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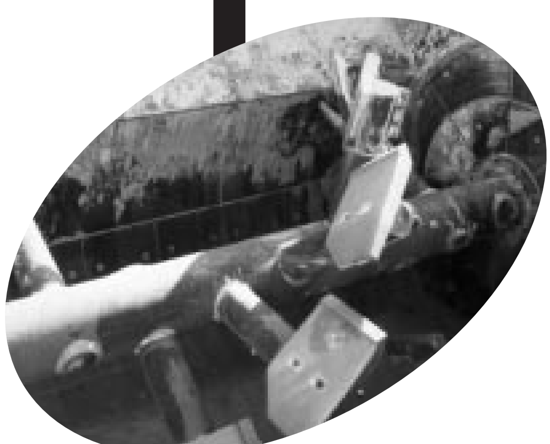
Solidification/Stabilization Use at Superfund Sites



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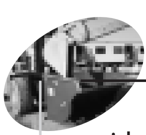
Summary

Solidification/stabilization (S/S) is an established technology that has been used for almost 20 years to treat a variety of wastes at Superfund remedial sites throughout the country. Historically, S/S has been one of the top five source control treatment technologies used at Superfund remedial sites. To provide interested stakeholders such as project managers, technology service providers, consulting engineers, site owners, and the general public with the most recent information about S/S applications at Superfund sites, as well as information about trends in use, specific types of applications, and cost, the U.S. Environmental Protection Agency (EPA) performed a review and analysis of S/S applications and prepared this summary.

Highlights of S/S use at Superfund remedial sites include:

- **Trends in Use** - S/S is one of the top five source control treatment technologies used at Superfund remedial sites, having been used at more than 160 sites since FY 1982. The frequency with which S/S was selected as a remedy increased during the late 1980s and early 1990s, reaching a peak in FY 1992, and then generally decreasing through FY 1998.
- **Project Status** - Many of the S/S projects (62 percent) have been completed, with an estimated 21 percent in the predesign/design stage. Overall, completed S/S projects represent 30 percent of all completed projects in which treatment technologies have been used for source control. In addition, the average operational time for S/S projects was 1.1 months, which is shorter than other technologies such as soil vapor extraction, land treatment, and composting.
- **Types of Applications** - A majority of S/S projects at Superfund remedial sites are *ex situ* applications where inorganic binders and additives were used to treat metal-containing waste. Organic binders were used for specialized waste such as radioactive wastes and those containing specific hazardous organic compounds. S/S was used to treat wastes containing only organics for a small number (6 percent) of the projects.
- **Performance** - Most performance testing for S/S waste products is conducted after curing is completed, and only limited data are available on long-term performance of S/S at Superfund remedial sites. Available performance data for metals for these projects showed that S/S met the established performance goals. Only limited data were available on organics; however, S/S met the established performance goals for several projects.
- **Cost** - Information about the cost of using S/S to treat wastes at Superfund remedial sites was available for 29 completed projects. The total cost ranged from $75,000 to $16 million. The average cost per cubic yard for these S/S projects was $264, including two projects with relatively high costs (approximately $1,200 per cubic yard each). Excluding those two projects, the average cost per cubic yard for S/S was $194.

Sources of information about S/S used for this summary included Superfund Records of Decision (RODs), ROD amendments, and Explanations of Significant Differences (ESDs) issued by EPA through FY 1998; data and analyses contained in EPA's *Treatment Technologies for Site Cleanup: Annual Status Report* (*ninth edition*) (ASR); information being collected for the tenth edition of the ASR, expected to be published later this year; and EPA's REmediation And CHaracterization Innovative Technologies (EPA REACH IT) system.



What is Solidification/Stabilization

The term "solidification/stabilization" refers to a general category of processes that are used to treat a wide variety of wastes, including solids and liquids. Solidification and stabilization are each distinct technologies, as described below (EPA, 1997, Portland Cement Association 1991):

- **Solidification** - refers to processes that encapsulate a waste to form a solid material and to restrict contaminant migration by decreasing the surface area exposed to leaching and/or by coating the waste with low-permeability materials. Solidification can be accomplished by a chemical reaction between a waste and binding (solidifying) reagents or by mechanical processes. Solidification of fine waste particles is referred to as microencapsulation, while solidification of a large block or container of waste is referred to as macroencapsulation.

- **Stabilization** - refers to processes that involve chemical reactions that reduce the leachability of a waste. Stabilization chemically immobilizes hazardous materials or reduces their solubility through a chemical reaction. The physical nature of the waste may or may not be changed by this process.

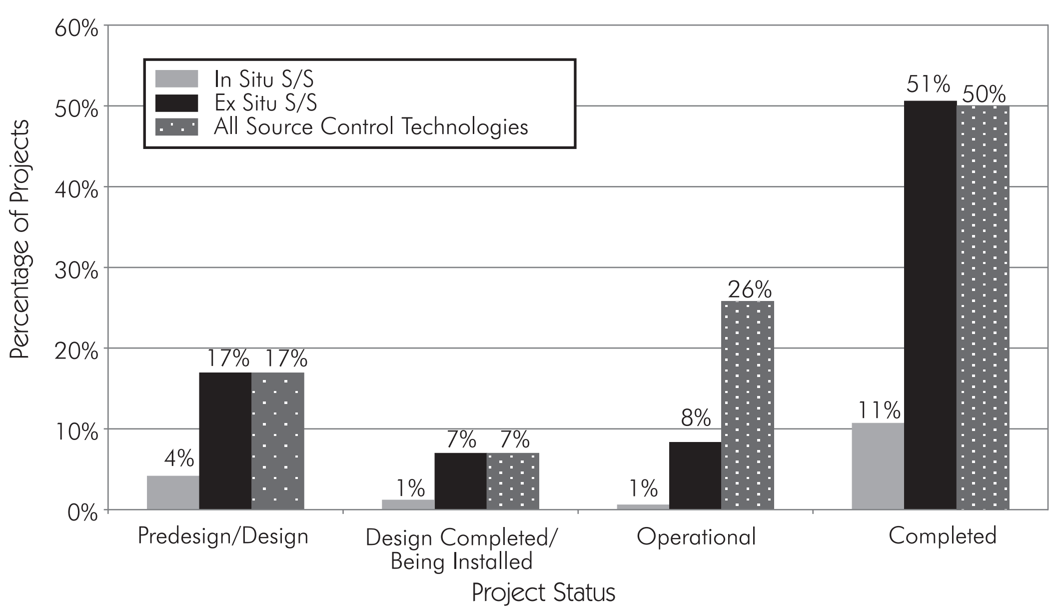
For S/S applications at Superfund sites, the regulatory definition of stabilization under the Resource Conservation and Recovery Act (RCRA) may be relevant to a project. Under the Land Disposal Restrictions (LDR) program (40 CFR part 268), stabilization is the required treatment standard for certain types of waste. In addition, stabilization may be used to render a RCRA hazardous waste (defined under 40 CFR part 260) non-hazardous prior to disposal. RCRA defines stabilization (40 CFR 268.42) as "[a process that] involves the use of the following reagents (or waste reagents): (1) Portland cement; or (2) lime/pozzolans (e.g., fly ash and cement kiln dust) - this does not preclude the addition of reagents (e.g., iron salts, silicates, and clays) designed to enhance the set/cure time and/or compressive strength, or to overall reduce the leachability of the metal or inorganic."

In addition, S/S processes can involve the use of very high temperatures (usually greater than 1,500 °F) to vitrify wastes, forming glass-like waste products. However, these S/S processes are not addressed in this summary.

Use of S/S at Superfund Sites

Recent information about the use of S/S at Superfund remedial sites indicates that S/S has been used at 167 sites since FY 1982. Exhibit 1 shows the number of projects by status for the following stages - predesign/design, design completed/being installed, operational, and completed. Data are shown for *in situ* and *ex situ* S/S projects. In addition, information about all source control technologies is provided. With respect to S/S projects, the majority of both *in situ* and *ex situ* projects (62 percent) are completed, followed by projects in the predesign/design stage (21 percent). Overall, completed S/S projects represent 30 percent of all completed Superfund projects in which treatment technologies have been used for source control. (Appendix A contains summary information, where available, for these S/S projects).

