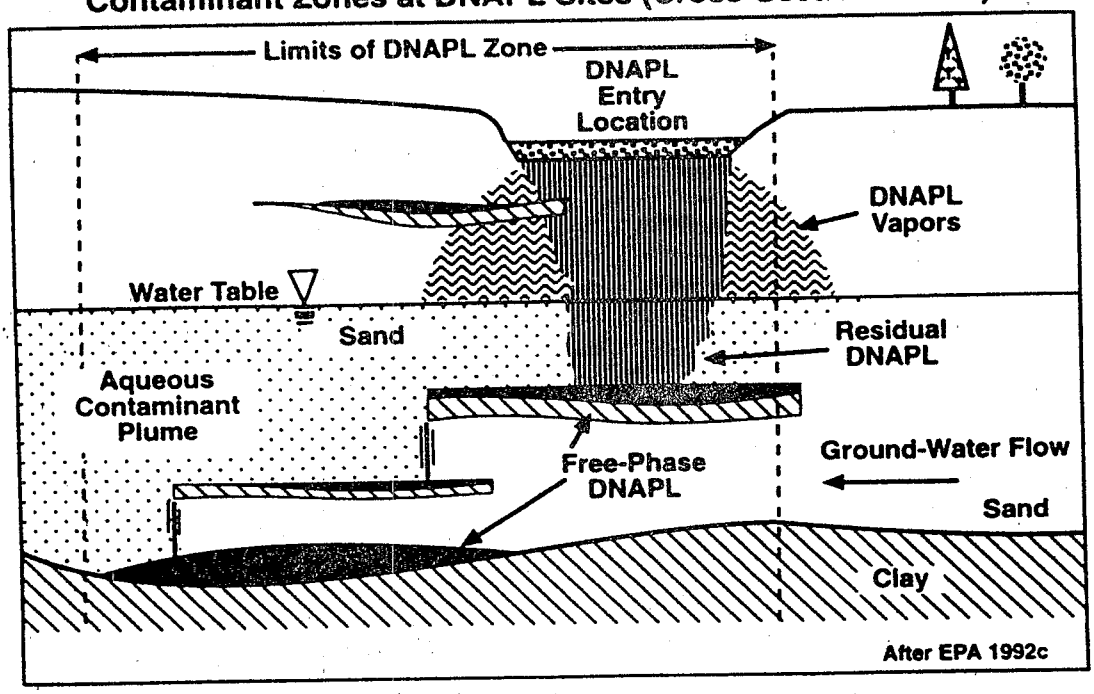


Figure A1-2: Types of Contamination and Contaminant Zones at DNAPL Sites (Cross-Sectional View)



Appendix A1: Background on DNAPL Contamination (continued)

Planning of site investigation and remedial activities at sites with subsurface DNAPLs should include certain precautions, to minimize the potential for further DNAPL migration resulting from such activities. Further detail on characterization of DNAPL sites is provided in EPA, 1994 and in Cohen and Mercer, 1993 (see below).

DNAPL References

Additional information concerning DNAPL contamination can be obtained from the following references:

Cohen, R.M., and J.W. Mercer, 1993. DNAPL Site Evaluation, C.K. Smoley, Boca Raton, FL, 1993; and EPA/600/R-93/022, February 1993.

EPA, 1991. "Ground Water Issue: Dense Nonaqueous Phase Liquids," OSWER Publication EPA/540/4-91-002, March 1991.

EPA, 1992a. "Estimating Potential for Occurrence of DNAPL at Superfund Sites," OSWER Publication 9355.4-07FS, January 1992.

EPA, 1992b. "Dense Nonaqueous Phase Liquids -- A Workshop Summary, Dallas, Texas, April 16-18, 1991," Office of Research and Development Publication EPA/600/R-92/030, February 1992.

EPA, 1992c. "Considerations in Ground-Water Remediation at Superfund Sites and RCRA Facilities - Update," OSWER Directive 9283.1-06, May 27, 1992.

EPA, 1993b. "Guidance for Evaluating Technical Impracticability of Ground-Water Restoration," OSWER Directive 9234.2-25, EPA/540-R-93-080, September 1993.

EPA, 1994. "DNAPL Site Characterization," OSWER Publication 9355.4-16FS, EPA/540/F-94/049, September 1994.

Appendix A2: Contaminants Most Frequently Reported in Ground Water at CERCLA NPL Sites[1]

Organic Contaminants:

Rank	Organic Contaminants (Other Names)	Chemical[2] Group	Halo-[2] genated?	DNAPL?[3]	No.[1] Sites
1	Trichloroethylene, 1,1,2- (TCE)[ca]	Volatile	Yes	Yes	336
2	Tetrachloroethene (perchloroethene; PCE)[ca]	Volatile	Yes	Yes	170
3	Chloroform (trichloromethane)[ca]	Volatile	Yes	Yes	167
4	Benzene[pf]	Volatile	No	No	164
5	Toluene[pf]	Volatile	No	No	159
6	Trichloroethane, 1,1,1- (methyl chloroform; 1,1,1-TCA)[ca]	Volatile	Yes	Yes	155
7	Polychlorinated biphenyls	PCB	Yes	Yes	139
8	Trans-Dichloroethylene, 1,2- (trans-1,2-DCE)[ca]	Volatile	Yes	Yes	107
9	Dichloroethane, 1,1- (1,1-DCA)[ca]	Volatile	Yes	Yes	105
10	Dichloroethene, 1,1- (vinylidene chloride; 1,1-DCE)[ca]	Volatile	Yes	Yes	95
11	Vinyl chloride (chloroethylene)[ca]	Volatile	Yes	No	82
12	Xylene[pf]	Volatile	No	No	76
13	Ethylbenzene[pf]	Volatile	No	No	68
14	Carbon tetrachloride (tetrachloromethane)[ca]	Volatile	Yes	Yes	68
15	Phenol	Semivol.	No	No	61
16	Methylene chloride (dichloromethane)[ca]	Volatile	Yes	Yes	58
17	Dichloroethane, 1,2- (ethylene dichloride; 1,2-DCA)[ca]	Volatile	Yes	Yes	57
18	Pentachlorophenol (PCP)	Semivol.	Yes	Yes	53
19	Chlorobenzene (benzene chloride)[ca]	Volatile	Yes	Yes	48
20	Benzo(A)Pyrene	Semivol.	No	Yes	37

Appendix A2: Contaminants Most Frequently Reported in Ground Water at CERCLA NPL Sites (continued)[1]

Inorganic Contaminants:

Rank	Inorganic Contaminants	No.[1] Sites
1	Lead	307
2	Chromium and compounds	215
3	Arsenic	147
4	Cadmium	127
5	Mercury[4]	81
6	Copper and compounds	79
7	Zinc and compounds	73
8	Nickel and compounds	44
9	Cyanides (soluble salts)	39
10	Barium	37

NOTES:

1 Number of CERCLA National Priorities List (NPL) sites for which the chemical was reported in ground water as a contaminant of concern in the Superfund Site Assessment, for either proposed or final NPL sites. This data was obtained from the Superfund NPL Assessment Program (SNAP) data base, as of August 30, 1994. At that time total of 1294 sites were listed on the NPL (64 proposed and 1230 final).

2 Classification of organic contaminants as volatile, semivolatile, PCB, or pesticide; and as halogenated or nonhalogenated is from EPA Publication, "Technology Screening Guide for Treatment of CERCLA Soils and Sludges," EPA/540/2-88/004, September 1988.

3 Classification of whether or not a chemical is a dense nonaqueous phase liquid (DNAPL) in pure form is from Cohen and Mercer, 1993 (see References).

4 In pure form mercury is also a DNAPL.

cs These organic contaminants are chlorinated solvents. A total of 12 are listed.

pf These organic contaminants are constituents of petroleum fuels. A total of four are listed.

Appendix A3: Examples of In-Situ Treatment Technologies[1]

I. Enhanced Recovery Methods	Treatment Agents (and process type)	Agent Delivery Methods
Recirculation/flooding:		
- Water flooding (physical)	- Water - Heated water	- Injection wells - Injection wells
- Steam flooding (physical)	- Steam	- Injection wells
- Chemical flooding[2] (chemical)	- Surfactants - Solvents - Redox agents	- Injection wells - Injection wells - Injection wells
- Nutrient flooding[2] (biological)	- Nitrate - Other	- Injection wells
Thermal enhanced recovery:		
- Radio frequency	- Heat	- Electrodes in wells
- Electrical resistance (AC or DC)	- Heat	- Electrodes in wells
Enhancement of secondary permeability:		
- Induced fracturing with water or or air pressure (physical)	Not applicable	Not applicable
Other methods:		
- Electromigration (electrical)	- Electric current	- Electrodes in wells

NOTES:

1 List of technologies and technology status is from EPA, 1993h (see References section of guidance).

2 Chemicals or nutrients for micro-organisms, respectively, are added to reinjection water.

Appendix A3: Examples of In-Situ Treatment Technologies (continued)[1]

II. In-situ Treatment Processes	Treatment Agents	Agent Delivery Methods
Physical/chemical treatment:		
- Volatilization and oxygen enhancement by **air sparging**	- Air	- Injection wells - **Permeable walls/gates**[3]
- Reductive dehalogenation by metal catalysts (abiotic)	- Iron filings - Other agents	- **Permeable walls/gates**[3]
Biological treatment:		
- Oxygen enhancement of aerobic organisms (also includes air sparging, above)	- Hydrogen peroxide - Oxygen/surfactant (microbubbles)	- Injection wells[4] - Injection wells[4]
- Nutrient enhancement of aerobic organisms	- Nitrate - Other	- Injection wells[3]
- Nutrient enhancement of anaerobic organisms to produce enzymes that degrade contaminants (cometabolism)	- Methane - Other	- Injection wells
- Sequential anaerobic-aerobic treatment	- Methane and/or Oxygen	- Injection wells

NOTES:

[3] In permeable treatment walls/gates, treatment agents are added with trench backfill materials or are injected via perforated pipes placed in the backfill. These walls are placed in the subsurface across the natural flow path of the contaminant plume. They can be combined with impermeable flow barriers in a "funnel and gate" arrangement, in which flow is directed through the treatment walls/gates.

[4] Use of permeable treatment walls/gates to deliver treatment agents for these methods may also be feasible.

Appendix A4: Definition and Discussion of Pulsed Pumping

Pulsed Pumping

In pulsed pumping, some or all extraction pumps are turned off and then back on for specified periods of time (e.g., one or more monitoring periods). The on and off cycles can be continued or the extraction and treatment remedy can be returned to continuous pumping. Although not widely used in remedies to date, this method may be effective in **enhancing the recovery of contaminants from the aquifer**. Pulsed pumping can recover contaminants located in the following portions of the aquifer that are relatively unaffected during pumping:

- Upper portions of the aquifer that have been dewatered by pumping, and
- Zones with minimal ground-water flow during pumping (flow stagnation zones).

Pulsed pumping **may** also enhance contaminant recovery for aqueous phase contaminants that are sorbed to the aquifer matrix. Therefore, pulsed pumping can be initiated as a **post-construction refinement** of an extraction and treatment remedy (see Section 2.4), when an evaluation of remedy performance indicates that this technique may increase the recovery of contaminants from the aquifer.

Pulsed pumping can also be used as a method of evaluating the effectiveness of an extraction and treatment remedy and/or the effectiveness of source control actions. For example, if contaminant levels increase substantially when pumping is stopped, it is an indication that contaminants continue to be derived from source materials, and that additional remedial measures (e.g., source control/removal) may be necessary. These source materials could include aqueous contaminants sorbed to aquifer solids in finer-grained aquifer layers, NAPLs (refer to Appendix A1), contaminated soils, or other sources.

Pulsed pumping should generally **not be initiated** until after sufficient monitoring data has been obtained from continuous pumping to establish a statistically valid performance trend. Also, the influence of pulsed pumping on plume containment should be considered; and extraction wells used primarily for containment (i.e, at plume leading edge) should generally not be pulsed.

APPENDIX B

ROD Language Examples For Selected Remedy

Appendix B1: Phased Implementation of Ground-Water Remedy

Appendix B2: Phased Implementation of **Extraction Component** of Remedy at a DNAPL Site

Appendix B3: **Deferring Selection** of Treatment Components to Remedial Design

Appendix B4: Suggested ROD Language from **1990 OSWER Directive**

Appendix B1: Phased Implementation of Ground-Water Remedy

Site Conditions:

At **hypothetical Site 1** (an LNAPL site) surficial soils and the underlying ground water in Aquifer C are contaminated with volatile organic compounds (VOCs). At this site, Aquifer C is currently used as a source of drinking water, with several wells located on-site and in the estimated path of the contaminant plume.

