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U.S. Environmental Protection Agency

Office of Solid Waste and Emergency Response

Office of Research and Development

BIOREMEDIATION

IN THE FIELD

An information update on applying bioremediation to site clean-up.

UPDATE ON THE BIOREMEDIATION FIELD INITIATIVE

The Bioremediation Field Initiative was established to provide EPA and State Project Managers, consulting engineers and industry with timely information regarding new developments in the application of bioremediation at hazardous waste sites. The initiative will fully evaluate the performance of selected full-scale field applications, provide technical assistance to RPMs and OSCs, and develop a treatability database to be available through the Alternative Treatment Technologies Information Center (ATTIC).

Six sites have currently been selected for field evaluation of bioremediation: Libby Superfund Site, Libby, Montana; Park City Pipeline Spill, Park City, Kansas; Allied Signal Superfund Site, St. Joseph, Michigan; Eielson Air Force Base, Alaska; Hill Air Force Base, Utah; and Brookhaven Superfund Site, Brookhaven, MS.

A work plan for the field evaluation of the Libby Site has been agreed upon by EPA, Utah State University and the Responsible Party for the Libby Site and the evaluation is currently in process. See page two for an update on current evaluation activities.

A site characterization has been completed at the Park City Pipeline Site in support of the design of the field evaluation. Start-up of field evaluation activities is anticipated by late summer.

A work plan for the Allied Signal Site is currently in preparation.

Two Air Force sites have been recently added to the bioremediation field evaluations, thanks to the Air Force's interest in and support of innovative remediation technologies. The two sites involve bioventing projects of JP-4 jet fuel and will be evaluated by EPA's Risk Reduction Engineering Laboratory in Cincinnati, Ohio. An update on plans for these two sites is provided in the following article.

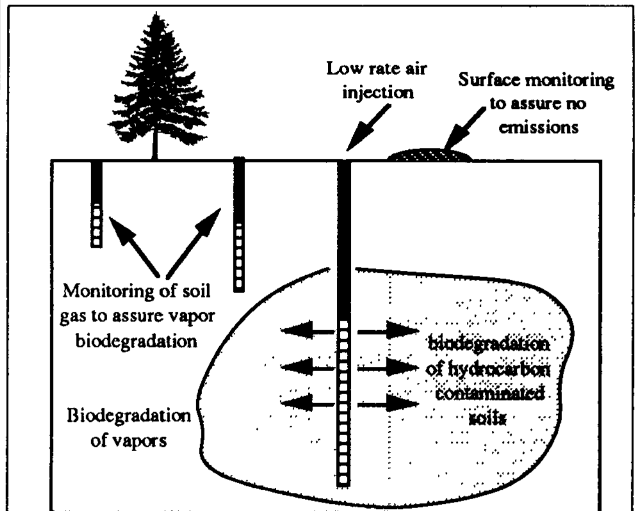
A work plan is being finalized for the Brookhaven site, with start-up scheduled for September 15.

Other bioremediation sites are still being screened as candidates for field evaluation.

TWO JET FUEL CLEANUP EVALUATIONS UNDER BIOREMEDIATION FIELD INITIATIVE

Two in-situ bioremediation projects, cooperative ventures with the U.S. Air Force, were begun in July 1991 under the supervision of the Risk Reduction Engineering Laboratory (RREL) in Cincinnati, Ohio. Both projects involve the bioremediation of JP-4 jet fuel contaminated soil. One project, taking place at Eielson Air Force Base (AFB) near Fairbanks, Alaska, involves JP-4 cleanup of a shallow (5-7 ft) vadose zone in an extremely cold climate. The other project involves JP-4 contamination extending to a depth of nearly 100 ft below the surface at Hill AFB, just north of Salt Lake City, Utah.

Bioventing is a process of injecting air into contaminated soil at rates low enough to increase soil oxygen concentrations and stimulate enhanced indigenous microbial activity without inducing surface release of volatile emissions. Previous work conducted by the Air Force at Hill and Tyndall AFBs indicated that bioventing can be an effective technique for bioremediating the hydrocarbons introduced to soil in jet fuel spills. A conceptual layout of a low-intensity bioventing installation is shown below.