Exhibit 1: Percentage of Superfund Remedial Projects by Status



Data Source: ASR (9th Edition), FY'98 RODs
Number of Projects: Source Control = 682, Ex Situ S/S = 139, In Situ S/S = 28

Remedy Selection Trends

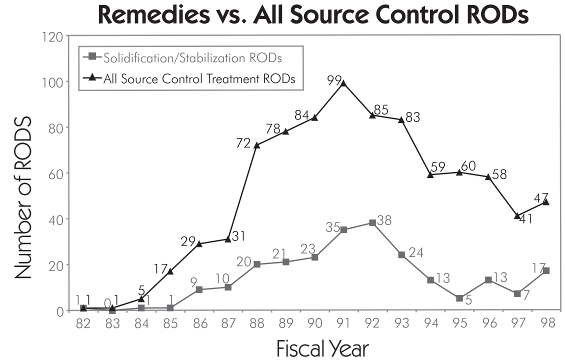
Exhibit 2 shows the top five source control treatment technologies used at Superfund remedial sites from FY 1982 through FY 1998. Cumulatively, S/S projects are the second most common type of source control treatment technology implemented at these sites, representing 24 percent of all source control treatment technology projects. Soil vapor extraction (SVE) is the most common technology implemented, representing 28 percent of all source control treatment technology projects.

Exhibit 3 shows the trend in selection of S/S as a remedy at Superfund remedial sites between FY 1982 and FY 1998 and compares the selection of S/S remedies with all other treatment technologies. The frequency with which S/S was selected as a remedy increased during the late 1980s and early 1990s, reaching a peak in FY 1992, and then generally decreasing through FY 1998. The trend in S/S remedy selection during this time frame is similar to that for all source control treatment technologies.

Exhibit 2: Top 5 Source Control Treatment Technologies Used at Superfund Remedial Sites

Soil Vapor Extraction	28%
Solidification/Stabilization	24%
Incineration (off-site)	13%
Bioremediation	11%
Thermal Desorption	9%

Exhibit 3: RODs Selecting Solidification/Stabilization Remedies vs. All Source Control RODs



Note: Source control treatment RODs are defined as RODs selecting one or more treatment technologies to treat the source of the contamination

Remedy Changes

Exhibit 4 compares the number of RODs in which S/S was selected with the actual number of S/S projects implemented each year from FY 1982 through FY 1998. The differences between the number of RODs where S/S was selected as the remedy and the number of S/S projects implemented reflects changes in the remedies that occurred during the remedial process. Between FY 1982 and FY 1987 and between FY 1994 and FY 1998, the number of S/S remedies implemented is close to the number of S/S remedies selected in RODs. From FY 1988 through FY 1993, there is a larger gap between the number of S/S remedies selected and the number implemented. As shown in Exhibit 3, this time frame corresponds to the fiscal years in which S/S was most frequently selected as a remedy.

Exhibit 5 shows the remedies that were selected to replace S/S. Off-site disposal was the most frequently selected (27 percent) remedy, followed by on-site containment (15 percent).

Exhibit 4: Selection Versus Implementation of Solidification/Stabilization Remedies

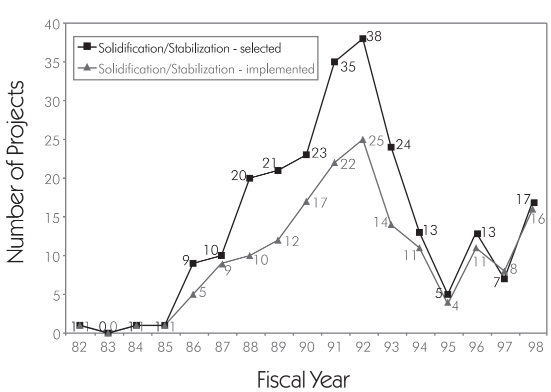
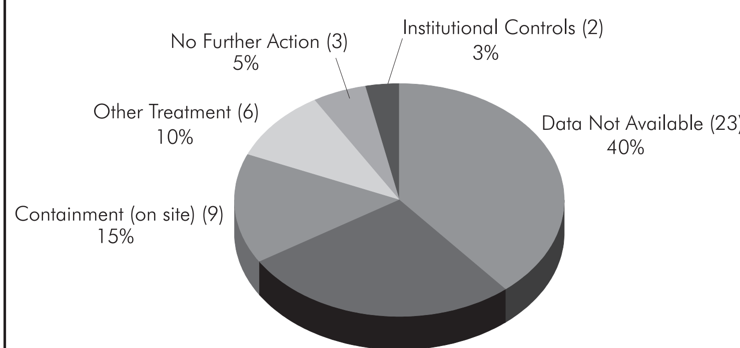


Exhibit 5: Remedies Selected to Replace Solidification/Stabilization

Total Number of Projects = 59



Data Source: ASR (9th Edition) FY'98 RODs

Note: Does include 4 projects in which other treatment technologies were changed to S/S

Reasons cited by project managers for replacing S/S as a remedy are presented in Exhibit 6.

Exhibit 6: Reasons Cited by Project Managers for Replacing S/S as the Remedy

(1) The estimated volume of contaminated material had decreased such that S/S was no longer cost effective

(2) S/S could not meet the required treatment standards for the waste at the site

(3) The cost of S/S was too high

(4) S/S had originally been selected to treat residuals from other treatment technologies at the site. When little or no residuals were generated, S/S was no longer necessary

(5) The community expressed concerns about on-site treatment of wastes

(6) There were problems implementing S/S

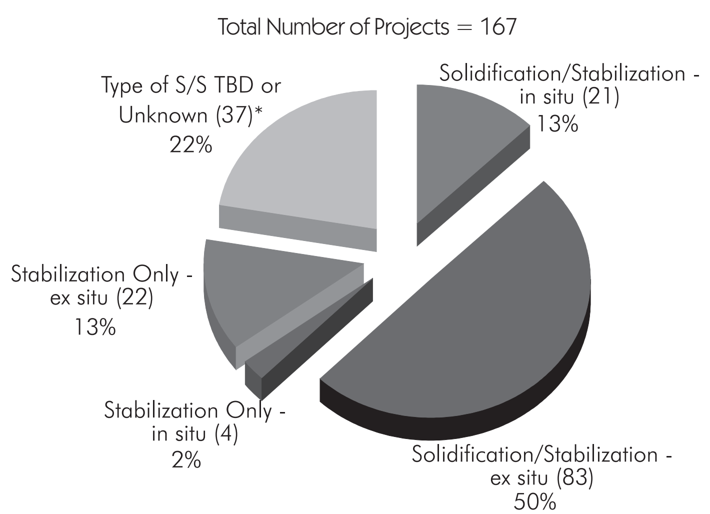
(7) S/S could not significantly reduce the mobility of a specific waste

Specific Types of S/S Applications

Exhibit 7 shows a breakdown of the S/S projects by type of application which include *ex situ* solidification/stabilization, *in situ* solidification/stabilization, *ex situ* stabilization only, and *in situ* stabilization only. A specific type of S/S application was identified for 88 percent of the projects. Solidification/stabilization (*in situ* and *ex situ*) represents 63 percent of the S/S projects compared to 15 percent for stabilization only (*in situ* and *ex situ*).

Exhibit 8 shows the types of binder materials used for S/S projects at Superfund remedial sites, including inorganic binders, organic binders, and combination organic and inorganic binders. Many of the binders used include one or more proprietary additives. Examples of inorganic binders include cement, fly ash, lime, soluble silicates, and sulfur-based binders, while organic binders include asphalt, epoxide, polyesters, and polyethylene. More than 90 percent of the S/S projects used inorganic binders. In general, inorganic binders are less expensive and easier to use than organic binders. Organic binders are generally used to solidify radioactive wastes or specific hazardous organic compounds.