Early actions were used for exposure prevention and source control. Under Superfund **removal authority**, an alternate water supply was provided to several residences, and leaking drums and heavily contaminated soils were excavated and taken off-site for disposal. A soil vapor extraction system was installed as an **interim remedial action**. No further source control actions are planned. DNAPLs are not likely to be present in the subsurface because most of the contaminants are LNAPLs rather than DNAPLs in pure form. The selected ground-water remedy relies on extraction and treatment for preventing further migration of the contaminant plume and for restoration of Aquifer C. **The selected remedy will be implemented in two construction phases.**

ROD Language for Extraction Component of Remedy:

The following, or similar language, should appear in the **Selected Remedy** section of the ROD:

> *The **ultimate goal** for the ground-water portion of this remedial action is to restore Aquifer C to its beneficial uses. At this site, Aquifer C is currently used as a source of drinking water. Based on information obtained during the remedial investigation and on a careful analysis of all remedial alternatives, EPA and the State of ___ believe that the selected remedy will achieve this goal.*
>
> *The **extraction portion of the ground-water remedy** will be implemented in two phases. **In phase one**, a sufficient number of extraction wells will be installed with the **objective of minimizing further migration of the contaminant plume**. It is currently estimated that two to four extraction wells will be required for phase one.[1] After construction of phase one is completed, the extraction system will be carefully monitored on a regular basis and its performance evaluated. **Operation and monitoring of phase one for a period of up to one year may be needed to provide sufficient information to complete the design of phase two.***
>
> *In phase two, additional extraction wells will be installed with the **objective of restoring Aquifer C** for use as a source of drinking water, in addition to maintaining the remedial objectives for phase one. Restoration is defined as attainment of required cleanup levels in the aquifer, over the entire contaminant plume. Cleanup levels for each ground-water contaminant of concern are specified in Table __ of the ROD. Current estimates indicate that an additional two to four extraction wells may be required to attain these cleanup levels within a timeframe of approximately 20 years.[1] However, **monitoring and evaluation of the performance of phase one will be used to determine the actual number and placement of wells for phase two.***

Appendix B1: Phased Implementation of Ground-Water Remedy (continued)

The selected remedy will include ground-water extraction for an estimated period of 20 years, during which the system's performance will be carefully monitored, in accordance with the monitoring plan defined in Section ___ of the ROD, and adjusted as warranted by the performance data collected during operation. ***Refinement of the extraction system may be required, if EPA determines that such measures will be necessary in order to restore Aquifer C in a reasonable timeframe, or to significantly reduce the timeframe or long-term cost of attaining this objective. Refinement of the extraction system may include any or all of the following:***

1) Adjusting the rate of extraction from some or all wells;

2) Discontinuing pumping at individual wells where cleanup goals have been attained;

3) Pulsed pumping of some or all extraction wells to eliminate flow stagnation areas, allow sorbed contaminants to partition into ground water, or otherwise facilitate recovery of contaminants from the aquifer; and

4) Installing up to two additional ground-water extraction wells to facilitate or accelerate cleanup of the contaminant plume.[1]

It is possible that performance evaluations of the ground-water extraction system - after completion of phase one, during implementation or operation of phase two, or after subsequent refinement measures - will indicate that restoration of Aquifer C is technically impracticable from an engineering perspective. ***If such a determination is made by EPA, the ultimate remediation goal and/or the selected remedy may be reevaluated.***[2]

NOTES:

1. Although not required in a ROD, the **estimated number of wells** is included in this example for the following reasons, to:

   - Provide a **basis for estimating the cost** of the selected remedy, including upper and lower costs for phase one, phase two and the potential refinement measures;

   - Provide some **specificity regarding how the extraction component of the remedy will be used in the overall remediation strategy**, because changes in the extraction system directly influence the time period required to attain the remedial objectives for this site; and to

   - Provide some **bounds for the scope, performance and cost of the selected remedy**, which will assist in determining whether future, post-ROD remedy modifications require an Explanation of Significant Differences (see Section 2.4 of this guidance).

2. Reevaluation of the ultimate remediation goal and/or the selected remedy would generally require an ESD or ROD amendment.

Appendix B2: Phased Implementation of Extraction Component of Remedy at a DNAPL Site

Site Conditions:

At hypothetical Site 2 (a DNAPL site), ground water in Aquifer A is contaminated with volatile and semivolatile organic contaminants (no metals as contaminants of concern). DNAPLs have also been observed in this aquifer. At this site, Aquifer A is not currently used as source of drinking water, but several wells are located off-site in the estimated path of the contaminant plume.

The selected remedy includes extraction and treatment for hydraulic containment of the likely **DNAPL-zone** (see Appendix A1 of this guidance) and for restoration of the aquifer outside the DNAPL-zone. Reinjection of a portion of the treated ground water will be used to enhance recovery of contaminants from the aquifer. It has been determined that aquifer restoration within the DNAPL-zone is technically impracticable from an engineering perspective, as explained in the **Statutory Determinations** section of the ROD. **The remedy will be implemented in two construction phases.**

ROD Language for Extraction Component of Remedy:

The following, or similar language, should appear in the **Selected Remedy** section of the ROD:

> *The ultimate goal for the ground-water portion of this remedial action is to restore the maximum areal extent of Aquifer A to its beneficial uses. At this site Aquifer A is potentially useable as a source of drinking water and is currently used off-site for this purpose. Based on information obtained during the remedial investigation and on a careful analysis of all remedial alternatives, EPA believes that the selected remedy will achieve this goal.*
>
> *The **extraction portion of the ground-water remedy** will be implemented in two phases. **In phase one**, a sufficient number of extraction wells will be installed to achieve **two remedial objectives for Aquifer A:** 1) minimizing further migration of contaminants from suspected subsurface DNAPL areas to the surrounding ground water; and 2) minimizing further migration of the leading edge of the contaminant plume. It is currently estimated that three to five extraction wells will be required for phase one.[1] After construction of phase one is completed, the extraction system will be carefully monitored on a regular basis and its performance evaluated. This evaluation may provide further information concerning the extent of the DNAPL-zone. **Operation and monitoring of phase one for a period of up to two years may be needed to provide sufficient information to complete the design of phase two.***
>
> *In phase two, additional extraction wells will be installed with the objective of **restoring the maximum areal extent of Aquifer A** for use as a source of drinking water, in addition to maintaining phase one objectives. Reinjection wells and related pumping equipment for flushing a portion of the treated ground water through the aquifer (water flooding) will also be installed in order to enhance the recovery of contaminants. Restoration is defined as attainment of required cleanup levels in the aquifer, over the portion of the contaminant plume outside the DNAPL-zone. Cleanup levels for each ground-water contaminant of concern are specified in Table __ ; although cleanup level ARARs within the DNAPL-zone have been waived by EPA due technical impracticability from an engineering perspective, as discussed in Section __ of the ROD. Current estimates indicate that these cleanup levels can be attained in the portion of Aquifer A outside the DNAPL-zone within a timeframe of approximately 25 years.*

Appendix B2: Phased Implementation of Extraction Component of Remedy at a DNAPL Site (continued)

Current estimates also indicate that an additional two to six extraction wells and two to four reinjection wells may be required for phase two.[1] ***However, monitoring and evaluation of the performance of phase one will be used to determine the actual number and placement of wells for phase two.***

The selected remedy will include ground-water extraction for an ***estimated period of 25 years,*** *during which the system's performance will be carefully monitored, in accordance with the monitoring plan defined in Section ___ of the ROD, and adjusted as warranted by the performance data collected during operation.* ***Refinement*** *of the extraction system may be required, if EPA determines that such measures will be necessary in order to restore the maximum areal extent of Aquifer A in a reasonable timeframe, or to significantly reduce the timeframe or long-term cost of attaining this objective.* ***Refinement of the extraction system may include any or all of the following:***

1) *Adjusting the rate of extraction from some or all wells;*

2) *Discontinuing pumping at individual wells where cleanup goals have been attained;*

3) *Pulsed pumping of some or all extraction wells to eliminate flow stagnation areas, allow sorbed contaminants to partition into ground water, or otherwise facilitate recovery of contaminants from the aquifer;*

4) *Installing up to two additional ground-water extraction wells to facilitate or accelerate cleanup of the contaminant plume; and*[1]

5) *Installing up to two additional reinjection wells.*[1]

It is possible that performance evaluations of the ground-water extraction system - after completion of phase one, during implementation or operation of phase two, or after subsequent refinement measures - will indicate that restoration of portions or all of Aquifer A is technically impracticable from an engineering perspective. ***If such a determination is made by EPA, the ultimate remediation goal and/or the selected remedy may be reevaluated.***[2]

NOTES:

1. The reasons for including the estimated number of wells in this example are discussed in the Notes section of the previous example, Appendix B2.

2. Reevaluation of the ultimate remediation goal and/or the selected remedy would generally require an ESD or ROD amendment.

Appendix B3: Deferring Selection of Treatment Components to Remedial Design

Site Conditions:

Hypothetical Site 2 is the same site used in the previous example, Appendix B2. Most of the treated ground water will be discharged to the nearby Muddy River, although a portion (20 to 30 percent) will be reinjected to Aquifer A to enhance contaminant recovery. Contaminant-specific and other water quality requirements for discharge to the Muddy River were specified by the state and are listed in Table ___ of the ROD. Other specifications for the treatment system are also listed in the ROD, which include filtering of suspended mineral solids to minimize clogging of reinjection wells; and treatment of vapor phase organic contaminants from air stripping or other processes, as requested by the local community.

ROD Language for Treatment Component of Remedy:

*The **ex-situ treatment component of the ground-water** remedy will utilize presumptive technologies identified in Directive 9283.1-12 from EPA's Office of Solid Waste and Emergency Response (OSWER), included as Attachment __ of the ROD. Since contaminants of concern include volatile and semivolatile organic compounds, **one or more of the presumptive technologies** - air stripping, granular activated carbon (GAC), chemical/UV oxidation and aerobic biological reactors - will be used for treating aqueous contaminants in the extracted ground water. Other technologies will also be needed in the treatment system for removal of suspended mineral solids and treatment of vapor phase contaminants. **The actual technologies and sequence of technologies used for the treatment system will be determined during remedial design.** Final selection of these technologies will be based on additional site information to be collected during the remedial design. (See Section 3.4 and Appendix C3 of OSWER Directive 9283.1-12 for a discussion of site information needed for selection and design of the ex-situ treatment system.) Based on this additional information and sound engineering practice the treatment system shall be designed to:*

- *Attain the chemical-specific discharge requirements and other performance criteria specified in Table __ and Section __ of the ROD; and*
- *Treat, or be easily modified to treat, the expected flow increase from phase one to phase two of the extraction system.*

Other design factors shall include:

- *Maximizing long-term effectiveness,*
- *Maximizing long-term reliability (i.e., minimize the likelihood of process upsets), and*
- *Minimizing long-term operating costs.*

Additional information concerning presumptive technologies for the ex-situ treatment component of the remedy is provided in OSWER Directive 9283.1-12. Descriptions of each of the presumptive technologies are presented in Appendices D1 through D8, and advantages and limitations of each of these technologies are listed in Appendix C4 of this directive.

Appendix B3: Deferring Selection of Treatment Components to Remedial Design (continued)

For the purpose of estimating the approximate cost of the treatment component of the selected remedy, the following treatment sequence is assumed for ***aqueous contaminants****: flow equalization tanks, a gravity oil-water separator, an air stripper, followed by GAC units. GAC will also be used to treat* ***vapor phase contaminants*** *from the air stripper. The GAC units will be thermally reactivated at an off-site facility. Separated DNAPL compounds will be recycled if possible, but since the actual composition of the recovered liquids is unknown, costs for incineration at an off-site facility were used for the cost estimate.*

Appendix B4: Suggested ROD Language from 1990 OSWER Directive

Recommended language for the Selected Remedy section of the ROD was given in OSWER Directive 9283.1-03, entitled "Suggested ROD Language for Various Ground-Water Remediation Options," dated October 10, 1990. For the RODs in which the final remedy without a contingency is selected, this Directive recommended that "the following type of language should appear in the **Selected Remedy** section of the ROD:"

> *The goal of this remedial action is to restore ground water to its beneficial use, which is, at this site, (specify whether this is a potential or actual drinking water source, or is used for non-domestic purposes). Based on information obtained during the remedial investigation and on a careful analysis of all remedial alternatives, EPA < (optional) and the State/Commonwealth of _____ > believe that the selected remedy will achieve this goal. It may become apparent, during implementation or operation of the ground-water extraction system and its modifications, that contaminant levels have ceased to decline and are remaining constant at levels higher than the remediation goal over some portion of the contaminated plume. In such a case, the system performance standards and/or the remedy may be reevaluated.*
>
> *The selected remedy will include ground-water extraction for an estimated period of _____ years, during which the system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation. Modifications may include any or all of the following:*
>
> *a) at individual wells where cleanup goals have been attained, pumping may be discontinued;*
>
> *b) alternating pumping at wells to eliminate stagnation points;*
>
> *c) pulse pumping to allow aquifer equilibration and to allow adsorbed contaminants to partition into ground water; and*
>
> *d) installation of additional extraction wells to facilitate or accelerate cleanup of the contaminant plume.*
>
> *To ensure that cleanup goals continue to be maintained, the aquifer will be monitored at those wells where pumping has ceased on an occurrence of every _____ years following discontinuation of ground-water extraction.*

APPENDIX C

Ex-Situ Treatment Technologies for Ground Water

Appendix C1: Ex-Situ **Technologies Considered** in Sample of 25 Sites

Appendix C2: **Other Components** Needed for Treatment Trains

Appendix C3: **Information Needed** for Selection of Technologies and Design of Treatment Train

Appendix C4: **Advantages and Limitations** of Presumptive Treatment Technologies

Appendix C1: Ex-Situ Technologies Considered in Sample of 25 Sites

Technologies that were **considered** for treatment of extracted ground in the sample of 25 sites reviewed in detail (EPA, 1996b) are listed below. These technologies were either considered in the feasibility study (FS), or considered and/or selected in the record of decision (ROD) or remedial design. The technologies are listed according to overall process type, and by design style within each type. Those technologies identified as **presumptive technologies** are also indicated. For further information on how presumptive technologies were identified, refer to Section 3.2 of this guidance and EPA, 1996b.