Conceptual Diagram of Low Intensity Bioventing

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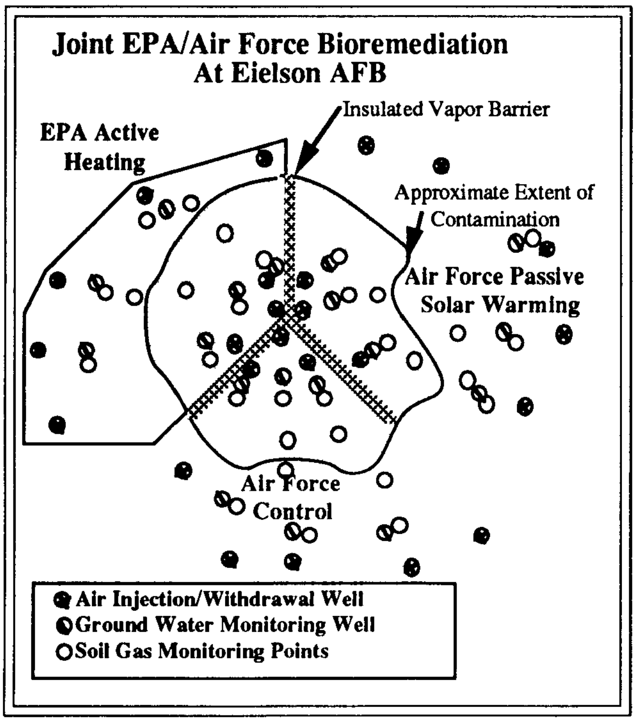
Bioventing is being utilized at both Eielson and Hill AFBs as the remediation technology. At Eielson, a one acre contaminated area has been roughly divided into thirds as shown below. The Air Force will conduct bioventing investigations at ambient temperatures (i.e., no soil warming) in one of the segments and with passive solar warming via the use of insulation tarps in a second segment. In the third segment, EPA will sponsor a study to actively increase soil temperature to enhance bioremediation rates. The temperature will be elevated by circulating ground water through an electric heater and then reapplying the heated water below the ground surface to the contaminated vadose zone. Bioremediation performance will be compared over time between the two forms of soil warming and the non-warmed control plot. The three segments have been isolated from each other with insulated vapor barriers. It is anticipated that active soil warming on the EPA project component will be able to increase annual average soil temperature from -2°C to 20°C.



At Hill AFB, a bioventing operation was begun in January 1991 on JP-4 contaminated soil. EPA has installed additional wells (July 1991) to monitor bioremediation performance over time in different parts of the contaminated zone. EPA will evaluate performance at three different air injection flow rates. A major task of the joint project is to effectively monitor bioremediation performances over the entire 100-ft depth of the contaminated vadose zone.

In addition to periodic analysis of soil boring samples, cleanup progress at the two sites will be monitored using a variety of routine soil gas analyses, in-situ respiration tests, and tracer tests. Both projects are scheduled to run through September 1993. Annual progress reports will permit periodic presentation of interim results in this bulletin and other technology information documents. For further information, contact Dick Brenner at (513) 569-7657, or FTS 684-7657

RSKERL EVALUATES BIOREMEDIATION AT LIBBY SUPERFUND SITE

The Champion International Superfund Site in Libby, Montana (Libby Site) is being evaluated as part of the bioremediation field initiative by the Robert S. Kerr Environmental Research Laboratory (RSKERL). Champion International agreed to cooperate with the RSKERL in carrying out the proposed performance evaluation studies for the three types of biological treatment processes in operation at the site. The RSKERL entered into an agreement with Utah State University (USU) under a subcontract with Dynamac Corporation, on-site support contractor for RSKERL's Subsurface Fate and Transport Technology Support Center, to carry out the project under the direction of Dr. Ronald C. Sims, Director of the Environmental Engineering Program at USU.

Implementation of the bioremediation field evaluation project at the Libby Site involves two phases of activities. Phase I, which is nearing completion, involves: 1) summarizing previous/current site bioremediation activities; 2) identifying critical site characterization and treatment parameters important to evaluation of performance of each of the three biological treatment units; 3) evaluating field performance based on available design, operational and monitoring information; and 4) designing a Phase II study plan, including a sampling/analytical plan required to supplement currently available information. Phase II, which recently has been initiated, involves implementing a field evaluation study designed to fill information gaps identified in Phase I.

