EPA/540/R-95/128
December 1995

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

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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, This page intentionally left blank.

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.
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).

[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 2
Comparison of Presumptive Remedy Technologies
(continued)

TECHNOLOGY	PERFORMANCE	ADVANTAGES	LIMITATIONS	COST
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.

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.

<u>Identification of the Universe of Wood Treater Sites</u>

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.

<u>Frequency of Technology Selection for Wood Treater Sites</u>

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).

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES (continued)

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:

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES (continued)

- 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) wer 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 didnot 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
III. Immobilization										
A. Solidification/ Stabilization	15	11	4			3	1	1	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
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.

GLOSSARY
(continued)

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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