For Treatment of **Organic** Contaminants:

<u>Presumptive Technologies:</u>

Air stripping:
- Packed tower
  - Ambient temperature
  - Higher temperature
- Aeration methods
  - Ambient temperature
  - Higher temperature
- Cascade falls

Granular activated carbon (GAC)

Chemical/UV oxidation:
- Chemical oxidation alone
  - Ozone
  - Hydrogen peroxide
  - Chlorine compounds
  - Potassium permanganate
- Chemical with UV oxidation
  - Ozone
  - Hydrogen peroxide
- UV oxidation alone (photolysis)
- Alkaline chlorination **(for cyanide)**
- Unspecified oxidation methods

Aerobic biological reactors:
- Attached growth
  - Trickling filter
  - Rotating biological contactors
  - Fixed bed
- Suspended growth
  - Activated sludge
  - Sequencing batch reactors
  - Aeration ponds/lagoons
  - Unspecified suspended growth
- Unspecified aerobic reactors

For Treatment of **Metals**:

Chemical precipitation:
- Hydroxide precipitants
  - Sodium hydroxide
  - Lime
  - With prior chemical reduction
- Sulfide precipitants
  - Sulfur dioxide
  - Sodium sulfide
  - Sodium bisulfide/bisulfites
  - With prior chemical reduction
  - Unspecified sulfide precipitant
- Other precipitation methods
  - Ferrous sulfate
  - Potassium permanganate
  - Activated consumable element
  - Unspecified chemical precipitation

Ion exchange/adsorption:
- Fixed bed
  - Impregnated/synthetic resin
  - Activated alumina
- Electrodialysis
- Unspecified ion exchange

Electrochemical methods:
- Electrochemical reduction
- Magnetically activated

Aeration of Background Metals:
- Aeration basin
- Cascade aeration
- Other aeration methods

Appendix C1: Ex-Situ Technologies Considered in Sample of 25 Sites (continued)

For Treatment of **Organic** Contaminants:

Other Technologies Considered:

Chemical treatment:
- Hydrolysis
- Catalytic dehydrochlorination
- Catalytic dechlorination
- Chlorinolysis

Thermal Destruction:
- Incineration
- Calcination
- Wet air oxidation
- Supercritical water oxidation
- Microwave discharge/plasma

High temperature separation:
- Steam stripping
- Distillation

Membrane filtration:
- Reverse osmosis
- Ultrafiltration

Anaerobic biological treatment:
- Anaerobic biological reactor
- Enzymatic degradation

Liquid-liquid extraction:
- Solvent extraction
- Liquid carbon dioxide extraction

Evaporation:
- Evaporation basin

Land treatment:
- Surface spreading
- Spray irrigation

For Treatment of **Metals**:

Granular activated carbon (for metals)

Reverse Osmosis

Biological treatment of metals

Appendix C2: Other Components Needed for Treatment Trains[1]

Solid or Liquid Separation Technologies	Effluent Polishing Technologies[2]	Vapor Phase Treatment Technologies[3]
• Oil/grease separation[4]	• Activated carbon	• Activated carbon
• Filtration[5]	• Ion exchange	• Resin adsorption
• Coagulation[5] (or flocculation)	• Neutralization	• Catalytic oxidation
• Clarification[5] (or sedimentation)		• Thermal incineration
		• Acid gas scrubbing
		• Condensation

General Sequence of Unit Processes Used in Aqueous Treatment Trains

Sequence	Unit Treatment Process	Treatment Stage
Begin	Equalize inflow	Pretreatment
	Separate solid particles	Pretreatment
	Separate oil/grease (NAPLs)	Pretreatment
	Remove metals	Treatment
	Remove volatile organics	Treatment
	Remove other organics	Treatment
	Polish organics[2]	Post-treatment
	Polish metals	Post-treatment
End	Adjust pH, if required	Post-treatment

NOTES:

1 In addition to the presumptive technologies listed in the guidance, other treatment components are needed either prior to (pretreatment) or subsequent to (post-treatment) the presumptive technologies. This listing is not intended to be presumptive. Not listed are technologies that may be required for treatment residuals, such as spent carbon.

2 Effluent polishing technologies are those used for the final stage of treatment prior to discharge, and can include pH adjustment (neutralization) as well as additional removal of aqueous constituents.

3 Vapor phase contaminants released during water treatment may need to be contained and treated. This includes organic contaminants volatilized during air stripping, from biological treatment, or other gases released from chemical oxidation, reduction or biologic processes (e.g., hydrochloric acid, hydrogen sulfide, methane, etc.).

4 Methods for separation of oil and/or grease from water include, but are not limited to, gravity separation and dissolved air floatation. These methods can be used to remove NAPLs from the extracted ground water.

5 These technologies can be used to remove solid particles at the beginning of the treatment train or for removal of other solids resulting from chemical precipitation, chemical/UV oxidation or biological treatment.

Appendix C3: Information Needed for Selection of Technologies and Design of Treatment Train

Information Needed	Purpose of Information
1. Total extraction flow rate: • Total extracted flow • Flow variability • Uncertainty of estimate	**Inflow** to the treatment system is the total flow from all extraction wells. Since this flow must also be discharged, large flows may determine the availability of some discharge options. Flow rate and concentration determines the mass loading (mass per unit water volume) of each contaminant entering the treatment system. The mass loading determines the dimensions and capacities of treatment vessels, and whether continuous flow or batch design are used for each treatment unit. Flow is also a factor for selecting among the presumptive treatment technologies because some are less cost effective for high or low flows. **Variable inflow** rates may require use of flow equalization tanks, batch instead of continuous flow operation or use of modular treatment units that can be added or subtracted from the treatment train. Some technologies can handle variable flow more easily than others. Variable extraction rates may result from short-term operational changes, seasonal changes or phased well installation. **Uncertainty** in the flow estimate can result from natural variability of aquifer properties over the site, and from the method used to measure these properties. Since flow is a critical design parameter, additional characterization may be needed to reduce the level of uncertainty. **Estimates of the total extraction rate should be based on pumping type aquifer tests, since this method provides a much better estimate of average aquifer properties than other methods.**

Appendix C3: Information Needed for Selection of Technologies and Design of Treatment Train (continued)

Information Needed	Purpose of Information
2. Discharge options and effluent requirements: • Options available • Target effluent concentrations, each option - Contaminants - Contaminant degradation products - Treatment additives - Natural constituents - Water quality parameters • Other requirements, each option - Regulatory - Operational • Community concerns or preferences	Options for discharge of treated ground water could include: discharge to surface waters; discharge to a drinking water system; reuse or recycling for other purposes (e.g., industrial processes); infiltration or reinjection to shallow subsurface or reinjection to the same aquifer; or discharge to POTW. Target effluent concentration levels for both contaminants and naturally occurring constituents may be markedly different for each discharge option. Effluent requirements could include those for chemicals added during treatment, contaminant degradation products, naturally occurring constituents (e.g., arsenic), and water quality parameters (e.g., suspended solids) in addition to maximum concentration levels for chemicals of concern. These requirements will determine the overall level of treatment needed, which in turn determines the type of components needed in the treatment train and is a critical factor in selecting appropriate treatment technologies. Each discharge option may have different water quality requirements for the treated effluent, from both a **regulatory** and **operational** standpoint. For example, reinjection to the subsurface must meet substantive federal and/or state requirements for underground injection (regulatory) as well as minimize chemical and biological clogging of injection wells or infiltration lines (operational). Use of the best available technology (BAT) could also be a regulatory requirement. The **affected community** may also have concerns or preferences regarding the type of discharge. **Target effluent concentrations** determine the overall removal efficiency the treatment train must attain for each constituent. For example, if the target effluent level is 10 mg/L and the inflow concentration is 1000 mg/L, then the treatment train must attain an overall removal efficiency of 99.0 percent (1000 - 0.99(1000) = 10). The treatment train may need to include more than one type of technology, or multiple units of a single technology, in order to attain the required overall removal efficiency.

Appendix C3: Information Needed for Selection of Technologies and Design of Treatment Train (continued)

Information Needed	Purpose of Information
3. Water quality of treatment influent: • Contaminant types and concentrations: - Inorganic chemicals - Organic chemicals - Concentration changes over time - Nonaqueous phase liquids (NAPLs)	**Contaminant types and concentrations** must be estimated for the total flow entering the treatment system. Since some technologies are more effective in removing certain contaminant types, this is an important technology selection factor. Inflow concentrations are needed to determine the removal efficiency of the treatment train, as discussed above. **The design should consider the potential for inflow concentrations to change over time.** Contaminant concentrations usually decrease as remediation progresses. Also, short term increases may occur if a "hot spot" of more highly contaminated ground water is captured by the extraction system. Samples obtained from **pumping type aquifer tests provide better estimates of average contaminant concentrations**, because such samples are obtained from a relatively large aquifer volume. If present, subsurface **NAPLs** (refer to Appendix A1) may become entrained in the extracted ground water. These immiscible liquids should be removed in a pretreatment step (process used prior to other treatment methods). Also, a specialized extraction system may be needed to remove free-phase NAPLs from the subsurface.
• Naturally occurring constituents: - Major cations (metals) and anions - Organic chemicals - Radionuclides	**Naturally occurring** or non-site related constituents may need to be removed to prevent interference with treatment processes and may be a factor in technology selection. **Metals** such as iron, manganese, and calcium can leave mineral deposits (scaling) on air stripper packing and on activated carbon or other treatment media. If not accounted for, these metals can also cause premature exhaustion of ion exchange capacity and increased consumption of reagents in chemical oxidation or precipitation processes. Iron also promotes biological fouling in air strippers. Heavy metals (e.g., lead, mercury) and cyanides can be toxic to microorganisms in biological reactors. Metals can also form deposits on well screens of extraction or reinjection wells (encrustation) or promote biological fouling (clogging) on well screens.

Appendix C3: Information Needed for Selection of Technologies and Design of Treatment Train (continued)

Information Needed	Purpose of Information
3. Water quality of influent (continued): • Other water quality parameters: - Indicator parameters - Design parameters	Dissolved **organic constituents** (e.g., from decay of organic materials or from landfill leachate) can interfere with adsorption of targeted compounds and can cause premature exhaustion of activated carbon. Metal-organic complexes can interfere with chemical oxidation or precipitation processes. If present, naturally occurring **radionuclides** can accumulate in treatment media or residuals (e.g., activated carbon or chemical sludges) resulting in potential exposure hazards for personnel and additional transportation and disposal considerations. Other water quality parameters are used as effluent quality standards, indicator parameters, or design parameters for treatment processes. **Indicator parameters** are used to indicate the presence of other constituents. For example, total dissolved carbon (TDC) is a measure of the relative level of dissolved organic constituents. Gross alpha and gross beta particle activity are relatively simple measurements that indicate the relative abundance of **naturally occurring radionuclides**. Other indicator parameters include: total dissolved solids (TDS), chemical oxygen demand (COD), biological oxygen demand (BOD) and total suspended solids (TSS). Temperature and pH are **design parameters** for most treatment processes. Also, high levels of total suspended solids (TSS) in extracted ground water may indicate that extraction wells are not properly designed or developed. Most treatment technologies require that suspended solids in excess of certain level be removed during pretreatment, where acceptable levels may differ for each technology.

Appendix C3: Information Needed for Selection of Technologies and Design of Treatment Train (continued)

Information Needed	Purpose of Information
4. Treatability information: • From technical literature • Treatability studies - Laboratory screening - Bench-scale testing - Pilot-scale testing • Modeling predictions •Projections of effluent quality	Treatability information is needed to select technology types and design styles from among the presumptive technologies; and for selection and design of other components of the treatment train. The particular mix of contaminants and naturally occurring constituents can vary considerably for different sites. Treatability information is available in the **technical literature** for some technologies, including air stripping and granular activated carbon (GAC). **Treatability studies** include 1) laboratory screening, 2) bench-scale testing, or 3) pilot-scale testing. These studies may begin with any tier and skip tiers that are not needed (see Section 3.4 of guidance). **Computer models** for predicting treatment performance are available for some technologies. In general, treatability studies should be performed prior or during the design of any system expected to provide **long-term treatment** of extracted ground water, including systems using presumptive technologies. Treatability studies are needed to accurately predict the effectiveness and cost of a technology for a given site, including construction and operating costs; and the costs of other components of the treatment train. Optimizing the cost effectiveness of the treatment train (i.e., minimizing the total cost per unit volume of water treated) is especially important for systems designed to operate over a long time period. Treatability studies **may reveal unexpected site conditions**, such as the presence of naturally occurring compounds that interfere with the planned treatment process or that metal contaminants can be effectively removed by removing mineral solids. Such studies are also needed to determine pretreatment requirements, and requirements for treating aqueous, vapor and solid waste streams resulting from a particular treatment process. Treatability studies are needed to determine optimum chemical reagents and reagent quantities for pH adjustment; oxidation, reduction or precipitation of contaminants; and parameters for design of biological and other reactors. Treatability studies should be performed on samples obtained from **pumping type aquifer tests** instead of from monitoring wells, because such samples are more representative of contaminated ground water that will enter the treatment system. Samples obtained for treatability studies should be obtained after several hours of pumping.

Appendix C4: Advantages and Limitations of Presumptive Treatment Technologies

Technology	Advantages	Limitations
Treatment Technologies for the Removal of Organic Contaminants		
Air Stripping	• Successfully used in hundreds of groundwater applications • Low operating cost relative to other technologies (e.g., energy usage is relatively low). • Operationally simple system requiring a minimum of operator assistance. • Treatability studies often not required for selection or design, but are recommended. • Trained contractors available to implement the technology.	• Contaminants transferred to air, and treatment of air emissions may be required. • Pretreatment for metals removal and pH control may be needed to reduce fouling and corrosion. • Post-treatment (polishing) may be required. • Large surges in influent concentrations can reduce removal efficiency because the efficiency for an individual compound is fixed regardless of influent concentrations. • Air stripping is not as effective for compounds with low Henry's law constants or high solubilities.[b,c] • Cold weather can reduce efficiency.
Granular Activated Carbon	• Successfully used for contaminated ground water at many Superfund and underground storage tank sites. • Operationally simple system requiring a minimum of operator assistance. • Regularly used as a polishing step following other treatment technologies. • Treatability studies generally not required, but are recommended (information is available from carbon vendors). • Trained contractors available to implement the technology. • Generally a cost-effective alternative as single- step treatment for flows less than about 3 gpm.[d]	• Activated carbon is generally too costly for use as a single-step treatment if ground-water chemistry requires high carbon usage rates. • Contaminants are not destroyed but are transferred to another media (i.e., spent carbon must be regenerated or disposed of properly). • Pretreatment for suspended solids removal is often required. • Pretreatment for metals removal and pH control may be needed to reduce fouling and corrosion. • Organic compounds that have low molecular weight and high polarity are not recommended for activated carbon (e.g., acetone). • Naturally occurring organic compounds may exhaust carbon bed rapidly and may interfere with the adsorption of targeted chemicals.