The Libby Site performance evaluation project addresses three distinct biological treatment processes: 1) surface soil bioremediation in a lined, prepared-bed land treatment unit (LTU); 2) oil-water separation of extracted ground water preceding aqueous phase treatment in an above-ground, fixed-film bioreactor; and 3) in situ bioremediation of the upper aquifer. Each treatment process is being addressed with regard to design, operational, monitoring and performance activities.

Two types of wood treating processes were used at the Libby Site: penta (pentachlorophenol in a fuel oil carrier) and creosote. Polycyclic aromatic hydrocarbons (PAHs), the major contaminants of concern, are generally associated with the soil phase, primarily through the process of adsorption. Contaminated soils from three primary source areas (tank farm, butt dip and waste pit) have been excavated and moved to one central location (waste pit). These soils are pretreated in the waste pit area, then further treated in the LTU. Planned activities associated with the field initiative are: l) statistical sampling of the LTU, 2) field scale treatment kinetics, 3) toxicity reduction, 4) clean-up levels achieved, 5) influence of moisture and soil structure, and 6) mass balance of contaminants by soil and leachate.

Statistical sampling has begun with a field visit on May 6 and 7 by USU to collect samples from the two lifts that were applied in the Land Treatment Unit (LTU) in 1990. Five hundred milliliter soil samples were collected at 32 locations from 0 - 9 inches in depth and 9 - 18 inches in depth. A new lift was applied on May 8 and 32 additional samples were collected from this new lift. The lifts were resampled on June 27 at three depths at the 32 locations. Additional samples will be taken until temperature changes begin to limit the amount of biotic activity.

The upper aquifer above-ground treatment unit provides for separation of LNAPL and DNAPL from extracted ground water and for subsequent biological treatment via the fixed film reactors that will be operated in series. The first reactor is for roughing purposes while the second is for polishing and reoxygenation of the effluent prior to reinjection through the infiltration gallery. Planned activities include: 1) flow composited sampling, 2) evaluation and prediction of reactor performance, 3) analysis of biofilm dynamics, 4) mass balance of contaminants, and 5) treatment optimization. The in-situ bioremediation system involves addition of hydrogen peroxide and inorganic nutrients to stimulate growth of contaminant-specific microbes. Planned activities include: 1) dissolved oxygen profiles, 2) aquifer material sampling to distinguish abiotic and biotic effects, 3) dissolved oxygen uptake evaluation and correlation to the rate of biodegadation, and 4) toxicity reduction.

For further information contact Bert Bledsoe or John

BIOREMEDIATION USED TO TREAT COAST GUARD AVIATION FUEL SPILLS

The efficacy and relative costs of three distinctly different approaches for bioremediation of fuel spills have been evaluated at a U.S. Coast Guard Air Station in Traverse City, Michigan. The water table aquifer underlying the Air Station is in a medium grained sand. The ground water is relatively hard, the pH is near neutral and the water is cold (10 to 12°C). Two large plumes emanate from an aviation gasoline spill and a jet fuel spill. The plumes are captured by a purge well field, treated through activated carbon, then discharged to a sanitary sewer.

A portion of the spill of aviation gasoline was remediated using conventional practice with hydrogen peroxide, a portion of the spill of JP-4 jet fuel was remediated using an innovative technology that supplied nitrate as an electron acceptor for microbial metabolism, and another portion of the aviation gasoline spill was remediated through bioventing.

In the peroxide demonstration, ground water was amended with 500 to 1000 mg/L hydrogen peroxide, 380 mg/L ammonium chloride, 100 mg/L disodium phosphate, and 190 mg/L potassium phosphate.

