Introduction and Summary 1

In 1994 the Office of Technology Assessment (OTA) was asked to evaluate technical alternatives to incineration for cleaning up the Texarkana Wood Preserving Company Superfund site, in Texarkana, Texas. The 25-acre site, a former wood-treating facility in Bowie County, Texas, became an U.S. Environmental Protection Agency (EPA) Superfund site in 1986 (27). Wood products had been treated there with preservative chemicals over many decades. These activities left behind chemical preservatives as contaminates in soil, sludge, sediment, and groundwater (see box 1-1). Using information available in the late 1980s, the EPA selected incineration in a 1990 record of decision (ROD) to clean up soil, sludge, and sediments contaminated with wastes from wood-treating activities at Texarkana.

However, public opposition has prevented incineration from being used at this site. Recently EPA funds that had been allocated to building and operating an incinerator were returned, and today the only work at the site is ongoing environmental monitoring, and interim analyses (2). OTA was asked to find and evaluate possible alternatives to incineration that might be more acceptable to residents who live nearby.

This report identifies technologies available for organic hazardous waste cleanup at wood-treating sites throughout the country. OTA has identified a range of such technologies that have been selected in the past and could be applied to other sites in the future. OTA has not recommended specific technologies for the Texarkana Wood Preserving Company site. The applicability of a technology to a particular Superfund site has to be based on many site-specific factors. Nevertheless, it is clear that a number of the approaches identified by OTA may be appropriate and could prove useful if more detailed site-specific studies and tests were done. Although this study focused on the Texarkana site, decisionmakers and the public could benefit from this analysis in selecting future cleanup strategies for other sites.

EPA'S EXPERIENCE WITH WOOD-TREATING SITES

The Texarkana Wood Preserving Company site is a member of a class of sites that have similar histories and contaminants present. Today EPA

BOX 1-1: The Texarkana Wood Preserving Company Site

The 25-acre Texarkana site is a former wood-treating facility in Bowie County, Texas. Surrounding land use is industrial, residential, and agricultural. Since the early 1900s, several lumber-related businesses have operated at the site. Wood-treating operations using creosote began in 1954. By 1971 pentachlorophenol (PCP) was also in use for wood treatment.

State investigations from 1968 and 1984 showed the company to be negligent or delinquent in fulfilling various permit requirements. Removal actions from 1986 to 1988 included site access restrictions, constructing a berm, and pumping down the creosote-contaminated onsite processing ponds to prevent runoff and overflow.

The present record of decision addresses onsite contaminated soil near the processing ponds and contaminated groundwater in a shallow aquifer. Incineration with onsite disposal of ash was considered a proven technique by EPA. The future use of this site is expected to be industrial, and not residential. Remediation of groundwater in a deeper aquifer will be addressed in a future ROD. The primary contaminants of concern affecting the soil, sediment, sludge, and groundwater are organics including dioxin, polycyclic aromatic hydrocarbons (PAHs), pesticides, and phenols including PCP. The location of the site in a 100-year floodplain complicates cleanup of this site.

The cleanup levels for soil specified for the Texarkana site are 3 parts per million (ppm) carcinogenic PAHs, 2,350 ppm total PAHs, 150 ppm PCP, and 20 parts per billion (ppb) combined dioxins and furans equivalents. Any potential cleanup technology must meet these levels, or these levels must be adjusted.

The selected remedial action for this site includes

- excavating approximately 77,000 cubic yards of contaminated soil (includes any affected sediment and sludges) and onsite treatment using incineration,
- onsite backfilling of ash with the installation of a soil cover (capping) and revegetation,
- pumping and treatment of approximately 16 million gallons of contaminated groundwater from the shallow aquifer using carbon adsorption and reinjecting the treated water onsite into the shallow aquifer, and
- use of institutional controls, including site deed restrictions to limit land use.

According to the ROD, the estimated cost for this remedial action is $47,500,000. Depending on the remedy actually used, and the results of competitive bidding, the actual costs may be quite different.