Appendix C4: Advantages and Limitations of Presumptive Treatment Technologies (continued)

Technology	Advantages	Limitations
Chemical/ UV Oxidation	• Where oxidation is complete, organic contaminants are destroyed and not transferred to other media; minimal residuals generated. • Effective on a wide variety of volatile and semivolatile organics, including chlorinated organics, as well as cyanide and some metals. • Operating costs can be competitive with air stripping and activated carbon.	• Incomplete oxidation will leave original contaminants and possibly toxic oxidation products; activated carbon polishing may be required. • Capital costs may preclude small-scale applications, especially for ozone systems. • Metals may precipitate during oxidation, requiring filtration post-treatment and residuals disposal. • UV light sources are subject to fouling and scaling from solids, iron compounds, carbonates, etc. Pretreatment may be required to remove these substances. • Process must be closely monitored to ensure contaminant destruction and to prevent safety hazards. • Peroxide and other chemical oxidants must be properly stored and handled. • Site-specific treatability studies are necessary (process may require large quantities of oxidizer to destroy target compound(s) if reactive nontarget compounds are present).
Aerobic Biological Reactors	• Organic contaminants degraded, often with minimal cross-media environmental impacts. • Proven effective for many organic compounds. • Some systems (e.g., trickling filters and rotating biological contactors) have minimal energy requirements and generally low capital and operating costs. • Can be designed to require a minimum of operator attention. • Relatively simple, readily available equipment. • Trained contractors available to implement the technology.	• A residual organic sludge is generated that must be disposed of properly. • Some compounds are difficult or impossible to degrade (recalcitrant) or slow to degrade. • Difficulties acclimating microorganisms to contaminants are possible; requires longer startup time than other technologies to achieve effective steady-state performance • Volatile organics may require air emission controls or pretreatment to remove them. • Variations in flow or concentration may require significant operator attention to prevent microorganisms from being killed. • Cold weather can cause operational difficulties. • Treatability studies are needed for selection and design. • Pretreatment may be needed to remove contaminants toxic to the microorganisms, such as heavy metals. • Low organic loading and the potential for supplementary nutrients and food sources must be considered.

Appendix C4: Advantages and Limitations of Presumptive Treatment Technologies (continued)

Technology	Advantages	Limitations
Treatment Technologies for the Removal of Inorganic Contaminants		
Chemical Precipitation	• Most commonly used method for removing soluble heavy metal ions from contaminated water. • Pretreatment for solids and iron generally not required. Hydroxide Precipitation • Reliable method, chemicals relatively easy to handle, and not costly. Carbonate Precipitation • Reliable method, calcium carbonate easy to handle, and not costly. • Effectively removes a variety of soluble metals. Sulfide Precipitation • Reliable method. • High removal efficiency over a broader pH range. • Relatively insensitive to most chelating agents. • Can remove chromates and dichromates without reducing hexavalent chromium to trivalent form if ferrous ions are present or added.	• A residual sludge is generated that must be treated and/or disposed of properly; metals are not usually easy to recover from sludge. • Up to four times stoichiometric chemical additions may be required, especially for sulfide precipitation (see below). Hydroxide Precipitation • Organics or complexing ions may form chelates/complexes instead of insoluble metal hydroxides. • Optimum pH is different for each metal hydroxide, one pH may not effectively treat all soluble metal ions; successive treatments may be required. • pH must be controlled within a narrow range. • Naturally occurring sulfate in ground water may react with lime to form gypsum, which increases sludge, can clog filters, and can coat pipelines (caustic soda addition can reduce this problem but increases costs and dissolved solids [sodium salts] that must be removed from treated ground water). Carbonate Precipitation • Calcium carbonate is not effective for ground water with high alkaline content. • Pretreatment to remove organic, chelating, or oil and grease contaminants may be required. Sulfide Precipitation (Soluble Sulfide) • Excess sulfide ions that are not precipitated remain in solution. They may be removed by using aeration to convert them from ionic to oxide form (sulfate). • pH control between 8 and 9.5 is required to avoid release of hydrogen sulfide gas. • Cost is high compared to hydroxide and carbonate precipitation Sulfide Precipitation (Insoluble Sulfides) • Ferrous sulfide is used in amounts greater than that required by stoichiometric considerations. • Produces more sludge than soluble sulfide or hydroxide processes.

Appendix C4: Advantages and Limitations of Presumptive Treatment Technologies (continued)

Technology	Advantages	Limitations
Treatment Technologies for the Removal of Inorganic Contaminants (continued):		
Ion Exchange/ Adsorption	• High removal efficiencies for heavy metals. • Suitable for use as a polishing step after other technologies. • Technology is reasonably well understood. • On-site backflushing of exchange media allows immediate reuse.	• Resins are usually costly and may not be cost-effective for large treatment loadings. • Generates large volume of backflush solution (approximately 2.5 to 5% of the original ground-water flow rate) that is concentrated in the metals removed and requires treatment or disposal. • Requires bench-scale testing to determine operational requirements and suitability of prospective resins. • Beds can be fouled by particulate matter, oxidizing agents, oils, greases, biological growths, and intra-bed precipitates; therefore, pretreatment may be needed. • Resins may be irreversibly harmed by aromatics and certain other organic compounds; and by iron, manganese, and copper if enough dissolved oxygen is present. Pretreatment may be needed. • Spent resins require treatment before disposal.
Electro-chemical Methods	• High removal efficiencies for certain heavy metals. • Can treat both metals and cyanide simultaneously. • Technology is reasonably well understood. • Requires little floor space due to short residence time for hexavalent chromium reduction. • Requires minimal operator attention. • Low operating costs compared to chemical reduction or precipitation. • Requires no chemical addition.	• Particulate matter, oxidizing agents, oils, greases, biological growths may reduce process efficiency; therefore, pretreatment may be needed. • Hexavalent chromium reduction generates a heavy metal precipitate that must be removed from solution in a subsequent clarification or settling process. • A heavy metal sludge residual may be generated that may require treatment (dewatering and/or fixation) and that will require disposal. • A spent acid rinse solution may be generated that requires treatment or disposal. • Electrodes must be replaced occasionally.

NOTES:

[a] U.S. Environmental Protection Agency. 1991. Engineering Bulletin: *Air Stripping of Aqueous Solutions.* EPA/540/2-91/022. 8 pp.

[b] B. Lamarre. 1993. Selecting an air stripper (what to consider!) *The National Environmental Journal*: 26-29.

[c] G. M. Long. 1993. Clean up hydrocarbon contamination effectively. *Chemical Engineering Progress*: 58-66.

APPENDIX D

Descriptions of Presumptive Treatment Technologies

Appendix D1: Air Stripping

Appendix D2: Granular Activated Carbon

Appendix D3: Chemical/UV Oxidation

Appendix D4: Aerobic Biological Reactors

Appendix D5: Chemical Precipitation

Appendix D6: Ion Exchange/Adsorption

Appendix D7: Electrochemical Methods

Appendix D8: Aeration of Background Metals

Appendix D1: Air Stripping

Air stripping uses volatilization to transfer contaminants from ground water to air. In general, water is contacted with an air stream to volatilize dissolved contaminants into the air stream. Stripping of a specific chemical depends on the equilibrium vapor pressure of that chemical as expressed by its Henry's law constant.

Applicability

Air stripping is *applicable* to most of the volatile organic compounds (VOCs) as well as volatile inorganics such as ammonia and hydrogen sulfide. VOCs with high solubility in water (e.g., acetone) are more difficult to air strip. Air stripping is *potentially applicable* to certain halogenated semi-volatile organic compounds (SVOCs). It is *not applicable* to nonhalogenated SVOCs; heavy organics such as PCBs, dioxins/furans and pesticides; or inorganic metal compounds (U.S. EPA, 1991).

Air stripping is most effective for contaminants with a dimensionless (molar volume) Henry's law constant greater than 0.01 (or 2.4×10^{-4} atm-m^3/gmol at 25° C). (Henry's law constants are available in U.S. EPA [1990]). Removal efficiencies greater than 99 percent are difficult to achieve for certain compounds. In general, other treatment technologies will be required for such chemicals when ground-water concentrations are high (e.g., above 10,000 ppm or 1 percent).

Contaminant Fate

Contaminants are not destroyed by air stripping but are physically separated from contaminated ground water and transferred to air. Depending on the level of contaminants in the air discharge, the contaminated air stream may need further treatment. Additional polishing treatment of the aqueous effluent also may be necessary, depending on discharge requirements.

Design

Air strippers are designed for a specific target chemical (either the predominant contaminant or the most difficult-to-strip contaminant) with a desired target removal efficiency. The air stripping process is well understood and the technology is well developed. Air stripping has an extensive track record in a variety of applications.

The most frequently used configuration is a packed tower equipped with an air blower. The ground water is fed into the top of the stripper and the air is introduced at the bottom, creating a countercurrent gas-liquid contact. Random plastic packing is frequently used to improve gas-liquid contact. Structured packing and steel packing may also be used. Packed-tower air stripper design involves specification of stripper column diameter and packing height for a specified ground-water flow rate and air-to-water ratio. Shallow-tray aeration devices provide an alternative gas-liquid contacting system that provides a more compact, lower profile system that is less subject to fouling.

Alternative Techniques/Enhanced Methods

- For high flow rates (over 1,000 gpm), cooling towers (large structures with cascading water primarily used to cool water using countercurrent ambient air flow) may provide a cost-effective alternative to conventional packed towers.
- Shallow tray air strippers or diffused tank aeration units are less susceptible to fouling problems than packed towers and may be preferable where the water to be treated contains high concentrations of certain inorganics (e.g., iron).

Alternative Techniques/Enhanced Methods (continued)

- Because the efficiency of air stripping increases at higher temperatures, increasing the influent ground-water temperature (typically about 55° F) using a heat exchanger can increase the stripper's removal efficiency, especially for less volatile contaminants.
- Steam stripping methods, which use steam rather than air as the stripping medium, can be used to remove highly soluble contaminants and SVOCs not usually amenable to air stripping. However, operation costs for steam stripping can be two to three times greater than air stripping, depending on the cost of steam. In this guidance, these methods are not considered a type of air stripping and are not identified as a presumptive technology for ex-situ treatment of ground water.

Pre/Post-treatment

- Pretreatment to remove iron and other metals and to control hardness may be necessary to reduce fouling and mineral deposition in packed tower air strippers.
- Granular activated carbon is sometimes used to polish the treated water from an air stripper to further reduce organic contaminant levels and meet discharge requirements.
- Contaminants in the air discharge may be reduced by activated carbon adsorption, catalytic oxidation, or incineration to meet air emission requirements.

Selected References

Lamarre, B. 1993. Selecting an air stripper (what to consider!). The National Environmental Journal: 26-29.

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Nyer, E.K. 1993. Practical Techniques for Groundwater and Soil Remediation. CRC Press, Inc., Boca Raton, FL. 214 pp.

Okoniewski, B.A. 1992. Remove VOCs from wastewater by air stripping. Chemical Engineering Progress: 89-93.

U.S. EPA Environmental Protection Agency. 1990. Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models. EPA/450/3-87-026. Office of Air Quality Planning and Standards, Research Triangle Park, NC. Appendix D.

U.S. Environmental Protection Agency. 1991. Engineering Bulletin: Air Stripping of Aqueous Solutions. EPA/540/2-91/022. Office of Research and Development, Cincinnati, OH. 9 pp.

Appendix D2: Granular Activated Carbon

Activated carbon removes contaminants from ground water by adsorption. The adsorption process takes place in three steps: (1) contaminant migration to the external sorbent surface; (2) diffusion into the sorbent pore structure; and (3) adsorption onto the sorbent surface. The principal form of activated carbon used for ground-water treatment is granular activated carbon (GAC). GAC is an excellent sorbent due to its large surface area, which generally ranges from 500 to 2,000 m^2/g.

Applicability

GAC is *applicable* to a wide variety of contaminants including: halogenated volatile and semivolatile organics, nonhalogenated volatile and semivolatile organics, PCBs, pesticides, dioxins/furans, most organic corrosives, metals, radioactive materials, inorganic cyanides, and certain oxidizers. GAC is *potentially applicable* to certain organic cyanides, and it is *not applicable* to asbestos, inorganic corrosives, and reducers (U.S. EPA, 1991). GAC is sometimes used alone for ground-water treatment. However, GAC is typically used for polishing aqueous effluents or controlling air emissions from other treatment technologies.

The adsorption capacity of activated carbon varies for specific organic compounds and for different types of GAC (based on the origin of coal and the percent binder used in the manufacture of the GAC). Contaminant-specific adsorption isotherms for a given type of GAC are generally available from the carbon manufacturer.

Contaminant Fate

Contaminants are not destroyed by carbon adsorption, but are physically separated from contaminated water and transferred to carbon. After exhaustion, the spent carbon may be reactivated, regenerated, incinerated, or disposed of. Thermal reactivation and incineration destroy most or all adsorbed organic contaminants. Steam or hot gas regeneration is not appropriate for spent GAC from treatment of contaminated ground water but can be used for spent GAC from air emission control devices. GAC used for metals sorption may require disposal. If disposed of, spent GAC may have to be managed as a hazardous waste.

Design

Activated carbon is a well-developed, widely used technology with many successful ground-water treatment applications, especially for secondary polishing of effluents from other treatment technologies. Contaminated ground water is contacted with a fixed GAC bed in a vessel. Flow direction is generally vertically downward, although an upward flow configuration is also possible. Fixed-bed configurations are also used for air emission control.

Adsorber design involves determining total carbon requirements and the number and dimensions of vessels needed to house the carbon. The amount of carbon required for a given application depends on the loading of adsorbable constituents in ground water (or contaminated air stream), the carbon's adsorption capacity for these constituents, and the carbon reactivation (or regeneration) frequency. Depending on the ground-water suspended solids content, it may be necessary to periodically backwash down flow carbon beds to relieve pressure drop associated with solids accumulation.

Alternative Techniques/Enhanced Methods

- Staged bed (multiple beds operated in series) and pulsed bed (carbon beds operated with nearly continuous "pulsed" addition of fresh carbon and withdrawal of spent carbon) designs can be used if higher removal efficiencies are required.

Alternative Techniques/Enhanced Methods (continued)

- Because the adsorption capacity of GAC is much higher for gas phase treatment than for liquid phase treatment, it is often more economical to use an air stripper followed by gas phase GAC to treat the air stripper exhaust than to use GAC alone for ground-water treatment.