Table 1

Comparison of Performance Evaluations for In-Situ Bioremediation of Fuel Spills, Traverse City, MI

	Hydrogen Peroxide For Aviation Gasoline	Nitrate For JP-4 Jet Fuel	Bioventing For Aviation gasoline
SIZE OF DEMONSTRATION			
Cubic meters of contaminated earth in demonstration area	200	235	354
Liters of fuel in demonstration area	3,200	2,500	83
REMEDIATION ACCOMPLISHED			
Benzene in ground water	<0.1 ug/L	<0.1 ug/L	<5 ug/L
Residual Fuel	>700 mg/kg 60% removed	>2, 700 mg/kg 25% removed	>1,000 mg/kg 60% removed
Vapor Emissions	<10 ug/L	<10 ug/L	<1 ug/L
Time Expended	18 months	6 months	4 months

Ground water in the nitrate demonstration was amended with 44 mg/L nitrate, 20 mg/L ammonium chloride, 10 mg/L disodium phosphate, and 10 mg/L potassium phosphate. Bioventing was applied to an area of the aviation gasoline spill where most of the fuel was trapped in the capillary fringe above the water table. Two configurations were evaluated. In the simplest configuration, air was simply injected across the fuel contaminated interval. In the second configuration, air was injected across the contaminated interval, recovered in a second pipe, then reinjected at mid depth in the unsaturated zone. The rate of injection allowed 8 to 24 hours residence in the unsaturated zone before the air was vented to the atmosphere.

All three technologies successfully reduced the concentration of carcinogenic alkylbenzenes in ground water below Federal Drinking Water Standards (Table 1), and air emissions from the demonstrations were acceptable, however none of the technologies reached Total Petroleum Hydrocarbon Standards (eg., 10 to 100 mg/kg) commonly required for underground storage tank cleanups.

Contrary to the general perception, bioremediation was expensive at this particular site (Table 2), although bioventing is very cost competitive compared to the other techniques.

The demonstration will continue until December 1991, and the Coast Guard plans to go to full scale with a system of hybrid wells that can be used to deliver nitrate and peroxide when the water table is high, and used for bioventing when the water table is low. This design is due to the seasonal variability of the depth to the water table. There is a reasonable chance that bioventing with the hybrid system will reduce total petroleum hydrocarbons below 100 mg/kg by the end of the project period.

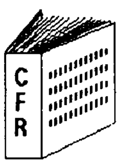
For further information contact John Wilson at FTS: 743-2259 or (405)-332-8800

Table 2

Cost Comparison for In-situ Bioremediation of Fuel Spills, Traverse City, MI.

	Hydrogen Peroxide	Nitrate	Bioventing
(Total Costs, $ per cubic meter of contaminated earth)			
Construction*	45.0	118.0	26.0
Labor/ Monitoring	72.0	96.0	40.0
Chemicals	500.0	30 0	0.44
Electricity	24.0	12.0	6.8
Total	641.0	256.0	73.0
(Operating Costs, $ per cubic meter per month)			
Labor Monitoring	4.0	9.6	10.0
Chemicals	28.0	3.0	0.1
Electricity	1.3	1.2	1.7
Monthly Total	33.0	14.0	12.0

* Prorated to a five year service life on buildings, pumps, and blowers.
Figures for bioventing only reflect the first four months of an ongoing demonstration.



Use of a No Migration Petition for Land Disposal Prohibitions at the Libby Superfund Site

The U.S. EPA, Region VIII, Montana Operations Office approved a No Migration Variance to the Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions (LDR) in October 1990. The petition applies to the Land Treatment Unit (LTU) located on the Champion International property in Libby, Montana. The LTU is part of the selected remedial action for the contaminated soil at the Libby Groundwater Superfund Site.

A remedial action was selected for the Libby Superfund Site in a December 1988 ROD. The response action for contaminated soils includes excavation and placement of soils into a lined land treatment unit. Treatment consists of enhanced biodegradation of the contaminants and the treatment unit will act as the final disposition location. The selected remedy stated that a federal requirement, the RCRA Land Disposal Restrictions (40 CFR Part 268 and RCRA Section 3004 (d), (e), and (g)), must be complied with during the cleanup activities.

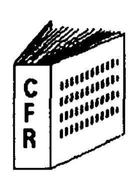
According to EPA LDRs for First Third Scheduled Wastes, land disposal of RCRA K001 wastes is prohibited after August 8, 1988, unless certain maximum concentration levels are met prior to land disposal. Because bottom sediment sludge from treatment of waste water from wood preserving processes containing creosote and/or pentachlorophenol are present at the waste pit area at Libby, and these are considered K001 wastes, this restriction is considered applicable to Libby, after August 8, 1990 (40 CFR Section 268.33 (c)). Field tests of the remedy for soils treatment show that contaminants are above the maximum concentration limits, but can be reduced to below best demonstrated available technology (BDAT) concentrations for all currently regulated K001 compounds, after the land disposal and treatment.