SOURCE: Environmental Protection Agency, Region 6, "Record of Decision: Texarkana Wood Preserving Company Superfund Site," Dallas, TX, September 1990; Hendrick, E., Senior Project Manager, EPA Region 6, Dallas, TX, written comments, August 9, 1995.

has considerably more experience with this type of site than it did in the late 1980s, when cleanup decisions were made about the Texarkana site. Since 1980, EPA has identified 56 Superfund wood-preserving sites in the United States, most of which are very similar to the Texarkana site (17). EPA has completed the process of selecting technologies and cleanup strategies for more than 30 of these sites. Chapter 2 of this report gives more details about EPA's history with wood-treating sites.

Table 1-1 summarizes the wood-preserving chemicals and the selected cleanup remedies for these sites. Sites contaminated only by metal-containing wood preservatives such as chromated copper arsenate (CCA) were not included in this survey since this class of contaminant is not important at the Texarkana site. Table 2-1 in chapter 2 gives more information about these sites including contaminants present, size of the site, current land use around the site, and selected cleanup technologies. Current land use was

TABLE 1-1: Remedy Selection at Wood-Treating Sites,[a] by date of ROD

Site name ROD Date	Chemical Present	Remedy Selected
American Creosote 85-09-30	Creosote PCP[b]	Landfill disposal
Burlington Northern 86-06-04	Creosote	Bioremediation and capping
Westline site 86-07-03	Creosote	Incineration
Coleman Evans 86-09-25	PCP	Incineration of more contaminated soil
Baxter/Union Pacific 86-09-26	Creosote PCP	Barrier wall (plan for more permanent remedy)
United Creosoting 86-09-30	Creosote PCP	Temporary cap and apply innovative technology when available
Mid-South 86-11-14	Creosote PCP	Remove sludges & oils to offsite facility; stabilization of soil hot spots, then capping
Bayou Bonfouca 87-03-31	Creosote PCP	Incineration and offsite disposal
Midland Products 88-03-24	Creosote PCP	Incineration
L.A. Clarke 88-03-31	Creosote	Soil flushing, bioremediation
Brown Wood Pre. 88-04-08	Creosote PCP	Bioremediation; landfill disposal of heavily contaminated material
North Cavalcade 88-06-28	Creosote PCP	Bioremediation
Southern Md. Wood 88-06-29	Creosote PCP	Incineration
Broderick Wood 88-06-30	Creosote PCP	Incineration
South Cavalcade 88-09-26	Creosote	Incinerate oily wastes; soil washing & capping (or bioremediation if effective)
Libby 88-12-30	Creosote PCP	Bioremediation and capping
American Creosote 89-01-05	Creosote PCP	Incineration
Koppers/Galesbrg 89-06-28	Creosote PCP	Bioremediation and capping
Cape Fear Wood 89-06-30	Creosote	Soil flushing or thermal desorption
Koppers (Oroville) 89-09-13	Creosote PCP	Soil washing, bioremediation, and capping
Newsom Brothers 89-09-18	Creosote PCP	Incinerate worst material; offsite disposal of other soils
American Creosote 89-09-28	Creosote PCP	Bioremediation

(continued)

TABLE 1-1: Remedy Selection at Wood-Treating Sites,[a] by date of ROD (Cont'd.)