- **GAC is not identified as a presumptive technology for removal of metals dissolved extracted ground water. Spent carbon used for metals removal can be difficult to regenerate and may require treatment and/or disposal as a hazardous waste.** Although GAC can remove low concentrations of certain metals, it has not been widely used for this purpose (U.S. EPA, 1991).

Pre/Post-treatment

- Pretreatment may be required to remove natural organic matter, such as fulvic and humic acids, that may interfere with the adsorption of the target contaminants or rapidly exhaust the GAC.
- Naturally occurring **radionuclides**, if present in ground water, can accumulate in the GAC during treatment, **which could result in potential exposure hazards for operating personnel and the spent carbon may require treatment and/or disposal as hazardous waste.**

- Thermal reactivation, using heat alone or steam, is typically used as a post-treatment method for the spent carbon. The carbon is reactivated in a high-temperature reactor under reducing conditions. Most organic contaminants are thermally degraded during the reactivation process.

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Long, G.M. 1993. Clean up hydrocarbon contamination effectively. *Chemical Engineering Progress*, 89(5):58-67.

Stover, E.L. 1988. Treatment of herbicides in ground water. *Ground Water Monitoring Review*: 54-59.

Stenzel, M.H. 1993. Remove organics by activated carbon adsorption. *Chemical Engineering Progress*: 36-43.

U.S. Environmental Protection Agency. 1991. *Engineering Bulletin: Granular Activated Carbon Treatment*. EPA/540/2-91/024. Office of Emergency and Remedial Response, Washington, D.C. 8 pp.

Appendix D3: Chemical/UV Oxidation

Chemical oxidation uses chemical oxidizing agents to destroy toxic organic chemicals and cyanide compounds (CN) in ground water. Commonly used oxidizing agents include: ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Ozone and hydrogen peroxide are generally preferred for removing organics and CN from ground water because chlorine-based oxidants can produce toxic byproducts (e.g., HCl, chlorinated organics). Ultraviolet light (UV) is often used in conjunction with ozone and/or hydrogen peroxide to promote faster and more complete destruction of organic compounds (reaction rates may be increased by factors of 100 to 1,000).

Applicability

Chemical oxidation is *applicable* to both volatile and semivolatile organic compounds and cyanide compounds. Chemical oxidation is *potentially applicable* to PCBs, dioxins/furans, and metals (oxidation can be used to precipitate metals under certain conditions). Chemical oxidation is *not applicable* to asbestos and radioactive materials (U.S. EPA, 1991).

Chemical oxidation generally is effective for concentrations less than 500 µgL, but has been used for certain compounds at concentrations ranging up to several thousand mg/L. UV can enhance the oxidation of compounds that are resistant to chemical oxidation alone (e.g., PCBs). Iron or copper catalysts may be required for efficient destruction of certain organic compounds (e.g., phenols).

Contaminant Fate

Complete oxidation decomposes hydrocarbons into carbon dioxide and water, although chlorinated organic compounds also yield chloride ions. CN is oxidized to ammonia and bicarbonate by hydrogen peroxide in an alkaline environment. If oxidation is incomplete, toxic constituents may remain, or intermediate degradation products can be formed that may be toxic. These toxic substances may be removed using GAC as a secondary or polishing treatment step.

Design

Chemical oxidation is a proven and effective technology that is carried out in either batch or continuous reactors. Oxidants are generally added to contaminated ground water in a mixing tank prior to introduction into the reaction vessel (reactor). The use of ozone as the oxidizing agent requires an onsite ozone generator and an ozone decomposition unit or other ozone emission control device. The use of hydrogen peroxide as the oxidizing agent requires storage tanks and special handling protocols to ensure operator safety. The use of chlorine as the oxidizing agent may produce HCl gas. If HCl is produced, an acid gas removal system may be necessary.

UV lamps, if used, are typically enclosed in quartz tubes submerged inside the reaction vessel. The tubes are subject to fouling or scaling from compounds such as iron oxide or calcium carbonate and from biological flocs from microorganisms in ground water. If fouling occurs, oxidation rates are drastically reduced.

Site-specific treatability studies are generally recommended for chemical oxidation systems. Extensive pretreatment may be required to condition ground water for effective oxidation. If UV lamps are used, the studies must evaluate the potential for fouling or scaling of the quartz tubes at the ground-water composition, oxidant concentration, and UV intensity conditions anticipated for long-term system operation. If fouling or scaling is likely, pretreatment and/or physical methods for keeping the tubes clean (e.g., wipers) may be required. If metals are to be removed by oxidation, solids should be removed by clarification or filtration prior to UV oxidation. Provisions for removing precipitated metal sludges also may be necessary.

Alternative Techniques/Enhanced Methods

- UV radiation can be used in combination with a chemical oxidizing agent to increase the effectiveness of oxidation, especially for difficult-to-oxidize compounds.
- Metal catalysts, such as iron or copper, can be used in combination with a chemical oxidizing agent to increase the effectiveness of oxidation for certain types of compounds.
- Hydrodynamic cavitation is an innovative technology recently demonstrated under EPA's SITE program that uses forced cavitation of gas to enhance destruction of organics during UV oxidation processes.

Pre/Post-treatment

- Pretreatment may be necessary to remove solids, microorganisms, calcium carbonate, iron oxides, and/or other metals that can interfere with the oxidation process or UV transmission. A pretreatment sequence of precipitation, flocculation, clarification, and/or filtration steps may be necessary.
- Post-treatment of the aqueous effluent with GAC may be necessary if destruction is not complete or if toxic byproducts are formed during oxidation.
- If toxic metals precipitate during the oxidation process, treatment and/or proper disposal of the resulting sludge may be required.

Selected References

U.S. Environmental Protection Agency. 1990. *CERCLA Site Discharges to POTWs Treatability Manual.* EPA/540/2-90/008. Office of Emergency and Remedial Response. PB91-921269/CCE. NTIS. Springfield, VA. pp. 11-7 to 11-17.

U.S. Environmental Protection Agency. 1991. *Engineering Bulletin: Chemical Oxidation Treatment.* EPA/540/2-91/025. Office of Emergency and Remedial Response, Washington, D.C. 8 pp.

U.S. Environmental Protection Agency. 1993. *Superfund Innovative Technology Evaluation Program. Technology Profiles. Sixth Edition.* EPA/540/R-93/526. Office of Research and Development, Washington, DC.

U.S. Navy. 1993. *UV/Oxidation Treatment of Organics in Ground Water.* NEESA Document Number 20.2-051.7. Navy Energy and Environment Support Activity, Port Hueneme, CA. 11 pp.

Appendix D4: Aerobic Biological Reactors

Biological reactors use microorganisms to degrade organic contaminants in ground water in ex situ reactors. There are two basic types of ex situ biological treatment processes: aerobic reactors and anaerobic reactors. Aerobic reactors use oxygen to promote biodegradation and are widely used. Anaerobic reactors degrade organics in the absence of oxygen. This guidance focuses on aerobic biological treatment because anaerobic treatment processes are not widely used for ground-water treatment.

Applicability

Aerobic biological reactors are *applicable* to a wide variety of halogenated and nonhalogenated volatile and semivolatile organics. Aerobic biological reactors are *potentially applicable* to heavy organics, such as PCBs and certain pesticides, and organic and inorganic cyanides, but are generally not as effective for such recalcitrant compounds. Aerobic processes are *not applicable* to metals, asbestos, radioactive materials, or corrosive or reactive chemicals (U.S. EPA, 1992).

Contaminant Fate

Organic compounds are decomposed to carbon dioxide and water (aerobic processes) or to methane and carbon dioxide (anaerobic processes). Volatile organics are also removed by volatilization as a competing mechanism. Microbial growth produces an excess organic sludge (biomass) that must be disposed of properly. This sludge may concentrate metals and recalcitrant organic compounds that are resistant to degradation. Biodegradation may produce decomposition byproducts that are emitted to the air or dissolved in the effluent, and these decomposition byproducts may require additional treatment.

Design

Ex situ biological treatment of ground water is conducted in bioreactors. The primary factors influencing bioreactor design are the microbial organic utilization rates and the peak organic loading rate (i.e., flow rate times organic concentration). Treatability tests are necessary to determine these and other design parameters. Under most circumstances, bioreactors require a significant startup time to acclimate the microorganisms to the specific contaminants being treated before the bioreactor will operate at optimal degradation rates. There are two general types of bioreactor design:

- In **suspended growth** reactors, microbes are kept suspended in water using mechanical aerators or diffused air systems. These aeration systems also keep the solution well mixed, improving contact between microbes and dissolved contaminants and supplying oxygen to the system. Activated sludge systems are the most common suspended growth bioreactors. Other examples include aerated ponds or lagoons, stabilization ponds (using both algae and bacteria), and sequencing batch reactors.
- In **attached growth** reactors, biomass is attached to a solid substrate, such as sand, rock, plastic, activated carbon, or resin. Reactor design is dependent upon the surface area of substrate media available for biomass growth. Examples include trickling filter, rotating biological contactor, fluidized bed, fixed bed, and roughing filter designs.

Alternative Techniques/Enhanced Methods

- Direct addition of powdered activated carbon (PAC) into suspended growth bioreactors can both improve removal efficiency and reduce the likelihood of process upsets by buffering the concentrations of toxic compounds at levels amenable to biodegradation.

Alternative Techniques/Enhanced Methods (continued)

- Microbial augmentation (the addition of specially cultured microorganisms) may be used to increase the system's removal efficiency for certain difficult-to-degrade contaminants.
- Anaerobic reactors (digesters) may be preferred for the treatment of certain ground-water contaminants (e.g., certain chlorinated organics) that are difficult to degrade aerobically. **However, anaerobic reactors have not been identified as a presumptive technology for the following reasons:** 1) anaerobic processes have not been widely used for ground-water treatment; 2) reaction rates are slower than for aerobic processes, which result in longer startup times (for acclimation) and longer treatment times; and 3) such reactors have a greater sensitivity to process upsets, especially where flow and contaminant concentrations vary over time. These factors generally result in higher operation and maintenance requirements and costs, and lower performance efficiencies than for aerobic processes in ground-water applications.

Pre/Post-treatment

- Chemical precipitation (for metals) or other pretreatment (e.g., PAC addition for organics) may be required to reduce (or buffer) concentrations of compounds that are toxic to microorganisms.
- Carbon adsorption post-treatment may be used to reduce contaminant concentrations in the treated water to meet discharge requirements.
- Because certain aerated bioreactor designs (e.g., mechanically aerated activated sludge systems, aerated ponds and lagoons) present difficulties for direct capture and control of air emissions, an air stripper (with emission controls) may be a cost-effective treatment prior to biodegradation if volatile contaminant emissions need to be controlled. For other bioreactor designs, such as diffused-aeration activated sludge and trickling filter systems, air emissions are more easily captured and can be treated using carbon adsorption, catalytic oxidation, or incineration.

Selected References

Eckenfelder, W.W., J. Patoczka, and A.T. Watkins. 1985. Wastewater treatment. *Chemical Engineering*: 60-74.

Flatman, P.E., D.E. Jerger, and L.S. Bottomley. 1989. Remediation of contaminated groundwater using biological techniques. *Ground Water Monitoring Review*: 105-119.

U.S. Environmental Protection Agency. 1979. *Selected Biodegradation Techniques for Treatment and/or Ultimate Disposal of Organic Materials.* EPA-600/2-79-006. Office of Research and Development, Cincinnati, OH.

U.S. Environmental Protection Agency. 1981. *Literature Study of the Biodegradability of Chemicals in Water (Volume 1. Biodegradability Prediction, Advances in and Chemical Interferences with Wastewater Treatment).* EPA/R806699-01. Office of Research and Development, Cincinnati, OH.

U.S. Environmental Protection Agency. 1992. *Engineering Bulletin: Rotating Biological Contactors.* EPA/540/S-92/007. Office of Research and Development, Cincinnati, OH. 8 pp.

Appendix D5: Chemical Precipitation

Chemical precipitation chemically converts dissolved metal and/or other inorganic ions in ground water into an insoluble form, or precipitate. Metal ions generally precipitate out as hydroxides, sulfides, or carbonates and are removed as solids through clarification and filtration. In this guidance, chemical precipitation is defined to include chemical precipitation of metals by oxidizing or reducing agents, as well as any pH adjustment (neutralization) and solids removal steps required.

Applicability

Chemical precipitation is *applicable* to dissolved metal and other inorganic ions (such as arsenate and phosphate). Chemical precipitation is *not applicable* to volatile or semivolatile organic compounds (U.S. Navy, 1993).

Contaminant Fate

Dissolved metals are converted to insoluble forms, which are subsequently removed by flocculation, clarification, and/or filtration. The solid residue (chemical sludge) containing the metal contaminant then must be treated and/or disposed of properly.

Design

The process generally takes place at ambient temperatures. Batch reactors are generally favored for lower flowrates (e.g., up to about 50,000 gpd), and usually use two tanks operating in parallel. Each tank can act as a flow equalizer, reactor, and settler, thus eliminating separate equipment for these steps. Continuous systems have a chemical feeder, flash mixer, flocculator, settling unit, filtration system (if used), and control system for feed regulation. Site-specific treatability tests are required to determine the optimum type and dosage of precipitation chemicals, necessary pretreatment steps, and post-treatment requirements for aqueous effluent and sludge residuals.

There are three types of precipitation chemicals:

- **Metal hydroxides** are formed by the addition of alkaline reagents (lime or sodium hydroxide). Precipitation is then initiated by adjusting pH to the optimum level for the particular metal ion. Maintaining pH levels within a relatively narrow optimum range is usually necessary to achieve adequate metal precipitation. Pretreatment with oxidizing or reducing chemicals (e.g., hydrogen peroxide, ferrous sulfate) may be necessary to precipitate some metals (e.g., iron, manganese, chromium) in their least soluble form. Natural organic matter can inhibit the formation of insoluble metal hydroxides by forming metal-organic complexes. Metal hydroxide precipitation is typically effective for arsenic, cadmium, chromium (+3), nickel, zinc, manganese, copper (+2), tin (+3), and iron (+3).
- **Metal sulfides** are formed by the addition of either soluble sulfides (e.g., hydrogen sulfide, sodium sulfide, or sodium bisulfide) insoluble sulfides (e.g., ferrous sulfide). Sodium sulfide and sodium bisulfide are most commonly used. Sulfur dioxide and sulfur metabisulfite have also been demonstrated for chromium reduction prior to precipitation. Metal sulfides have lower solubilities than metal hydroxides, and effective metal removal efficiencies can be achieved over a broader pH range. The method is mainly used to remove mercury and lead and may be used to remove arsenic, cadmium, chromium (+3,or +6), silver and others. Sulfide precipitation also can be used to treat filtered ground water after hydroxide precipitation.