Exhibit 7: Solidification/Stabilization Projects by Type

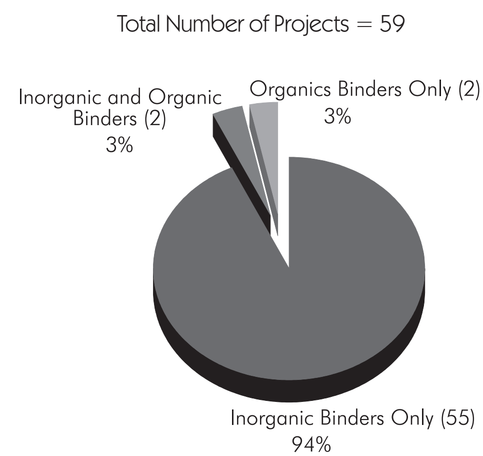


* Includes 3 *in situ* projects

Data Source: EPA and State Project Managers

Note: Number of projects for each type is shown in parenthese. TBD = to be determined

Exhibit 8: Binder Materials Used for Solidification/Stabilization Projects



Data Source: EPA and State Project Managers

Note: Inorganic binders consist of cement, fly ash, lime, soluble silicates, or sulfur. Organic binders consist of asphalt, organophilic clay, or activated carbon.

Exhibit 9 summarizes the specific types of binders and reagents used in S/S projects at Superfund remedial sites. Cement is the most common binder (47 projects), followed by proprietary additives (22 projects), and phosphate (14 projects).

Exhibit 10 shows the types of contaminant groups and combination of contaminant groups treated by S/S at Superfund remedial sites. S/S was used to treat metals only in 56 percent of the projects, and used to treat metals alone or in combination with organics or radioactive metals at approximately 90 percent of the sites. S/S was used to treat organics only at 6 percent of the sites.

Exhibit 11 provides a further breakdown of the metals treated by S/S at Superfund remedial sites. The top five metals treated by S/S are lead, chromium, arsenic, cadmium, and copper.

Exhibit 9: Binders and Reagents Used for S/S Projects

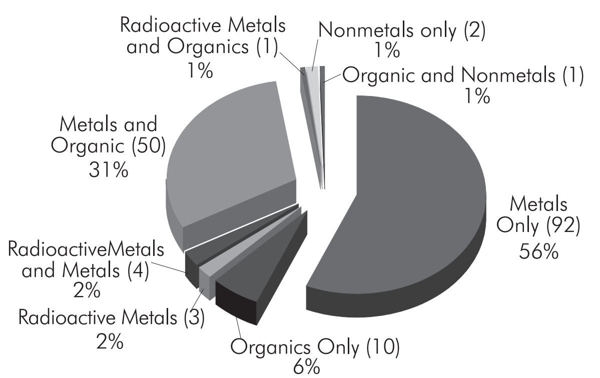
Binder or Reagent	Number of Projects*
Cement	47
Proprietary reagents	22
Phosphate	14
pH controls	12
Fly ash	10
Lime	10
Sulfur	4
Asphalt	1

Other organics used include granular activated carbon and organophilic clay.

* A project may use more than one binder or reagent

Exhibit 10: Contaminant Types Treated by S/S

Total Number of Projects = 163



Data Source: EPA and State Project Managers

Note: Metals are defined as heavy metals. Data indicates how many projects are addressing each type of contaminant group and are not necessarily indicative of how well the technology has treated each type of group

Exhibit 11: Number of S/S Projects Treating Specific Metals

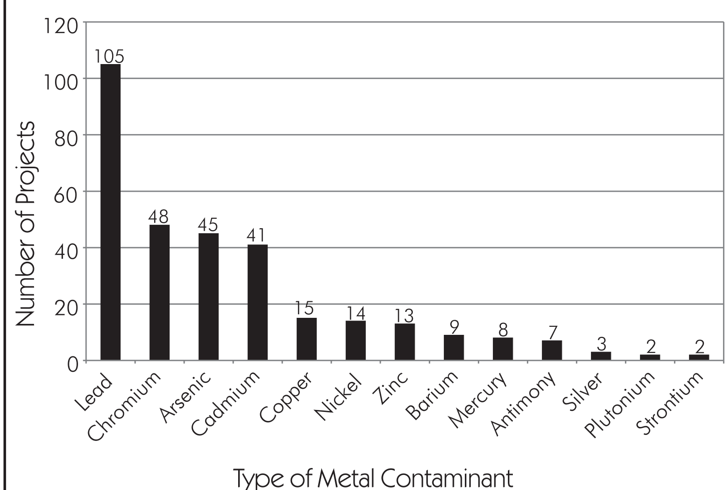
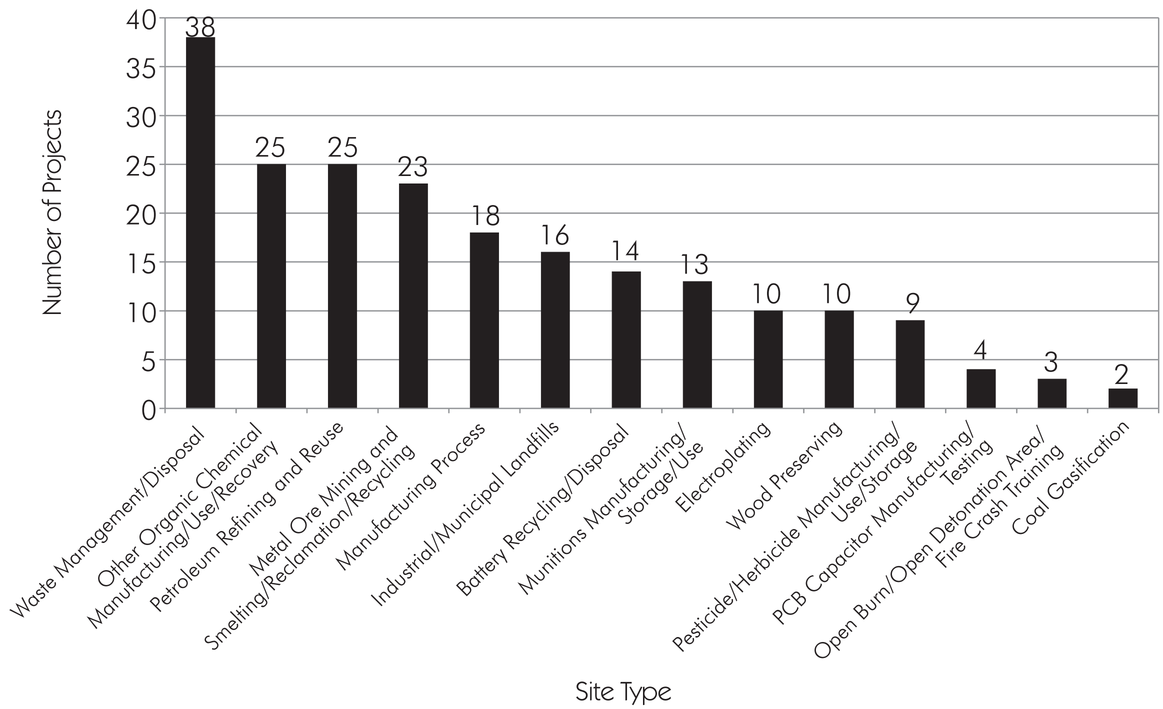


Exhibit 12 shows the types of sites treated by S/S projects. Waste management/disposal areas, organic chemical manufacturing, petroleum refining, and metal ore mining, smelting and recycling facilities were the most common site types addressed by S/S.