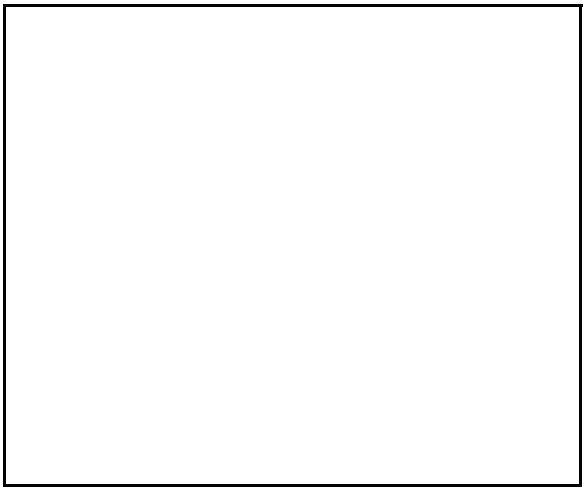
Site name ROD Date	Chemical Present	Remedy Selected
United Creosoting 89-09-29	Creosote PCP	Solvent extraction (critical fluid) with offsite incineration of residues
Havertown PCP 89-09-29	Creosote PCP	Landfill disposal
Texarkana Wood 90-09-25	Creosote PCP	Incineration
Coleman-Evans 90-09-26	PCP	Soil washing, bioremediation; solidification/stabilization, then capping
Cabot/Koppers 90-09-27	Creosote	Soil washing & bioremediation; then solidification/stabilization
J H Baxter Co 90-09-27	Creosote PCP	Bioremediation followed by solidification/stabilization if inorganics are found
Moss-American 90-09-27	Creosote	Incinerate sludges & oils; soil washing & bioremediation followed by capping
Arkwood, Inc 90-09-28	Creosote PCP	Soil washing (incineration if this fails)
Broderick Wood 91-09-24	Creosote PCP	Recycle oils (with incineration of residues)
Macgillis & Gibbs 91-09-30	Creosote PCP	Remove sludges & oils to offsite facility
Saunders Supply 91-09-30	PCP	Dechlorination of sludges & sediments; thermal desorption of soils
Idaho Pole 92-09-28	Creosote PCP	Soil wash & bioremediation, then capping
Koppers (Morrisv.) 92-12-23	PCP	Thermal desorption & dechlorination (incineration if this fails)
Popile, Inc. 93-02-01	Creosote PCP	Bioremediation and capping
American Creosote. 93-04-28	Creosote PCP	Incinerate sludges; bioremediation of soils
Rentokil Virginia 93-06-22	Creosote PCP	Incinerate sludges & oils (with dechlorination for dioxins); thermal desorption for soils, followed by capping
Montana Pole 93-09-21	Creosote PCP	Incinerate sludges & oils; soil flushing & bioremediation

NOTES:
[a] Additional wood-treating sites with primarily metals contamination are not included in this table.
[b] Sites with PCP use can be expected to have some dioxin contamination.

included as an indicator of future land use. The basic features of the Texarkana site are similar to those of other wood-treating sites. Figure 1-1 shows how often the various technologies and strategies are chosen for the selected 40 sites. Usually more than one technology was selected to deal with various contaminated parts of a single site.

The wood-treatment industry, which treats wood with chemicals to preserve them from decay and insect damage, has operated in the United States for over 100 years (23). Many common and widely used wood products are produced by this industry, including railway ties, fencing posts, outdoor decks, telephone and util-

FIGURE 1-1: Frequency of cleanup strategies for wood-treating sites



Superfund cleanup strategies selected by EPA for 40 wood-treating sites contaminated with pentachlorophenol (PCP) or creosote. Many of these treatments are used together at a single site as part of a treatment train.

SOURCE: Office of Technology Assessment

ity poles, and other wood products intended for outdoor use.

Wood preserving typically involves treating the wood under pressure with the preservative chemicals pentachlorophenol (PCP), creosote, or chromated copper arsenate (CCA), usually dissolved in some suitable solvent (23). These activities often left behind widespread soil, sediment, sludge, and water contamination at the site. The preservative PCP always contains some dioxin and furan impurities, and creosote contains polycyclic aromatic hydrocarbons (PAHs). These compounds are considered by EPA and other health agencies to be likely human carcinogens (see boxes 2-1 and 2-2 in chapter 2 for more information about creosote, PAHs, PCP, and dioxins).