Alternative Techniques/Enhanced Methods

- **Metal carbonates** are formed by the addition of calcium carbonate or by adding carbon dioxide to metal hydroxides. Solubilities of metal carbonates are intermediate between the solubilities of metal hydroxides and metal sulfides. Insoluble metal carbonates are easily filtered from treated ground water. The method is particularly good for precipitating lead, cadmium, and antimony.
- Sodium xanthate has shown promise as a precipitation agent similar to sodium sulfide.

Pre/Post-treatment

- Pretreatment to adjust pH is normally required to obtain the lowest precipitate solubility.
- Pretreatment may be necessary to oxidize iron or manganese compounds or reduce hexavalent chromium compounds into forms that can be readily precipitated.
- Depending on discharge requirements, the aqueous effluent may need pH adjustment and/or further polishing. Activated alumina or ion exchange media are regenerable treatment options for effluent polishing for metals. Activated carbon also may be used but spent carbon may require treatment and disposal as a hazardous waste.
- The sludge may require stabilization treatment by addition of lime/fly ash or portland cement to reduce permeability and the leachability of metals prior to disposal. In some cases, metals may be recovered from the residue for reuse, but this is generally not economical.

Selected References

Monopoli, A.V. 1993. Removing dissolved inorganics from industrial wastewater. *The National Environmental Journal:* 52-56.

U.S. Environmental Protection Agency. 1987. *Handbook on Treatment of Hazardous Waste Leachate.* EPA/600/8-87/006. Office of Research and Development, Cincinnati, OH. pp. 44-45.

U.S. Environmental Protection Agency. 1990. *CERCLA Site Discharges to POTWs Treatability Manual.* EPA/540/2-90/008. Office of Emergency and Remedial Response. PB91-921269/CCE. NTIS, Springfield, VA. pp. 11-23 to 11-36.

U.S. Navy. 1993. *Precipitation of Metals from Ground Water.* NEESA Document Number 20.2-051.6. Navy Energy and Environment Support Activity. Port Hueneme, CA. 11 pp.

Appendix D6: Ion Exchange/Adsorption

Ion exchange removes metal contaminants from water by passing contaminated ground water through a granular solid or other porous material, usually an impregnated resin, that exchanges sorbed ions (e.g., H^+, OH^-, Na^+, Li^+, CO_3^-) for contaminants dissolved in ground water. The ion exchange media are selected to have sorptive affinity for the ionic forms (cation or anion) of the contaminants being removed. The ion exchange media can therefore be either cationic, anionic, or a mixture of the two. Because ion exchange is a reversible process, resins can be regenerated by backwashing with a regeneration solution (e.g., brine; strong or weak acids or bases). Conventional ion exchange resins are generally too costly for large-scale ground-water treatment and are predominantly used for polishing of aqueous effluents after other treatment processes.

Applicability

Ion exchange is *applicable* to ionic contaminants such as dissolved metals or nitrates. Ion exchange is *not applicable* to non-ionic contaminants such as most organic compounds.

Contaminant Fate

Contaminants are removed from ground water through sorption onto the exchange media. When most of the exchange sites of the media become filled, the exchange media are regenerated by backflushing with a suitable regeneration solution. The concentrated backflush solution must then be disposed of or stripped of its contaminants. Exchange resins can generally be regenerated many times and have a relatively long useful life.

Design

Various resin types are available to tailor systems to discrete ionic mixes. For example, acid exchangers replace cations in water with hydrogen ions and base exchangers replace anions with hydroxide ions. Weak acid and base exchangers are selective for more easily removed ions while strong acid and base exchangers are less selective, removing most ions in the ground water. Generally, ease of cation and anion removal follows an affinity sequence specific to the ions in question. Synthetic resins are available with unique selectivity sequences. The wide variety of resins and other ion exchange media (e.g., activated alumina, biological materials) that are available make the selection of an appropriate exchange media a critical design step. Information on the applicability of specific resins may be obtained from resin manufacturers. In addition, ion exchange resins generally have an optimum pH range for effective metals removal. pH control may be required to achieve maximum removal efficiency from ground water.

A typical ion exchange installation has two fixed beds of resin. While one is in operation, the other is regenerated. Batch, fixed column, and continuous column bed designs can be used. Downflow column designs are generally preferred. Continuous column systems eliminate the need for backwashing but are not commonly used because of the complexity of the resin removal mechanics.

Flow rates up to 7,000 gpm have been reported for ion exchange systems. However, conventional ion exchange is generally cost-effective for ground-water treatment only at low flow rates or low contaminant concentrations. It is therefore primarily used as a polishing step following chemical precipitation or other treatment.

Alternative Techniques/Enhanced Methods

- Activated alumina is an anionic exchange medium comprised of granulated, dehydrated aluminum hydroxide. Activated alumina is effective for removing fluoride, selenium, chromium (+6), and arsenic ions, which are exchanged for hydroxide ions. Adjustment of pH may be necessary to achieve optimal removal efficiency. The alumina is regenerated with a sodium hydroxide solution.
- Biological materials (e.g., algae, crop residues) have recently shown great promise as an innovative ion exchange media for metals. Biological media are significantly less costly than conventional resins (cents per pound vs. dollars per pound), and may become more commonly used for metals removal from ground water.
- Electrodialysis uses alternately placed cation and anion permeable membranes (made of ion exchange resin) and an electrical potential to separate or concentrate ionic species.
- Activated carbon adsorption can also be used to remove inorganics at low concentrations. **However, activated carbon is not identified as a presumptive technology for removal of metals dissolved extracted ground water.** Spent carbon used for metals removal can be difficult to regenerate and may require treatment and/or disposal as a hazardous waste.

Pre/Post-treatment

- Pretreatment may be required to remove suspended solids at concentrations greater than about 25 mg/L or oil at concentrations greater than about 20 mg/L. Large organic molecules also can clog resin pores and may need to be removed.
- pH adjustment may be necessary to achieve optimal metals removal.
- The backwash regeneration solution must be treated to remove contaminants.
- Post-treatment of spent ion exchange media may be required to recover concentrated contaminants or management as a hazardous waste may be required.

Selected References

Clifford, D., Subramonian, S., and Sorg, T.J., 1986. "Removing Dissolved Inorganic Contaminants from Water," *Environmental Science and Technology*, Vol. 20, No. 11.

Nyer, E.K. 1985. *Groundwater Treatment Technologies.* Van Nostrand Reinhold. New York, NY. 187 pp.

U.S. Environmental Protection Agency. 1990. *CERCLA Site Discharges to POTWs Treatability Manual.* EPA/540/2-90/008. Office of Emergency and Remedial Response. PB91-921269/CCE. NTIS. Springfield, VA. pp. 11-102 to 11-112.

Appendix D7: Electrochemical Methods

Electrochemical processes use direct electrical current applied between two immersed electrodes to drive chemical oxidation-reduction reactions in an aqueous solution. Historically, electrochemical processes have been used to purify crude metals or to recover precious metals from aqueous solutions. Positively charged metal ions are attracted to the negatively charged electrode (the cathode), where they are reduced. The reduced metals typically form a metallic deposit on the cathode. Negatively charged ions are attracted to the positively charged electrode (the anode), where they are oxidized.

For contaminated ground water treatment, electrochemical cells have been used for the reduction (and subsequent precipitation) of hexavalent chromium to trivalent chromium. In this process, consumable iron electrodes are used to produce ferrous ions (Fe^{2+}) at the anode and hydroxide ions (OH^-) at the cathode. An oxidation-reduction reaction then occurs between the ferrous, chromium, and hydroxide ions to produce ferric hydroxide $Fe(OH)_3$ and chromic hydroxide $Cr(OH)_3$, which subsequently precipitate from solution.

Applicability

Electrochemical processes are *applicable* to dissolved metals. It is most commonly used in ground water treatment for the reduction and precipitation of hexavalent chromium. The process also may be applicable to removing other heavy metals including arsenic, cadmium, molybdenum, aluminum, zinc, and copper ions. Electrochemical processes have also been used for the oxidation of cyanide wastes (at concentrations up to 10 percent). Electrochemical processes are *not applicable* to organic compounds or asbestos.

Contaminant Fate

Dissolved metals either deposit on the cathode or precipitate from solution. Precipitates form an inorganic sludge that must be treated and/or disposed of, typically in a landfill. Spent acid solution, which is used to periodically remove deposits formed on the electrodes, will also require proper treatment and disposal. Cyanide ions are hydrolyzed at the anode to produce ammonia, urea, and carbon dioxide.

Design

Electrochemical reactors generally operate at ambient temperatures and neutral pHs. Both batch reactors and continuous flow reactors are commercially available. A typical electrochemical cell for hexavalent chromium reduction consists of a tank, consumable iron electrodes, and a direct current electrical supply system. An acid solution is used to periodically clean the iron electrodes, which need to be replaced when they are significantly consumed. Reactor residence times required for treatment depend on the contaminants present as well as the degree of mixing and current density. Reduction of hexavalent chromium generally requires short residence times (approximately 10 seconds), whereas treatment of cyanide compounds requires longer process times.

Pre/Post-treatment

- Pretreatment may be necessary to remove suspended solids.
- Settling or clarification post-treatment may be necessary to remove the precipitated trivalent chromic and ferric hydroxides formed during hexavalent chromium electrochemical reduction.

Pre/Post-treatment (continued)

- The sludge may require stabilization prior to disposal by addition of lime/fly ash or portland cement to reduce permeability and metal leachability. In some cases, metals may be recovered from the plated electrode or precipitated residue, but this is generally not economical for typical ground-water applications.

Selected References

Englund, H.M. and L. F. Mafrica. 1987. *Treatment Technologies for Hazardous Waste.* APCA Reprint Series RS-13. Air Pollution Control Association, Pittsburgh, PA. pp. 43-44.

U.S. Environmental Protection Agency. 1990. *A Compendium of Technologies Used in the Treatment of Hazardous Wastes.* EPA/625/8-87/014. Office of Research and Development. PB91-90-274093. NTIS. Springfield, VA. p. 23.

Appendix D8: Aeration of Background Metals

Aeration (contact with air) removes some metals from water by promoting chemical oxidation and the formation of insoluble hydroxides that precipitate from the water. Aeration for metals removal differs from air stripping in that precipitation rather than volatilization is the desired effect of the technology.

Applicability

Aeration techniques are useful for the removal of limited number of dissolved cations and soluble metal compounds. This method is well suited for the removal of background metals such as iron and manganese which is necessary as part of a selected remedy such as pretreatment to air stripping. Methods of aeration for metals include aeration tanks, aeration basins, or cascade aeration. Aeration methods are usually not sufficient as an independent technology for iron and manganese, but are utilized as a step in the treatment process. Often, the air-water contact in tank and cascade aeration is not enough to obtain high removal efficiencies. Spray basins are limited by area, wind, and ice particle formation (Nyer, 1985).

Contaminant Fate

Dissolved metals are oxidized to insoluble hydroxides which precipitate from solution, and can then can be subsequently removed by flocculation, sedimentation, and/or filtration.

Design

The three types of aeration systems:

- Aeration tanks bubble compressed air through a tank of water.
- Cascade aeration occurs when air is made by turbulent flow and agitation.
- Spray or aeration basins use an earthen or concrete basin with a piping grid and spray nozzles that spray the water into the air in very fine droplets.

Related methods include aeration used to remove volatile organic contaminants from water are considered to be a type of air stripping, as discussed in Section 2.1.1. The use of aeration to promote aerobic biological treatment processes is considered to be an element of biological treatment as discussed in Section 2.1.4.

Pre/Post Treatment

- Aeration is often a pretreatment for other remediation technologies, such as air stripping, to remove certain metals.
- Aeration can be followed by other treatments such as flocculation, sedimentation, and/or filtration to remove oxidized metals.

Appendix D8: Aeration of Background Metals

Selected References

Betz. 1962. *Betz Handbook of Industrial Water Conditioning.* Trevose, PA. pp.19-22

Nyer, E.K. 1985. *Groundwater Treatment Technologies.* Van Nostrand Reinhold, New York, NY. 187 pp.

Nyer, E.K. 1993. *Practical Techniques for Groundwater and Soil Remediation.* CRC Press, Inc, Boca Raton, FL. 214 pp.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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MEMORANDUM

SUBJECT: Presumptive Remedies and NCP Compliance

FROM: James E. Costello, Chairperson
CERCLA Administrative Records Workgroup
ORC Region VI

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TO: CERCLA Branch Chiefs
Office of Regional Counsel
Regions I - X

I. Purpose

This memorandum explains the relationship of EPA's presumptive remedies initiative for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site remediation to the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. In addition, this is to suggest methods for meeting the NCP administrative record requirements for Superfund sites where presumptive remedies are considered. We are providing this information in response to questions that have been brought to the CERCLA Administrative Records Workgroup and the Office of General Counsel.

Presumptive remedies are preferred technologies for addressing common types of sites such as municipal landfills or sites with VOCs in soil,[1] based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of

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[1] As these examples indicate, "site types" may be defined in a variety of ways, including the nature of the facility involved, the type of waste present, or possibly other criteria.

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performance data on technology implementation. EPA has issued directives explaining its recommendations regarding the use of presumptive remedies to expedite remediation at certain types of CERCLA sites.[2] See e.g. *Presumptive Remedies: Policy and Procedures*, September 1993 (OSWER Directive 9355.0-47FS); *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites With Volatile Organic Compounds In Soils*, September 1993 (OSWER Directive 9355.0-48FS); *Presumptive Remedy for CERCLA Municipal Landfill Sites*, September 1993 (OSWER Directive 9355.0-49FS). The presumptive remedy initiative is intended to make CERCLA responses faster and more efficient. The initiative is part of the Superfund Accelerated Cleanup Model (SACM).