Time of Operation

Data on completed S/S projects were analyzed to determine the average operational time for S/S projects compared to other technologies. For this analysis, operational time was defined as the period from when operations began (following design and installation) to the time the project was determined to have been completed by the project manager. Assuming treatment of 1,000 cubic yards of waste, the average operational time for S/S projects was 1.1 months. For the same volume of waste, the average operational time was

Exhibit 12: Superfund Remedial Actions: Site Types for Solidification/Stabilization



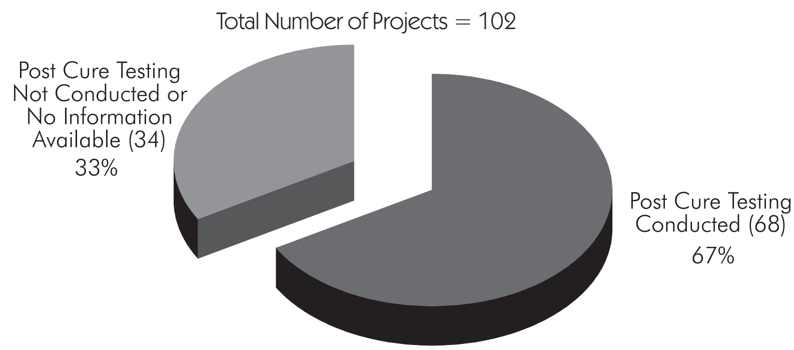
approximately 0.75 months for thermal desorption, 1 month for incineration (on site), 2.5 months for soil vapor extraction, 3 months for land treatment, 3.8 months for composting, and 5.8 months for soil washing.

Post Cure Testing and Performancee

The performance of S/S at Superfund remedial sites often is measured after the solidified material has cured. As shown in Exhibit 13, post cure testing was performed for 67 percent of the S/S projects. Exhibit 14 lists the types of post cure tests used for S/S projects, which include; (1) physical tests - to provide information about the physical characteristics of the treated waste, such as its moisture content or strength; and (2) chemical tests - to measure the potential of a stabilized waste to release contaminants to the environment; to define the composition of the waste and assess the performance of the binder. The most common post cure tests used were the toxicity characteristic leaching procedure (TCLP) test and the unconfined compressive strength (UCS) test.

Available performance data for treatment of metals by S/S from completed projects indicated that concentrations of metals before treatment typically ranged from 50 mg/kg to 70,000 mg/kg, with concentrations as high as 424,000 mg/kg for lead and 170,000 mg/kg for cadmium. In general, post-treatment concentrations of metals met the RCRA TCLP standards.

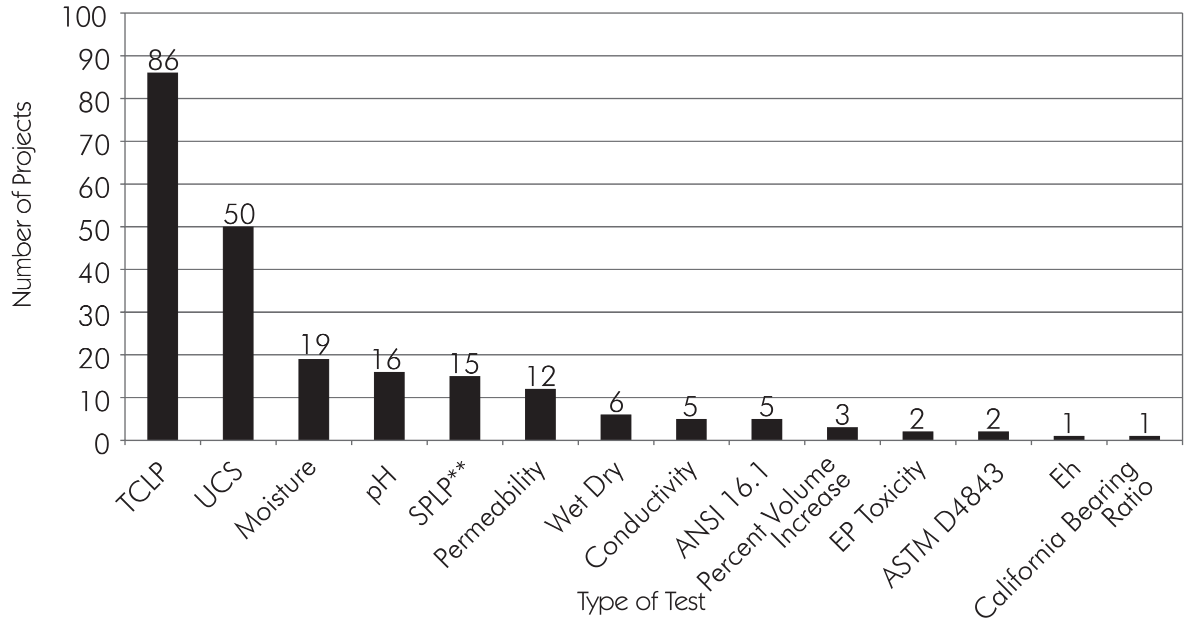
Exhibit 13: Percentage of Completed S/S Projects Conducting Post Cure Testing



Performance data for completed S/S projects where organics had been treated were limited. Typical organics treated by S/S at Superfund sites included trichloroethene, benzene, methylene chloride, pentachlorophenol,

Exhibit 14: Type of Post Cure Testing Used for S/S Projects

Total Number of Projects = 66



* A project may use more than one type of test. ANSI 16.1 is the American Nuclear Society test 16.1 which is a leaching test.

** Synthetic precipitation leaching procedure.

polycyclicaromatic hydrocarbons, pesticides (dieldrin, endrin, isodrin, and aldrin), and polychlorinated biphenyls (PCBs). Concentrations of contaminants before treatment typcially ranged from about 100 mg/kg to 1,100 mg/kg (PCBs).

While only limited post-treatment performance data were available for organic wastes, the data indicated that S/S met the established performance goals for several projects. For example, at the American Creosote, a wood preserving site in Tennessee, soils were contaminated with wood preserving compounds such as pentachlorophenol, benzo(a)pyrene, dibenz(a,h) anthracene, and dioxin. As shown in Exhibit 15, S/S met the cleanup goals for each of these constituents.

Exhibit 15: S/S Performance at American Creosote, TN

Contaminant	Cleanup Goal*	Result
Pentachlorophenol	<200 µg/l	Passed
Benzo(a)pyrene	<10 µg/l	Passed
Dibenz(a,h) anthracene	<4.4 µg/l	Passed
Dioxin	<30 ppq**	Passed

* Results reported as concentration of SPLP extract

**ppq = parts per quintillion

Limited data are available on long-term performance of S/S at Superfund sites. The long-term environment and conditions to which the solidified waste is exposed can affect the stability of the treated waste. For example, studies (Klich *et al*) have shown that cement-based stabilized wastes are vulnerable to the same physical and chemical degradation processes as concrete and other cement-based materials (that is, have the potential to disintegrate over a period of 50 to 100 years).

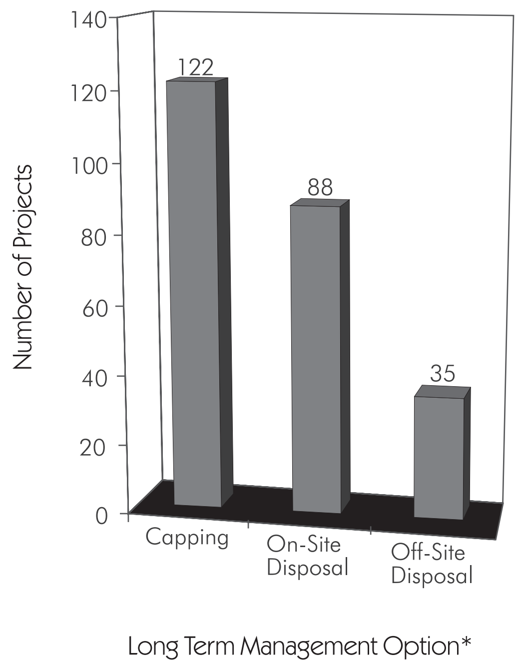
Cost Data

Information about the cost of using S/S to treat wastes at Superfund remedial sites was available for 29 completed projects. Total costs for S/S projects ranged from $75,000 to $16 million including the cost of excavation (if *ex situ*), treatment, and disposal (if *ex situ*). The cost per cubic yard treated ranged from $8 to approximately $1,200 per cubic yard. The average cost per cubic yard for these projects was $264, including two projects with relatively high costs (approximately $1,200 per cubic yard). Excluding those two projects, the average cost per cubic yard was $194.