The presence of any one of these contaminants, including dioxins and furans present as impurities in PCP, has not necessarily dictated the use of any one technology such as incineration (see tables 1-1 and 2-1). Dioxins and furans, when they occur at contaminated wood-treating sites, are always in very much smaller concentrations compared with the primary site contaminants PCP or creosote. Dioxins and furans are present at a wood-treating site as low-level impurities contained in the PCP used at the site for wood preservation. This has led to very different cleanup strategies for this type of site compared with other sites where the primary contaminate is dioxins or furans. For an analysis of technologies for cleanup of dioxin contaminated soils, see the Office of Technology Assessment (OTA) background paper "Dioxin Treatment Technologies" (4). Table 1-1 also shows that before 1990, incineration was more commonly selected as the primary cleanup strategy. After 1990, incineration, if it was selected at all, appears to be only one part of an overall cleanup strategy. For example, incineration may be chosen for the cleanup of small, highly contaminated "hot spots" while bioremediation is chosen for dealing with the remainder of the site.

EPA'S PRESUMPTIVE REMEDIES FOR WOOD-TREATING SITES

EPA's experience over the years with cleaning up wood-treating sites has led to an evolution and maturation in EPA's cleanup approach. Some cleanup technologies that EPA now considers established were not seriously considered when decisions were made about the Texarkana site. EPA's experience with this type of site has provided new cleanup options.

Today EPA formally recognizes wood-treating sites as a class of site that has similar problems and similar cleanup options. It recently summarized the variety of successful technologies and approaches that have proven useful for cleaning up wood-treating sites such as the Texarkana site. EPA refers to proven technologies for a class of sites as "presumptive remedies." EPA reviewed successful cleanup strategies for wood-treating sites with similar characteristics, including the contaminants present, the environmental media affected by those contaminants, and the cleanup technologies selected (23). The fact that contaminated wood-treating sites had many features in common made it practical and

useful for EPA to summarize successful cleanup technologies.

On the basis of this review of many full-scale cleanup projects at wood-treating sites, EPA concluded that a variety of demonstrated treatment technologies are capable of meeting stringent cleanup requirements (16,21,23). EPA presumptive remedies for contaminated soil, sludge, and sediments at wood-treating sites are bioremediation, thermal desorption, or incineration for organic contaminants, and immobilization for inorganic contaminants. Chapter 3 provides more information on how these technologies have performed with the various contaminants found at wood-treating sites. Although EPA focused mostly on technologies that had proven themselves in full-scale cleanup projects at contaminated wood-treating sites, it also considered certain other technologies that had less performance data available (21,23). EPA has not yet developed presumptive remedies for contaminated groundwater at these sites.

FOCUS OF OTA'S ANALYSIS

This report presents OTA's analysis of the treatment technologies and strategies selected by EPA for cleaning up contaminated soil at wood-treating sites. OTA's identification of these technologies is intended to capture the evolution since the mid-1980s of the approaches EPA has available to clean up contaminated soil, sludge, and sediments at these sites. OTA gathered information on various technologies selected for use to clean up Superfund wood-treating sites from two main sources. The first source was OTA's review of EPA's decisions and the technology selected for the cleanup of Superfund wood-treating sites as they are described in the ROD for each site. The second source was an analysis of the presumptive remedy strategy recently developed by EPA for wood-treating sites. Considering both of these sources, OTA concluded that EPA has selected at least 10 different approaches for cleaning up contaminants at such sites.

OTA did not try to compare the relative safety or hazards of these alternatives to incineration. Nevertheless, some concerns should be kept in mind when comparing the safety and hazards of incineration to any alternative. Concerns about possibly toxic emissions from incinerators used for cleaning up wood-treating sites are likely to apply equally or possibly even more to some of the alternative technologies reviewed by OTA. In most cases the emissions that would come from these alternative technologies are less well characterized than those for incineration.

Many alternative technologies are less mature; they have less of a record by which their relative safety can be judged. At some sites the technologies selected by EPA have not yet been fully implemented, and their success cannot be evaluated. Some alternatives may work well with certain types of sites, but poorly or not at all with others. Soil cleanup standards and relevant cleanup laws may vary for each site. Nevertheless, some of the alternatives evaluated by OTA will undoubtedly be useful alternatives to incineration for cleaning up contaminated soil, sludge, and sediment at wood-treating sites.