The relationship of the presumptive remedy initiative to the requirements of the National Contingency Plan, and especially the NCP requirements relating to the administrative record, has never been expressly addressed in EPA guidance. The CERCLA Administrative Records Workgroup has, therefore, prepared this memorandum explaining how the presumptive remedies initiative comports with the NCP, and how the administrative record should be developed for a presumptive remedy site. This memorandum suggests steps that can be taken to help ensure that use of presumptive remedies is consistent with the NCP. In particular, this memorandum suggests steps to be taken to ensure that a complete administrative record is prepared for sites at which presumptive remedies are used. A complete administrative record, as described in this memorandum, will show that complete NCP remedy selection procedures were followed at a CERCLA site where the presumptive remedies initiative is used. In that many factors involved in the use of presumptive remedies are site-specific, the suggested approaches in this memorandum are expressed in terms of what "generally" should be done. Other approaches may be more appropriate in some cases depending upon the circumstances, and regional counsel should use their professional judgement in this regard.[3]

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[2] The presumptive remedy directives generally focus on remedial, rather than removal, actions (e.g., they analyze the presumptive remedy in terms of the criteria for remedy selection). However, the information they provide will generally be adequate to support the use of presumptive approaches in removals as well, where appropriate (e.g., for non-time-critical removals). Similarly, the discussion here, while focusing on the remedial process, is generally applicable to removals as well.

[3] For a general introduction to presumptive remedies, and explanation of Agency policies on their use, see *Presumptive Remedies: Policy and Procedures*, September 1993 (OSWER Directive 9355.0-47FS).

II. Executive Summary

The use of presumptive remedies advances the NCP remedy-selection objectives in that the presumptive remedy initiative promotes consistency in decision-making. The use of presumptive remedies as part of the remedy selection process is also consistent with the program management principle that site-specific documentation and analysis should be tailored to the scope and complexity of the problems being addressed. 40 CFR § 300.430(a)(1)(ii)(C).

The use of presumptive remedies does not avoid compliance with the remedy selection process in 40 CFR § 300.430. The use of presumptive remedies follows the NCP remedy selection process because the identification of presumptive remedies serves, in effect, to carry out the screening and detailed analysis steps in a generic manner that minimizes the need to perform those steps at a site-specific level.

In order to meet the Administrative Record requirements for presumptive remedies, it is recommended that the administrative record for a presumptive remedy site generally should include the following: (1) relevant OSWER generic presumptive remedy documents; (2) a "bridging" memorandum or other documentation which shows that the presumptive remedy fits the site; (3) a site-specific analysis discussing how the presumptive remedy fits under the three site-specific remedy selection criteria (state ARAR compliance, state acceptance and community acceptance); (4) EPA's written responses to comments which pertain to EPA's decisions regarding the use of presumptive remedies; (5) a site-specific response to any comments regarding new technology; and (6) a notice in the administrative record file and in the administrative record file index regarding the availability of the data upon which the presumptive remedy is based.

III. Presumptive remedies are consistent with the NCP.

The purpose of the presumptive remedies initiative is to use the Superfund program's past experience to streamline site investigations and speed up selection of cleanup actions. Where EPA's experience and technical knowledge show that a single technology, or limited group of technologies, will generally be the most appropriate remedy for a particular type of site or waste, it would be inefficient to routinely continue analyzing a wider range of technologies at each such site. By identifying "presumptive" remedies, EPA can narrow and focus feasibility studies, and allow such studies to move ahead to narrower issues that might in the past have been put off to the design stage. This should lead to better-focused feasibility studies, and to faster progress from remedy selection to remedy implementation.

While the presumptive remedy approach is not expressly addressed in the NCP, it is fully consistent with the NCP.

A. **The use of presumptive remedies advances NCP remedy-selection objectives.**

The use of presumptive remedies advances NCP remedy-selection objectives as follows:

1. **The presumptive remedy initiative promotes consistency in decision-making.**

One objective of the NCP's requirements for selecting remedies is to provide a uniform framework to promote consistency in decision-making. 55 Fed. Reg. 8666, 8700 (March 8, 1990). The use of presumptive remedies, when appropriate, also helps ensure that EPA is consistent in its decision-making, and it meets this NCP objective. That is, by using the presumptive remedy as a point of departure in the remedy selection process for addressing specific types of sites with similar characteristics, EPA advances a consistent remedy selection process at appropriate sites.

2. **The use of presumptive remedies as part of the remedy selection process at appropriate sites is consistent with the program management principle in § 300.430(a)(1)(ii)(C).**

Another objective of the remedy selection process, as stated in 40 CFR § 300.430(a)(1), is that remedial actions are to be implemented as soon as site data and information make it possible to do so. To further this NCP objective, and others, EPA has established certain program management principles to assist in the identification and implementation of appropriate remedial actions. Among the program management principles that EPA generally shall consider is that site-specific data needs, the evaluation of alternatives, and the documentation of the selected remedy should reflect the scope and complexity of the site problems being addressed. 40 CFR § 300.430(a)(1)(ii)(C). The use of presumptive remedies as part of the remedy selection process at appropriate sites is consistent with the program management principle in § 300.430(a)(1)(ii)(C). That is, using a remedy found to be generally appropriate for a class of sites narrows the scope and complexity of the remaining issues that need to be addressed on a site-specific basis. In other words, presumptive remedies speed up the remedy selection process so that, once site data has been gathered, EPA can begin action more quickly.

B. **The use of presumptive remedies follows the NCP remedy selection process.**

The use of presumptive remedies is also consistent with the remedy selection process set forth in the NCP. That process involves several steps: characterizing the risks presented by the site, screening technologies for possible remediation, and performing a detailed analysis of those technologies that appear most promising. The screening step is based on three criteria (effectiveness, implementability, and cost), excluding technologies that are clearly inferior (for example, where the cost is "grossly excessive compared to the overall effectiveness of alternatives"(see 40 CFR § 300.430(e)(7)(iii))). The detailed analysis step is based on nine criteria set forth in 40 CFR § 300.430(e)(9)(iii).

The identification of presumptive remedies serves, in effect, to carry out the screening and detailed analysis steps in a generic manner that minimizes the need to perform those steps at a site-specific level. In developing a presumptive remedy for a certain type of site, or sites containing a certain type of waste, EPA evaluates technologies that are commonly considered for a certain type of site and identifies one or more technologies as being generally most appropriate. Part of the selection of a presumptive remedy is a comparison of various possible technologies for such sites under the nine remedy selection criteria set out in the NCP.[4]

Where circumstances at a site correspond to those for which the presumptive remedy was identified as generally suitable, the generic analysis of the NCP remedy selection criteria that was performed in identifying the presumptive remedy should be adequate, and need not be repeated site-specifically. Therefore, once initial data collection confirms that a site is of a type for which presumptive remedies exist, a focused feasibility study (FS) may be prepared, focusing only on the presumptive remedy (which may be general enough to allow for several alternatives),

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[4]In most cases, the nine criteria for the detailed analysis of alternatives, rather than the three initial screening criteria, are used to identify presumptive remedies. While the identification of presumptive remedies performs a function similar to the initial screening step in some respects, it is not limited to excluding technologies that are grossly inappropriate. Therefore, the nine criteria used in the detailed analysis of alternatives are more relevant to the presumptive remedy choice. It should also be noted that certain criteria cannot be analyzed at a national level: compliance with state ARARs, state acceptance and community acceptance. Analysis of these criteria is discussed below.

and the no action alternative.[5] In effect, as will be discussed in more detail below, the materials prepared in the generic analysis will substitute for a broader FS. Similarly, the technology identification and screening steps done for the generic presumptive remedy analysis will serve as the technology and screening steps for the site at hand.

Some NCP criteria are, by their nature, invariably site-specific: compliance with state ARARs, community acceptance, and state acceptance.[6] Therefore, the generic analysis of the remedy selection criteria cannot address these factors, and they will have to be addressed in the site-specific analysis. However, the site-specific analysis need not examine technologies that were considered and rejected in the generic presumptive remedy analysis, unless it appears that the presumptive remedy fares so poorly under one of the site-specific criteria as to call its appropriateness seriously into question.[7] In that case,

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[5]The "Quick Reference Fact Sheet" entitled "Presumptive Remedies: Policy and Procedures" (OSWER Directive 9355.0-47FS) states at page 4 that:

> ... In most cases, after a site is confirmed as being a type for which presumptive remedies exist, a focused FS or EE/CA <u>which eliminates the technology identification and screening step</u> would be prepared....

(emphasis added). To avoid any confusion, this statement means that the NCP requirements for the technology identification and screening step are fulfilled by the presumptive remedy development materials, not that the existence of the presumptive remedy guidance means that step is no longer needed. The availability of the presumptive remedy materials simply obviates the need for further <u>site-specific</u> screening.

[6] In some cases, circumstances at a site may differ in some respects from the "typical" site for which the presumptive remedy is recommended. In such cases, the site specific record should address whether the differences affect the assessment of the presumptive remedy under the nine criteria. In unusual cases, it is possible that generally recommended remedies may be rejected, or that generally rejected remedies may be selected, based on exceptional site conditions. The presumptive remedy approach does not preclude such adjustments; it is intended to be a tool for streamlining decisions and not a straightjacket for imposing inappropriate remedies.

[7] This may raise a concern that, with regard to those criteria, there has never been a direct comparison of the presumptive remedy with the other rejected technologies. However, the approach recommended here reflects the fact that on

technologies that would generally be considered inferior for this category of sites may come back into consideration. Which and how many additional technologies to consider will depend on the circumstances at the site.

IV. Administrative Record requirements for presumptive remedies.

The presumptive remedy initiative is, in large part, a program for developing a generic administrative record that reduces the need for further site-specific analysis by addressing issues that would arise repeatedly at site after site and can generally be answered in the same way for most sites. Proper development of the administrative record for a presumptive remedy depends largely on understanding what additional steps, beyond those reflected in the generic materials, are (or are not) required to compile the full administrative record for the remedial action.

A. Suggested components of the administrative record

In the context of developing an administrative record for a presumptive remedy, it is important to keep in mind that presumptive remedies are identified in EPA guidance rather than rules. This means that they are neither legally binding nor conclusively established as a matter of law. Accordingly, the basis for determining that a presumptive remedy is appropriate (or inappropriate) at a particular site, and for excluding non-preferred technologies, should be fully set out in the administrative record for each site.

An adequate record can generally be ensured if the following steps are followed. This thorough documentation of EPA's decision-making process is important to ensuring that the remedy selection will be defensible if litigated.

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the criteria that were analyzed generically, one technology was sufficiently superior to be singled out as presumptive. Therefore, it can be presumed that unless that technology does very poorly on one of the site-specific criteria, it would still be superior to other alternatives if all alternatives were subjected to a full nine-criteria analysis. More specific consideration of how other technologies fare under these criteria will generally be necessary only when the issue is raised in comments on the proposed plan.

1. **<u>The administrative record for a presumptive remedy site should include the relevant OSWER generic presumptive remedy documents</u>.**

First, the record should include the relevant generic presumptive remedy materials issued by the Office of Solid Waste and Emergency Response (OSWER). In most cases, these will consist of the following:

(a) *Presumptive Remedies: Policy and Procedures*, September 1993 (OSWER Directive 9355.0-47FS);

(b) The OSWER directive (usually in the form of a fact sheet) explaining which technology or technologies are recommended for the site type;

(c) An analysis of the technologies that were rejected (sometimes referred to as a "Feasibility Study Analysis"); and

(d) Technical documents and other supporting materials that were used in developing the OSWER Directive(s) concerning the presumptive remedy in question.[1]

Together, these documents provide information regarding a variety of possible technologies and a comparison of each of those technologies under those remedy selection criteria that are not inherently site-specific. In effect, these documents serve as a generic FS establishing that technologies other than those recommended in the directive are generally not preferred under the NCP's criteria for remedy selection.

The conclusions in the generic materials about the appropriateness of a particular technology are sometimes qualified. This is because the suitability of a given technology may vary depending on site-specific conditions. Therefore, while technology, which was considered and rejected at other sites, may be unsuitable generally, it may be suitable at least for further consideration in exceptional cases at certain sites where the conditions that limited its usefulness are not present. Before choosing the presumptive remedy approach, EPA personnel may review the remedial investigation (RI) and the FS analysis to determine whether unusual site conditions might warrant studying a technology that would normally be excluded for that site type.

Because these supporting materials tend to be bulky, and of limited public information value, steps that may be taken to avoid unnecessary administrative burden while ensuring that they are available as needed are discussed below in part IV.D.

2. **The administrative record for a presumptive remedy site should include a "bridging" memorandum or other documentation which shows that the presumptive remedy fits the site (if a presumptive remedy is considered, but determined to be inappropriate, that determination should be documented as well).**

Second, site-specific documentation is needed in almost all cases to support the determination that the site is a good "fit" with the type of site for which the presumptive remedy was recommended, and that unusual site conditions do not appear to warrant departing from that recommendation. This documentation is needed because the generic analysis of alternatives under the remedy selection criteria is necessarily based on typical conditions at a general site type. If conditions at a particular site differ significantly from those previously assumed, the presumptive remedy may not be appropriate.

In most cases, a brief "bridging" memorandum may be sufficient to show that conditions are similar to those assumed in the generic analysis; in other cases, a more detailed analysis may be needed. To the extent that any characteristics of the site differ from those identified for the presumptive remedy, the record generally should reflect how EPA has analyzed this difference and whether any modification of the presumptive remedy is required.

For example, where a dump site is similar to a municipal landfill, but contains very unusual kinds of wastes not normally found in such landfills, the site-specific record should address whether anything about those wastes would make the engineering controls specified in the presumptive remedy for municipal landfills (primarily containment of the landfill mass and collection and/or treatment of landfill gas) less suitable as a remedy. Ultimately, the record must support the remedy selection decision for the site, and, to the extent the site raises concerns not addressed in EPA's generic presumptive remedy documents, those concerns should be discussed in written, site-specific analyses placed in the record.