Disposal/Long Term Management Options

The waste forms produced by *ex situ* S/S processes are either disposed of off-site or disposed of on-site (with or without capping). The waste products of *in situ* S/S processes are left in place at the site (i.e., disposed of on-site) with or without capping. For completed S/S projects at Superfund remedial sites, on-site disposal of waste forms produced by *ex situ* processes and capping were used for the majority of projects, as shown in Exhibit 16.

Exhibit 16: Long Term Management Options for S/S Projects



* A project may implement more than one option.; on-site disposal is for wastes from *ex situ* processes.

Additional Information

The following sources provide additional information about S/S processes in general and their use at Superfund sites:

EPA's *Solidification/Stabilization Resource Guide* (EPA/ 542-B-99-002) contains summaries of information from 125 references, including technical, guidance and policy documents, and provides an easy-to-use matrix that cross-references resources by technology type, medium, and contaminant to help readers easily locate resources that meet their specific needs.

EPA's *Treatment Technologies for Site Cleanup: Annual Status Report (ninth edition)* includes information about Superfund remedial action sites at which S/S projects are being or have been implemented.

EPA's REACH IT system, <www.epareachit.org>, provides detailed data, in a searchable system, about specific applications of S/S at Superfund sites, as well as a wide range of information about technologies, technology vendors, and other technology applications.

EPA's *Updating Remedy Decisions at Select Superfund Sites Summary Report, FY 1996 and FY 1997* contains additional information about remedy changes that affected S/S projects.

The Federal Remediation Technology Roundtable (FRTR) site includes case studies of S/S applications, available at <www.frtr.gov/cost>.

References

EPA. 1999. *Treatment Technologies for Site Cleanup: Annual Status Report (ninth edition)* (EPA-542-R99-001). April.

EPA. 1997. *Innovative Site Remediation Technology, Solidification/Stabilization. Design & Application, Volume 4.* (EPA 542-B-97-007)

Klich, I., B. Batchelor, L.P. Wilding, L.R. Press. *1999. Mineralogical alterations that affect the durability and metals containment of aged solidified and stabilized wastes.* Cement and Concrete Research, Vol. 29.

Means, Jeffery et al. 1995. *The Application of Solidification/Stabilization to Waste Materials.* Lewis Publishers.

Portland Cement Association. 1991. *Solidification and Stabilization of Waste Using Portland Cement*.

Wiles, C.C. 1987. *A Review of Solidification/Stabilization Technology.* Journal of Hazardous Materials, 14:5-21.

Appendix A

List of Superfund Remedial Sites Using Solidification/Stabilization

Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
1	W.R. Grace (Acton Plant) And Co., Inc.	MA	1989	Arsenic	Completed	Dave Lederer 617-573-9665
1	PSC Resources	MA	1992	Trichloroethylene (TCE) Methylene chloride Acetone Bis(2-ethylhexyl) phthalate Benzene Trans 1,2-Dichloroethylene 1,1,1-Trichloroethane Arsenic Lead Zinc Tetrachloroethylene (PCE) 1,1-Dichloroethane Polyaromatic hydrocarbons (PAHs) Polychlorinated biphenyls (PCBs) Cis-1,2-Dichloroethylene	Completed	Don Mcelroy 617-223-5571
2	Chemical Control	NJ	1987	Pesticides Polychlorinated biphenyls (PCBs) Arsenic	Completed	Nigel Robinson 212-637-4394
2	NL Industries, Inc.	NJ	1991	Lead Cadmium	Completed	Joseph Gowers 212-637-4413
2	Waldick Aerospace Devices, Inc.	NJ	1991	Chromium Cadmium	Completed	Daniel Weissman 212-637-4384
2	Asbestos Dump - New Vernon Road and White Bridge Road Cleanup	NJ	1991	Asbestos	Completed	Maryanne Rosa 212-637-4407
2	Nascolite Corp. - OU 2	NJ	1991	Lead	Designed/ Not Installed	Farnaz Saghafi 212-637-4408
2	American Cyanamid Co. - Group I Impoundments (11, 13, 19, And 24)	NJ	1993	Toluene Ethylbenzene 1,2,4-Trichlorobenzene Zinc Lead Acetone Chromium Xylene Copper Nickel Naphthalene Chlorobenzene Bis(2-ethylhexyl)phthalate Benzo(a)anthracene	Operational	James Haklar 212-637-4414
2	NL Industries, Inc. - OU 1	NJ	1994	Cadmium Lead	Design	Joseph Gowers 212-637-4413

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Appendix A (continued)

Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
2	Caldwell Trucking - Amendment	NJ	1995	1,1,1-Trichloroethane Lead Cadmium Tetrachloroethylene (PCE) Chloroform Trichloroethylene (TCE)	Completed	Richard Robinson 212-637-4371
2	American Cyanamid Co. - Group II Impoundments (15, 16, 17, And 18)	NJ	1996	Naphthalene 1,2,4-Trichlorobenzene Toluene Zinc 2-Methylnaphthalene Nickel Benzo(a)anthracene Copper Nitrosodiphenylamine Acetone Ethylbenzene Bis(2-ethylhexyl)phthalate Chromium Xylene Lead Anthracene Chlorobenzene Benzene	Predesign	James Haklar 212-637-4414
2	Cosden Chemical Coatings	NJ	1998	Beryllium Lead Chromium	Predesign	Edward Finnerty 212-637-4367
2	Marathon Battery Corp. - Areas I, II, And III	NY	1986	Cobalt Nickel Cadmium	Completed	Pam Tames 212-637-4255
2	York Oil Co. - OU 1	NY	1988	Polychlorinated biphenyls (PCBs) Lead Total petroleum hydrocarbons (TPH) Cis-1,2-dichloroethene	Operational	Joel Singerman 212-637-4258
2	Facet Enterprises	NY	1992	Polychlorinated biphenyls (PCBs) Cadmium	Completed	Isabel Rodrigues 212-637-4248
2	Preferred Plating Corp. - OU 2	NY	1992	Cadmium Chromium	Completed	Janet Cappelli 212-637-4270
2	FMC Corp. (Dublin Road)	NY	1993	Dichlorodiphenyldichloroethane (DDD) Zinc Mercury Lead Dichlorodiphenyldichloroethylene (DDE) Copper Arsenic Alpha BHC	Completed	Kevin Lynch 212-637-4287
2	York Oil Co. - OU 02	NY	1998	Lead Polychlorinated biphenyls (PCBs)	Designed/ Not Installed	Joel Singerman 212-637-4258

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Appendix A (continued)

Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
3	Bruin Lagoon	PA	1982	Lead Sulfuric Acid Sulfur Hydrogen Sulfide	Completed	Bhupendra Khona 215-814-3213
3	Hebelka Auto Salvage Yard	PA	1989	Lead Chromium	Completed	Frederick N. Macmillan 215-814-3201
3	Douglassville Disposal	PA	1989	Polyaromatic hydrocarbons (PAHs) Volatile organic compounds (VOCs) Polychlorinated biphenyls (PCBs) Chromium Lead	Design	Victor J. Janosik 215-814-3217
3	Craig Farm Drum	PA	1989	Benzene Resorcinol Phenol	Completed	Garth Connor 215-814-3209
3	Letterkenny Army Depot (SE Area) - Former Solvent Disposal Lagoon/Earthen	PA	1991	Lead	Completed	Stacie Driscoll 215-566-3368
3	Whitmoyer Laboratories - OU 2 (Bldg Structures)	PA	1991	Arsenic Tar	Completed	Christopher J. Corbett 215-814-3220
3	Eastern Diversified Metals	PA	1991	Lead	Predesign	Steven J. Donohue 215-566-3215
3	Whitmoyer Laboratories - OU 3	PA	1991	Arsenic	Design	Christopher J. Corbett 215-814-3220
3	Paoli Rail Yard	PA	1992	Polychlorinated biphenyls (PCBs)	Design	Frances Costanzi 215-566-3196
3	Tonolli Corp.	PA	1992	Lead Cadmium Arsenic	Being Installed	Steven J. Donohue 215-566-3215
3	C&D Recycling	PA	1992	Copper Lead	Completed	Joseph Mcdowell 215-566-3192
3	Hunterstown Road	PA	1993	Trichloroethylene (TCE) Chromium Lead	Design	John Banks 215-814-3214
3	Jacks Creek/Sitkin Smelting And Refining	PA	1997	Lead	Design	Garth Connor 215-814-3209
3	Whitmoyer Laboratories - OU 04 and OU 5	PA	1998	Arsenic	Completed	Christopher J. Corbett 215-814-3220
3	M.W. Manufacturing	PA	1998	Lead	Design	Bhupendra Khona 215-814-3213
3	C&R Battery Co., Inc.	VA	1990	Lead	Completed	Ronnie M. Davis 215-814-3230
3	First Piedmont Rock Quarry (Route 719)	VA	1991	Lead Arsenic Cadmium	Operational	David Iacono 215-814-3231
3	Rhinehart Tire Fire Dump	VA	1992	Zinc	Completed	Russell H. Fish 215-566-3226
3	Abex Corporation OU 1 - Inner Focus Area	VA	1992	Lead	Operational	David Iacono 215-814-3231
3	Ordnance Works Disposal Areas	WV	1989 Lead	Arsenic	Predesign	Melissa Whittington 215-566-3235

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Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
4	Mowbray Engineering	AL	1986	Polychlorinated biphenyls (PCBs)	Completed	Humberto Guzman 404-562-8942
4	Interstate Lead Co.	AL	1991	Lead	Designed/ Not Installed	Astrid Aponte 404-562-8932
4	Alabama Army Ammunition Plant, Area B, Study Areas 5, 10, 16, 19, OU 6	AL	1992	Lead	Operational	Dann Spariosu 404-562-8552
4	Alabama Army Ammunition Plant, OU 5	AL	1997	Lead	Completed	Dann Spariosu 404-562-8552
4	Davie Landfill	FL	1985	Lead Chromium Cadmium Mercury Arsenic	Completed	Bill Denman 404-562-8939
4	Pepper Steel & Alloys, Inc.	FL	1986	Polychlorinated biphenyls (PCBs) Heavy metals	Completed	John Zimmerman 404-562-8936
4	Sapp Battery Salvage	FL	1986	Cadmium Antimony Lead	Operational	David Lloyd 404-562-8917
4	Kassauf-Kimerling Battery Disposal - OU 1 (Landfill Wastes)	FL	1989	Chromium Battery casings Lead	Completed	Maxwell Kimpson 404-562-8941
4	Kassauf-Kimerling Battery - Wetlands Soils	FL	1990	Lead Battery casings	Completed	Maxwell Kimpson 404-562-8941
4	Zellwood Soil Contamination - OU 1 (Amendment)	FL	1990	Chlordane	Completed	Julie Santiago 404-562-8948
4	Yellow Water Road Dump	FL	1990	Polychlorinated biphenyls (PCBs)	Completed	David Lloyd 404-562-8917
4	Schuylkill Metal	FL	1990	Chromium Antimony Cadmium Lead	Completed	Galo Jackson 404-562-8937
4	62nd Street Dump	FL	1990	Cadmium Chromium Lead	Completed	Maxwell Kimpson 404-562-8941
4	Zellwood Soil Contamination - OU 1 (Amendment)	FL	1990	Lead Chromium Volatile organic compounds (VOCs)	Completed	Julie Santiago 404-562-8948
4	Yellow Water Road Dump	FL	1990	Polychlorinated biphenyls (PCBs)	Completed	David Lloyd 404-562-8917
4	Cabot/Koppers - Koppers OU	FL	1990	Chromium Arsenic	Predesign	John Blanchard 404-562-8934
4	Agrico Chemical	FL	1992	Arsenic Lead Fluoride	Completed	Ken Lucas 404-562-8953
4	Whitehouse Oil Pits - Amendment	FL	1992	Lead Polychlorinated biphenyls (PCBs) Cadmium Antimony Bis(2-ethylhexyl)phthalate Polychlorinated biphenyls (PCBs)	Design	Randa Chichakli 404-562-8907

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Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
4	Peak Oil/Bay Drum - OU 3	FL	1993	Chromium Lead Zinc	Design	Randall Chaffins 404-562-8929
4	Peak Oil/Bay Drum - OU 1	FL	1993	Lead Polychlorinated biphenyls (PCBs)	Design	Randall Chaffins 404-562-8929
4	Jacksonville Naval Air Station - OU 2 PSCs 2, 41, and 43	FL	1994	Nickel Chromium Cadmium Arsenic Lead	Completed	Martha Berry 404-562-8533
4	Florida Steel Corp. - OU 2	FL	1994	Polychlorinated biphenyls (PCBs) Lead	Completed	Bill Denman 404-562-8939
4	Jacksonville Naval Air Station - OU 2 PSC 42	FL	1995	Cadmium Nickel Lead Chromium Silver	Completed	Martha Berry 404-562-8533
4	Stauffer Chemical Co. (Tarpon Springs) - OU 01	FL	1998	Antimony Carcinogenic PAHs Phosphorus Thallium Radium-226 Beryllium Arsenic	Predesign	John Blanchard 404-562-8934
4	Robins Air Force Base - Sludge Lagoon	GA	1991	Lead Cadmium	Completed	Elizabeth Wilde 404-562-8528 Bill Downs 912-926-1197
4	Hercules 009 Landfill	GA	1993	Toxaphene	Completed	Annie Godfrey 404-562-8919
4	Cedartown Industries, Inc.	GA	1993	Lead	Completed	Annie Godfrey 404-562-8919
4	Maxey Flats Nuclear Disposal	KY	1991	Xylene Radioactive metals Tritium Benzene Volatile organic compounds (VOCs) Ethylbenzene Toluene	Being Installed	Antonio Deangelo 404-562-8826
4	Flowood Site	MS	1988	Lead	Completed	John Mcqueen 404-562-8913
4	Celanese - OU 2	NC	1989	Ethylene glycol	Completed	Ken Mallary 404-562-8802
4	Carolina Transformer Co.	NC	1991	Polychlorinated biphenyls (PCBs)	Designed/ Not Installed	Luis Flores 404-562-8807
4	JFD Electronics/Channel Master	NC	1992	Chromium Nickel Antimony	Design	Ken Mallary 404-562-8802
4	Bypass 601 Groundwater Contamination - Amendment	NC	1993	Lead	Completed	David Mattison 919-733-2801 Giezelle Bennett 404-562-8824