SUMMARY OF CLEANUP TECHNOLOGIES

OTA looked at the treatment strategies that EPA selected in 47 RODs for 40 different wood-treating sites. Table 1-1 summarizes this review, and figure 1-1 lists the various technologies and approaches selected by EPA, as well as how often they were selected. Chapter 2 gives further information about the various sites and the technologies selected for them, and chapter 3 provides more detailed information about the technologies and approaches.

In virtually every case, several different technologies and other approaches were selected in combination to make a complete site cleanup strategy. Sometimes one technology such as incineration or bioremediation was selected as the key technology for addressing the main contamination source. However, in general no single technology can clean up an entire wood-treating site, and a combination of control and treatment

strategies is chosen (17). For example, capping a site and making some restrictions on future use **after** incineration or bioremediation was used in more than half the RODs reviewed by OTA. Capping involves providing some type of cover, made of clean soil and other materials, that isolates contamination from the environment and limits human exposure.

OTA also reviewed EPA's recently released presumptive remedies strategy for cleaning up contaminated soil, sludge, and sediments at wood-treating sites. This strategy is a summary of EPA's experience with technologies that have proven successful in full-scale cleanups of such sites (17). Only full-scale successfully demonstrated technologies and strategies were included in EPA's list of presumptive remedies, which eliminated some of the less mature technologies listed in figure 1-1. EPA selected as wood-treating site presumptive remedies bioremediation, thermal desorption, or incineration for organic contaminants; immobilization is the presumptive remedy for inorganic contaminants. Chapter 3 describes these technologies.

EPA concluded that bioremediation is the primary presumptive remedy for organic contaminants such as PCP or creosote. If bioremediation is not feasible, thermal desorption may be appropriate. For some situations, such as the treatment of sludge "hot spots" with very high concentration of contaminants, EPA concluded that incineration may be the best choice (17).

CONCLUSIONS

EPA today has a range of technologies and strategies available for addressing contaminated wood-treating sites. Some of the technologies were not available when EPA completed the ROD for the Texarkana wood-treating site in 1990; others were too new to have been evaluated thoroughly. Although every Superfund site has some unique characteristics and cleanup requirements, it is likely that some combination of technologies may be applicable as alternatives to incineration for cleaning up the Texarkana site. OTA found that typically several different technologies and control methods are put together for an overall cleanup strategy in order to meet the requirements of a specific wood-treating site. In virtually no wood-treating site reviewed by OTA was a single technology such as incineration or bioremediation selected as the only form of cleanup.

The availability of new strategies for cleaning up contaminants from wood-treating sites suggests that EPA could reexamine the cleanup decisions made in the 1990 ROD for the Texarkana site. This would be responsive to concerns among some in that community about those earlier decisions. However, there are significant risks with choosing alternatives to incineration. EPA cautions that some alternatives are good only for certain contaminants under specific conditions. They might be much less effective for other situations. Thus, an alternative technology should be selected only if it has been tested and proven under the specific conditions for the site where it is to be used. It should also be pointed out that EPA's chosen technology for a given site may not have been found in practice to be effective at that site. At some of the sites reviewed by OTA, according to some EPA officials, cleanup has not been completed or was not as successful as had been hoped.

Although some of these incineration alternatives have significant track records so that their possible use at a specific site can be evaluated, none are as mature and developed as incineration. For example, in its presumptive remedies strategy, EPA warns that the effectiveness of the primary presumptive remedy, bioremediation, is site and contaminant specific, requiring careful site characterization and treatability studies of appropriate scale. Thus, selection of some of these alternatives may carry with it a greater risk that cleanup goals for a specific site will not be adequately met.

The permanence of the cleanup offered by these alternative technologies is also a factor. Incineration was often selected by EPA in the past in part because it offered a **permanent** reduction in the concentrations of contaminants, including dioxins and furans in soil and sludge.

Some alternatives, such as bioremediation and capping, give less complete destruction of contaminants, even though they can offer adequate protection of human health and the environment by eliminating exposure. If the cleanup strategy selected leaves significant concentrations of contaminants **after** the cleanup is complete, it will be necessary to monitor the site for as long as the contaminants remain, possibly indefinitely.