EPA has said that "[p]resumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances." OSWER 9355.0-49FS at p. 1. Accordingly, if a presumptive remedy was considered, and determined to be inappropriate, EPA should explain that decision in the administrative record. Such documentation should help rebut any challenges alleging that remedy selection was inconsistent with the presumptive remedy policy.

3. **The administrative record for a presumptive remedy site should include a site-specific analysis discussing how the presumptive remedy fits under the three site-specific remedy selection criteria (state ARAR compliance, state acceptance and community acceptance).**

Third, as discussed above, a site-specific analysis must be prepared discussing how the presumptive remedy fits under the three site-specific remedy selection criteria (state ARAR compliance, state acceptance and community acceptance). This analysis should be included in the administrative record. Again, in some cases a short bridging memorandum may be sufficient; in other cases the analysis may be more complex (and a serious problem may suggest a need to consider other alternatives).

B. **Administrative records should include EPA's written responses to comments which challenge EPA's decisions regarding the use of presumptive remedies.**

Special administrative record considerations arise if outside parties submit comments supporting technologies other than those recommended in the generic guidance. Since the presumptive remedies are only policy, and are not legally binding, it is important to ensure that all such comments are adequately addressed. It will not be sufficient simply to reject the comment on the ground that a presumptive remedy has been selected for this site type. EPA's responses to comments which challenge EPA's decisions regarding presumptive remedies should be included in the administrative record.

It may be possible to respond to comments by relying on information already in the generic OSWER materials. However, a decision will usually have to be made in each such case as to whether the generic material adequately addresses the comment, or whether additional record support is needed.[9] The generic documents are meant to provide a basic level of justification for the presumptive remedy, not to answer all possible questions or comments about the selection of the presumptive remedy over other possible technologies. Generally whenever the generic materials are used to respond to a comment, a statement should preface the response, explaining how the generic information appropriately responds to the comment for this specific site.

Again, it is important to remember that the generic materials are not legally binding. Thus, if a factual statement in a generic directive is challenged in a comment, it may be necessary to find record support for that statement. The technical supporting material used in developing the presumptive remedy may be a useful source of information for such purposes.

Furthermore, the generic materials sometimes exclude certain technologies based on assumptions about likely site conditions. Where unusual site conditions are present, the generic OSWER materials may actually support considering a different technology. Therefore, in responding to comments of this kind, the RI and the FS analysis generally should be reviewed to determine whether they tend to support or refute the comment.

Where the generic OSWER materials themselves are not adequate, the supporting materials relied on in preparing them may provide the necessary support. In other cases, some new, site-specific technical analysis may be necessary. In any case, EPA's response should be placed in the administrative record.

C. **If a commenter supports a new technology, a site-specific response may have to be provided, and placed into the administrative record.**

The generic materials provide a "ready to use" record comparing the presumptive remedy with a wide range of technologies. However, it is possible that either EPA, or other parties, will be interested in evaluating some other technology not previously addressed (e.g., an innovative technology).[10] In that case, the generic materials do not provide the necessary record.

If a commenter supports a new technology, a site-specific response may have to be provided because the existing documents do not address that issue. In such cases a decision might be made to consider the new technology along with the recommended technologies, although this would not always be necessary. Deciding to consider one additional technology does not require abandoning the entire presumptive remedy approach. The presumptive remedy materials can still be relied on to justify limiting analysis to a small number of alternatives. Whatever EPA's response may be, the written record of the response should be placed in the administrative record.

D. **The OSWER presumptive remedy guidances should be kept in the administrative record. It may be useful to place a notice in the administrative record file and in the administrative record file index regarding the availability of the underlying data upon which the presumptive remedy is based.**

The relation between the presumptive remedy approach and the general policy encouraging consideration of innovative technologies is discussed in more detail on page 5 of *"Presumptive Remedies: Policy and Procedures,"* September 1993 (OSWER Directive 9355.0-47FS).

The NCP requires that the administrative record be maintained both at the lead agency's office (or other central location), and in a repository at or near the site. In general, it is desirable for the repository record to be as complete as possible, but in some cases space limitations and copying expenses may make it necessary to limit the repository record. In such cases, the NCP allows certain categories of materials to be kept only in the central location (40 CFR § 300.805(a)), so long as they are made available at the repository near the site on request (40 CFR § 300.805(b)).

One of the categories of materials that need not be kept at the repository near the site is "guidance documents not generated specifically for the site at issue." 40 CFR § 300.805(a)(2). The OSWER Directives establishing presumptive remedies would fall in this category. Nevertheless, such materials are generally short enough that they can be easily maintained in the local file, and because they are so central to the remedy selection process it may be desirable to keep them in the local file to ensure that the public is fully informed.

For each presumptive remedy, EPA has also developed a file containing all the technical references, and past feasibility studies, that were studied in developing that presumptive remedy. One copy of the file for each presumptive remedy developed so far has been provided to each Region. These files are generally bulky, and would generally not be necessary for public information purposes (or even particularly useful, because of their highly technical nature). Accordingly, we do not recommend that these files be physically kept in each local administrative record file. (Since these materials simply represent support for non-site-specific guidance, the NCP provision cited above provides authority for that approach.) However, we do recommend placing a notice in the local file noting that these materials exist and are available for public review and copying. They should also be made available locally if requested.

Maintaining a separate copy of these "backup" materials in the site-specific administrative record file maintained at the regional office should not be necessary. So long as the materials are readily available, it should be sufficient to place a notice in the index to the administrative record file (e.g., in the preamble) indicating that they are part of the record and where they are available.

cc: Bruce Diamond, OSRE
Steven Luftig, OERR

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 26 1994

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Feasibility Study Analysis and Administrative Record for Presumptive Remedies

FROM: David A. Bennett, Acting Director
Hazardous Site Control Division

TO: Addressees

PURPOSE

The purpose of this memorandum is to transmit for Regional use the Administrative Record documents supporting the directives entitled "Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils," and "Presumptive Remedy for CERCLA Municipal Landfills Sites." These directives were forwarded to the Regions in October, 1993, and the enclosed materials should be placed with these directives in the Regional Administrative Record center to justify the presumptive remedy approach at these types of sites. The actual administrative record is fairly large and is being forwarded to the list of Regional individuals provided in **Attachment A.** The contents along with a general guide on the presumptive remedies Administrative Record is provided to you in **Attachment B.**

BACKGROUND

Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The use of presumptive remedies will improve the efficiency of the Superfund process by building on past program experience. The directives, along with this supporting documentation, will provide practical tools to the Regions for streamlining and accelerating remedy selection in accordance with the Superfund Accelerated Cleanup Model (SACM).

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Seven site categories have been identified for presumptive remedy guidance development. The supporting documentation to the VOCs in soils and municipal landfill sites directives are presently being forwarded to the Regions. Additional directives addressing woodtreater, polychlorinated biphenyls (PCBs), groundwater, coal gasification, and grain storage sites are currently under development and are scheduled to be completed and distributed to the Regions early in 1995.

IMPLEMENTATION

The attached documents along with the above cited presumptive remedies directives, are key elements of the administrative record for VOCs in soils and municipal landfill sites where the "presumptive remedy" approach is being used. Under the presumptive remedy approach, the Feasibility Study (FS) or Engineering Evaluation/Cost Analysis (EE/CA) is limited to considering only those technologies identified by EPA as presumptively appropriate for the specific site.

The attached documents in essence serve as a generic FS establishing the preferred technologies and screening out all other technologies. The documents should be placed in the administrative record, along with the appropriate directive, at the time the decision is made to use the presumptive remedy approach.

Regional personnel involved with particular presumptive remedies sites should familiarize themselves with all contents of the directive and the administrative record for their site type. A brief summary on how to use the administrative record along with the associated directives is presented in **Attachment B.**

For further information, please contact Shahid Mahmud of my staff at 703-603-8789.

Attachments

Addresses:

Superfund Regional Branch Chiefs w/ Attachments A,B
Superfund Regional Section Chiefs w/Attachments A,B
Regional Counsel Branch Chiefs w/Attachments A,B
Presumptive Remedies Regional Contacts w/ Attachments A,B
Administrative Records Contacts w/ Attachments A,B and Administrative Record

cc: Henry Longest
George Wyeth

ATTACHMENT A

PRESUMPTIVE REMEDIES ADMINISTRATIVE RECORDS CONTACTS

REGION	CONTACT	PHONE
I	Margaret Meehan	617-573-9647
II	Jenny Delcimento	212-262-8676
III	Anna M. Butch	215-597-3037
IV	Debbie Jourdan	404-347-2930
V	Janet Pfundheller	312-353-5821
VI	Nancy Yarberry	214-655-6537
VII	Barry Thierer	913-551-7515
VIII	Carol Macy	303-294-7038
IX	Craig Cooper	415-744-2370
X	Lynn Williams	206-553-2121

ATTACHMENT B

PRESUMPTIVE REMEDY ADMINISTRATIVE RECORD CONTENTS AND GUIDE

PURPOSE

This guide is intended to assist the U.S. Environmental Protection Agency (EPA) Regional staff and the public in understanding the administrative record documents and site-type directives for supporting presumptive remedies at individual sites. These documents and directives in essence serve as a generic FS establishing the preferred technologies as presumptive, and screening out all other technologies. Using this information will potentially streamline and accelerate the remedy selection process. In general, the administrative record for a site using presumptive remedies will consist of site-specific information (e.g., technical, administrative, legal) and the presumptive remedies administrative record components highlighted in the section below.

CONTENTS OF ADMINISTRATIVE RECORD

This section highlights and provides a brief discussion of the primary components of the administrative record for a site where the presumptive remedy approach is being used. The contents of the Record include:

I. Presumptive Remedies Directives

II. Feasibility Study Analysis Report (FSAR) and Supporting Technical Background Documents

III. Feasibility Studies for sites supporting FSAR

IV. Records of Decision for sites supporting FSAR

V. Other Reference Documents

A general discussion on the Presumptive Remedies Directives and the FSAR is provided below.

I. Directives:

The appropriate site-type directives (e.g., Presumptive Remedy for CERCLA Municipal Landfill sites) together with the General Policy and Procedure directive must be included in the Administrative Record. The policy and procedures directive addresses overall policy and programmatic issues associated with presumptive remedies. The site-type directive's text and associated tables provide information on the technologies that were <u>selected</u> as presumptive remedies and provides the justification for such a selection. Appendix A to the site-type directive provides a statistical summary (drawn from the

Feasibility Study Analysis for the site category) of the technologies screened out from further consideration. Appendix B contains a "nine criteria" analysis of the recommended technology or technologies. (NOTE: only seven criteria are addressed, because state and local acceptance can only be evaluated site specifically.)

II. FS Analysis Reports

Another key component of the Administrative Record is the FS Analysis Report for the particular category of site. The FS Analysis Report provides information on the technologies that were screened from further consideration in site universe of FSs analyzed. This report in essence provides the justification for not considering these technologies in site-specific FSs when the presumptive remedy approach is being implemented. The report describes each technology, and the strengths and weaknesses of each, including factors that tend to limit each technology's usefulness. For each technology considered, the FS Analysis contains a conclusion explaining why that technology is not generally suitable for such sites. Finally, each document contains tables analyzing the technologies in terms of the remedy selection criteria.

The conclusions in the FS Analyses often contain some caveats because the suitability of a given technology may vary depending on site specific conditions. While the technology may be generally unsuitable for the particular type of site, it may be suitable for further consideration in exceptional cases.

The information in the FS Analyses is drawn in part from prior feasibility studies, and partly from other sources (e.g., technical resource documents). In some cases, either to respond to comments or for other reasons, users may wish to review the underlying documentation used in developing the FS analysis.

Finally, the appendices the FS Analysis contain useful supporting information. Appendix A to the FS Analyses provides a statistical summary of the rationale or basis used for screening out the non-recommended technologies as cited in past feasibility studies (similar to Appendix A in directive). Appendix B describes in greater detail the reasons given in past feasibility studies for screening each technology out where it was excluded at the preliminary screening phase. Appendix C summarizes the findings of each feasibility study analyzed as part of this study, on a site by site basis.

III. Technical Background Documents, Feasibility Studies, Records of Decision, and Other Reference Materials

The directives and the FS Analyses discussed above are documents that were based on various technical literature, site-specific FS Reports and Records of Decisions and other reference materials. As such, this material is also an integral

part of the administrative record and should be placed with the other materials to support presumptive remedies at a particular site.

IMPLEMENTATION

The user should be aware that both the directives and FS analyses present statistical information on the conclusions drawn in past feasibility studies including the number of times each technology was rejected at the preliminary screening phase, the number of times each was rejected at the detailed analysis phase, and the number of times each was selected. While such statistical analysis does not provide reasons for such decisions (and the reasons may have differed from site to site), it can be valuable as a reflection of the agency's past experience.

Before choosing the presumptive remedy approach, Agency personnel should review the FS Analysis to determine whether unusual site conditions exist that warrant further consideration of non-presumptive remedy technologies. Additionally, the use of this approach should be discussed early and often with the community, state, and the potentially responsible parties (PRPs). Further assistance on the implementation of this initiative is available through the Headquarters and Regional Presumptive Remedies contacts.

Additionally, the user should note that these documents are meant to provide a basic level of justification for the presumptive remedy, not to answer all possible questions or comments about the selection of the presumptive remedy. In some cases, outside parties may submit comments supporting technologies other than those recommended. A decision will have to be made in each such case as to whether the material provided here adequately addresses the comment, or whether additional record support is needed.

For example, if a commenter contends that unusual site conditions warrant considering a different technology, the FS analysis should be reviewed to determine whether it adequately addresses that argument. If a comment supports a technology not discussed in the FS analysis at all (e.g., an innovative technology), a site specific response will have to be provided. In such cases a decision might be made to consider the innovative technology along with the recommended technologies. A case-by-case decision will have to be made based on the information available on the technology and best engineering judgement.

Finally, if all parties have agreed to this approach, the administrative and technical documents (e.g., Work Plan, FSs, EE/CAs, Proposed Plans, RODs, etc.) for the site should indicate that the site followed the presumptive remedy approach and is supported by the documentation provided in the administrative record.

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