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Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
4	North Carolina State University - Lot 86, Farm Unit #1	NC	1996	Bis(2-ethylhexyl)phthalate Heavy metals Solvents Radioactive metals	Design	Michael Townsend 404-562-8813
4	Palmetto Wood Preserving	SC	1987	Chromium Arsenic	Completed	Al Cherry 404-562-8828
4	Independent Nail Co.	SC	1987	Chromium Cyanide Cadmium Zinc Nickel	Completed	Terry Tanner 404-562-8797
4	Golden Strip Septic Tank Service	SC	1991	Cadmium	Completed	Craig Zeller 404-562-8827
4	Geiger (C&M Oil) - Amendment	SC	1993	Lead Chromium Toluene	Completed	Sheri Panabaker 404-562-8810
4	Savannah River (Usdoe) - Old F-Area Seepage Basin, Srs Building Number 904-49g	SC	1997	Mercury Cesium-137 Uranium	Design	Tania Smith 803-725-8131
4	Savannah River (Usdoe) - L-Area Oil And Chemical Basin And L-Area Acid/ Caustic Basin	SC	1997	Chromium Radioactive metals Tritium	Being Installed	Les Germany 803-725-8033
4	Shuron Inc - OU 01	SC	1998	Lead	Predesign	Ralph O. Howard Jr. 404-562-8829
4	Oak Ridge Reservation (USDOE) - OU 3, Pond Waste Management Project	TN	1991	Radioactive metals	Completed	Ed Carreras 404-562-8509
4	Oak Ridge Reservation (USDOE) - OU 40, Burial Complex 4	TN	1996	Strontium	Completed	Ed Carreras 404-562-8509
4	Oak Ridge Reservation (USDOE) - OU 14, Surface Impoundments	TN	1997	Cesium-137 Plutonium Radioactive metals Strontium	Designed/ Not Installed	Ed Carreras 404-562-8509
5	Velsicol Chemical	IL	1988	Phenol Benzene	Completed	Eric Runkel 217-782-0451
5	Sangamo Electric Dump/Crab Orchard National Wildlife Refuge - PCB Areas OU	IL	1990	Lead Cadmium	Completed	Nanjunda Gowda 312-353-9236
5	Sangamo Electric Dump/Crab Orchard National Wildlife Refuge - Metals Areas OU	IL	1990	Cadmium Chromium Lead	Completed	Nanjunda Gowda 312-353-9236
5	Acme Solvent Reclaiming, Inc.	IL	1991	Lead	Completed	David Linnear 312-886-1841
5	Acme Solvent Reclaiming, Inc.	IL	1991	Chromium Arsenic	Completed	David Linnear 312-886-1841
5	Midco I	IN	1989	Chromium Polychlorinated biphenyls (PCBs) Pentachlorophenol (PCP) Nickel Lead Copper Cyanide	Predesign	Richard Boice 312-886-4740

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Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
5	Midco II	IN	1989	Polychlorinated biphenyls (PCBs) Pentachlorophenol (PCP) Nickel Lead Chromium	Predesign	Richard Boice 312-886-4740
5	Continental Steel Corp. - OU 02	IN	1998	Lead Volatile organic compounds (VOCs) Polychlorinated biphenyls (PCBs) Cadmium Chromium	Predesign	Jon Peterson 312-353-1264
5	Forest Waste Products	MI	1986	Polychlorinated biphenyls (PCBs) Lead	Completed	Anthony Rutter 312-886-8961 Elizabeth Reiner 312-353-6576
5	Liquid Disposal, Inc.	MI	1987	Polychlorinated biphenyls (PCBs) Volatile organic compounds (VOCs) Lead Cadmium Barium	Completed	Leah Evison 312-886-4696
5	Auto Ion Chemicals	MI	1989	Bis(2-ethylhexyl)phthalate 1,1-Dichloroethane Vinyl chloride Trichloroethylene (TCE) Lead Nickel Chromium Silver Cadmium Mercury Barium Arsenic Copper Cyanide	Completed	Michael Mcateer 312-886-4663
5	Springfield Township Dump-90ROD	MI	1990	Arsenic Lead	Design	Tim Penderville 312-886-5122
5	Carter Industrials, Inc.	MI	1991	Lead	Completed	Jon Peterson 312-353-1264
5	Peerless Plating	MI	1992	Lead Cadmium Nickel	Completed	Michael Ribordy 312-886-4592
5	Organic Chemicals, Inc. - OU 2	MI	1997	Chromium Indeno(1,2,3-cd)pyrene Lead Dibenzo(a,h)anthracene Benzo(a)pyrene Dieldrin 2,3,7,8-Tetrachlorodibenzodioxin (TCDD) Benzo(a)anthracene Bis(2-ethylhexyl)phthalate Beryllium Benzo(b)fluoranthene	Predesign	Thomas Williams 312-886-6157
5	Springfield Township Dump - OU 01	MI	1998	Lead Barium Arsenic	Predesign	Tim Penderville 312-886-5122

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Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
5	St. Louis River/Intertake/Duluth Tar Site - Wire Mill Pond And OU J	MN	1990	Coal tar	Completed	Jon Peterson 312-353-1264 Brenda Winkler 651-296-7813
5	Waite Park Wells - OUs 1, 2, & 3	MN	1994	Polychlorinated biphenyls (PCBs) Lead	Operational	Brenda Winkler 651-296-7813
5	Macgillis And Gibbs/Bell Lumber And Pole -OU 3	MN	1994	Arsenic Chromium	Completed	Darryl Owens 312-886-7089
5	New Brighton/Arden Hills/TCAAP (USArmy) - OU 07	MN	1997	Cadmium Antimony Trichloroethene Lead Copper Volatile organic compounds (VOCs)	Operational	Thomas Barounis 312-353-5577
5	Ormet Corporation	OH	1994	Polychlorinated biphenyls (PCBs)	Completed	Anthony Rutter 312-886-8961
5	Fernald Environmental Management Project, Formerly The Feed Materials Production Center, OU 5	OH	1996	Uranium Lead Arsenic	Completed	James Saric 312-886-0992
5	United Scrap Lead Company	OH	1997	Lead	Completed	John O'Grady 312-886-1477
5	Northern Engraving Corporation - Sludge Lagoon	WI	1987	Copper Zinc Nickel Fluoride	Completed	Robert Whippo 312-886-4759
5	Oconomowoc Electroplating	WI	1990	Lead Volatile organic compounds (VOCs) Chromium	Completed	Thomas Williams 312-886-6157
5	N.W. Mauthe Site	WI	1994	Chromium Copper Silver Zinc Cadmium	Completed	Jon Peterson 312-353-1264
6	Gurley Pit	AR	1987	Polychlorinated biphenyls (PCBs) Lead Zinc Barium	Completed	Ernest R. Franke 214-665-8521
6	Mid-South Wood Products	AR	1987	Pentachlorophenol (PCP) Copper Arsenic Copper chromated arsenic (CCA) Chromium Creosote	Completed	Shawn Ghose 214-665-6782 Glenn Celerier 214-665-8523
6	Industrial Waste Control	AR	1988	Xylene Lead Toluene 1,1,1-Trichloroethane Methylene Chloride Ethylbenzene Chromium	Completed	Shawn Ghose 214-665-6782

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Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
6	Rogers Road Municipal Landfill	AR	1990	Dioxin Dieldrin Lead Herbicides	Completed	Kathleen Aisling 214-665-8509
6	Jacksonville Municipal Landfill	AR	1990	Herbicides Lead Dioxin	Completed	Kathleen Aisling 214-665-8509
6	South 8th Street Landfill - OU 1	AR	1998	Lead Polychlorinated biphenyls (PCBs)	Being Installed	Phillip Allen 214-665-8516
6	Cleve Reber	LA	1987	Barium Cadmium Lead Organics Nickel Arsenic Chromium Mercury	Completed	Bart Canellas 214-665-6662
6	Gulf Coast Vacuum Services - OU 1	LA	1992	Benzene Barium Arsenic Polyaromatic hydrocarbons (PAHs)	Operational	Kathleen Aisling 214-665-8509
6	Pab Oil & Chemical Services, Inc.	LA	1993	Arsenic Barium	Completed	Caroline Ziegler 214-665-2178
6	Cimarron Mining Corp.	NM	1991	Lead	Completed	Tetra Sanchez 214-665-6686
6	Cal West Metals	NM	1992	Lead	Completed	Tetra Sanchez 214-665-6686
6	Sand Springs Petrochemical Complex	OK	1987	Trichloroethylene (TCE) 1,1-Dichloroethylene (DCE) Mineral acids Petroleum hydrocarbons	Completed	Shawn Ghose 214-665-6782
6	Fourth Street Abandoned Refinery	OK	1992	Lead Sulfuric acid	Completed	Carlos Sanchez 214-665-8507
6	Oklahoma Refining Co.	OK	1992	Cadmium Chromium Lead Arsenic	Operational	Earl Hendrick 214-665-8519 Kelly Dixon 405-702-5141
6	Double Eagle Refinery Co.	OK	1992	Lead Polyaromatic hydrocarbons (PAHs) Acids	Completed	Phillip Allen 214-665-8516
6	Bio-Ecology Systems, Inc.	TX	1984	Cyanide Trichloroethylene (TCE) Toluene Naphthalene Arsenic Benzene Lead Methylene chloride	Completed	Olivia Balandran 214-665-6584 Ernest R. Franke 214-665-8521
6	French Limited	TX	1988	Arsenic	Completed	Ernest R. Franke 214-665-8521

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Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
6	Pesses Chemical Co.	TX	1989	Cadmium Nickel	Completed	Earl Hendrick 214-665-8519
7	Vogel Paint & Wax	IA	1989	Chromium Lead	Completed	Bob Drustrup 515-281-8900 Jim Colbert 913-551-7489
7	Mid-America Tanning	IA	1991	Chromium	Being Installed	Bob Stewart 913-551-7654
7	Shaw Avenue Dump	IA	1991	1,1,2-Trichloroethane Arsenic	Completed	Paul Roemerman 913-551-7694
7	El Dupont De Nemours & Co. Inc.	IA	1991	Cadmium Selenium Lead Chromium	Completed	Nancy Swyers 913-551-7703
7	Iowa Army Ammunition Plant - OU 01	IA	1998	Lead	Operational	Sharon Lehn 402-221-7768
7	Weldon Spring Quarry/Plant/Pits (USDOE)	MO	1993	Radium-226 Thorium Uranium Heavy metals	Being Installed	Steve Mccracken 314-441-8978 Glenford A. Newtown Jr. 314-441-8978
7	Former Weldon Spring Ordnance Works - OU 1, Soils And Pipeline	MO	1996	Lead Polychlorinated biphenyls (PCBs)	Designed/ Not Installed	Tom Lorenz 913-551-7292
7	Oronogo - Duenweg Mining Bell Site - OU 2 And 3	MO	1996	Lead	Predesign	Mark Doolan 913-551-7169
7	Hastings Groundwater Contamination - Hastings East Industrial Park Surface Soils, Former Naval Ammunition Depot	NE	1990	Cadmium Lead	Completed	Ronald King 913-551-7568
8	Lockheed/Martin (Denver Aerospace)	CO	1990	Chromium Arsenic Lead	Design	George Dancik 303-312-6206
8	Denver Radium Site - OU 8	CO	1992	Arsenic Selenium Radium-226 Lead Uranium Thorium	Completed	Rebecca Thomas 303-312-6552
8	Broderick Wood Products - OU 1 (Impoundment Sludges)	CO	1992	Cadmium Arsenic Lead	Completed	Armando Saenz 303-312-6559 Steve Laudemann 303-692-3462
8	Rocky Flats Plant (USDOE) - OU 4, Industrial Areas	CO	1992	Plutonium	Completed	William Fraser 303-312-6257 Steve Gunderson 303-692-3367

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Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
8	Rocky Mountain Arsenal - Onpost OU, Former Basin F	CO	1996	Arsenic Dieldrin Isodrin Endrin Chloroacetic acid DCPD Aldrin		Kerry Guy 303-312-7288
8	Rocky Mountain Arsenal - Onpost OU, Buried M-1 Pits	CO	1996	Arsenic Mercury Aldrin Cadmium Isodrin Dieldrin	Design	Kerry Guy 303-312-7288
8	Anaconda Co. Smelter - Flue Dust	MT	1991	Cadmium Arsenic Lead	Completed	Charles Coleman 406-441-1150
8	Portland Cement (Kiln Dust #2 & #3) - OU 2, Chromium Bearing Bricks And Contaminated Soils	UT	1992	Chromium	Completed	Jim Christiansen 303-312-6748 Bob O'Brien 801-536-4166
9	Apache Powder Co.	AZ	1994	Lead Perchlorate	Predesign	Andria Benner 415-744-2361
9	Tucson International Airport Area - Site 4, 5, 6	AZ	1998	Chromium Cadmium	Operational	Sean Hogan 415-744-2334
9	Selma Pressure Treating	CA	1988	Pentachlorophenol (PCP) Dioxin Copper Chromium Arsenic	Operational	Michelle Lau 415-744-2227
9	Rhone-Poulenc/Zoecon	CA	1992	Arsenic Selenium Lead Cadmium	Completed	Rose Marie Caraway 415-744-2231
9	Sacramento Army Depot	CA	1993	Lead Arsenic Cadmium	Completed	Xaun-Mai Tran 415-744-2386
9	Mather Air Force Base - OU 04 (86&87)	CA	1998	Lead	Completed	Kathleen Salyer 415-744-2214
9	J.H. Baxter	CA	1998	Arsenic	Designed/ Not Installed	Travis Cain 415-744-2341 Beatriz Bofill 415-744-2235
10	Arctic Surplus	AK	1995	Lead Polychlorinated biphenyls (PCBs)	Predesign	Neil Thompson 206-553-7177
10	Standard Steel And Metal Salvage Yard, (USDOT)	AK	1996	Polychlorinated biphenyls (PCBs) Lead	Completed	Christopher Cora 206-553-1148
10	Pacific Hide & Fur Recycling	ID	1988	Polychlorinated biphenyls (PCBs) Lead	Completed	Neil Thompson 206-553-7177

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Region	Site Name	State	ROD Year	Contaminants	Project Status	Project Manager
10	Idaho National Engineering Laboratory - Power Burst Facility, OU 13	ID	1995	Cesium Chromium	Completed	Keith A. Rose 206-553-7721 Allan Jines 208-526-7524
10	Gould, Inc.	OR	1988	Lead	Completed	Chip Humphrey 503-326-2678
10	Teledyne Wah Chang	OR	1990	Polychlorinated biphenyls (PCBs) Radium sludge Thorium Uranium Volatile organic compounds (VOCs) Heavy metals	Completed	Kevin Rochlin 206-553-2106
10	Umatilla Chemical Depot (Lagoons) - OU 1	OR	1993	Lead	Completed	Harry D. Craig 503-326-3689
10	Umatilla Chemical Depot (Lagoons) - OU 4	OR	1994	Lead	Completed	Harry D. Craig 503-326-3689
10	Umatilla Chemical Depot (Lagoons) - OU 6	OR	1994	Lead Cyclotetramethylene tetranitramine (HMX) Cadmium Barium 2,4,6-Trinitrotoluene (TNT) RDX Trinitrobenzene (TNB)	Operational	Harry D. Craig 503-326-3689
10	Commencement Bay, Nearshore/Tideflats - OU 3, Tacoma Tar Pits	WA	1988	Cadmium Arsenic Polyaromatic hydrocarbons (PAHs) Acids Copper Lead Zinc Polychlorinated biphenyls (PCBs)	Completed	Lee Marshall 206-553-2723
10	Pacific Car And Foundry	WA	1992	Diesel fuel Chromium Polyaromatic hydrocarbons (PAHs) Total petroleum hydrocarbons (TPH) Lead Arsenic Polychlorinated biphenyls (PCBs)	Completed	David South 415-649-7200 Lynda Priddy 206-553-1987 Bob Butler 425-468-7435
10	Commencement Bay, South Tacoma Field	WA	1994	Lead Copper Arsenic	Completed	Cami Grandinetti 206-553-8696
10	Wyckoff/Eagle Harbor - West Harbor OU (Amendment)	WA	1996	Mercury Antimony Arsenic Copper Lead Zinc	Completed	Ellen Hale 206-553-1215

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