Placement of contaminated soils into the land treatment unit will occur after the August 8, 1990 deadline, and therefore land disposal restrictions are applicable for the Libby site. A No Migration Variance is a formal decision that can be rendered by EPA to allow the land disposal at a particular facility of specific, prohibited wastes not meeting the treatment standards established by EPA. The statutory language requires anyone pursuing a No Migration Variance to demonstrate "to a reasonable degree of certainty that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous." EPA codified this language on November 7, 1986 (40 CFR 268.6). EPA has interpreted the statutory language to mean that it must be demonstrated, to a reasonable degree of certainty, that hazardous constituents will not exceed Agency-approved human health-based levels (or environmentally protective levels, if they are appropriate) beyond the boundary of the disposal unit.

EPA anticipated the need for No Migration Variance and approved construction of a Land Treatment Demonstration Unit (LTDU), April 1989, to assess the possibility of migration of contaminants from the unit during the treatment processes. The LTDU was operated above an engineered liner and leachate collection system and an evaluation was conducted of air, soil, surface water, leachate and groundwater. The data collected were analyzed and presented to EPA by the PRP in the No Migration Variance Report.

According to current agency policy, CERCLA review and approval of No Migration Variances is conducted by the Regional offices. Site information to demonstrate no migration of contaminants from the unit boundary was presented to EPA in a draft petition February 1990. The petition was reviewed by EPA, Montana Operations Office, Superfund Branch, EPA's oversight contractor, and the Montana Department of Health and Environmental Services. Meetings were held with Champion International and written comments were provided. A revised Final Petition and a written response to comments were submitted to EPA September 1990. In addition to the review process, EPA announced its intention to grant a No Migration Variance with a 30 day public comment period. Final approval for the petition was given by the Regional Administrator October 1990

Use of the No Migration Variance was an effective means for meeting the RCRA LDRs for a land treatment unit using bioremediation. The factors which contributed to the success of the approval of the petition included anticipation of the need for a variance in the ROD, use of a demonstration unit to collect data to assess whether migration of contaminants would occur, and open dialogue and review between the PRP and EPA.



RESEARCH AND DEVELOPMENT PERMITTING FOR BIOREMEDIATION UNDER TSCA

EPA's PCB disposal permitting program began with the passage of the Toxic Substances Control Act (TSCA) in 1976. TSCA Section 6(e) required that PCBs be disposed of and that the disposal be approved by EPA officials.

Although a TSCA permit can be issued for bioremediation as an alternative technology to incineration, crafting a commercial operating permit for a bioremediation process presents a substantial challenge. In order to write a permit for bioremediation as an alternate disposal method, EPA must make the finding that the process not only destroys PCBs, but produces no toxic by-products or toxic emissions, and that any microorganisms used as inoculum pose no unreasonable risk to human health or the environment.

In the original PCB disposal regulations, EPA Regional Administrators were given sole authority to approve PCB disposal facilities. Since 1983, PCB disposal approvals have been issued by each of the ten Regions and by Headquarters. The Regions enforce compliance by companies whether TSCA approvals are issued by Headquarters or by the Region. Headquarters permits are valid anywhere in the United States, and most are for disposal technology alternatives to incineration that involve destruction of PCBs in transformer oils and in other oils.

EPA issues two types of PCB disposal permits, the Commercial Operating permit and the Research and Development (R&D) permit. If a technology is relatively new(e.g., bioremediation), and has never been used to destroy hazardous wastes, a company may be asked to apply for an R&D permit to obtain data of known quality to properly evaluate the technology. Regional R&D permits, under the PCB regulations, involve small scale laboratory research on less than 500 pounds of material. Headquarters permits involve research on more than 500 pounds of material.

Applying for a PCB disposal permit is a multi-step process. The permit application must contain a complete and acceptable written description of the permitted activities. This includes: the material to be treated; the concentration of PCBs in the material; the location of the activities; the equipment operators; parties responsible for operations; and the closure plan.

The length of time from permit application to permit issuance should take less than one year, but varies with the permitting authority. When the permitting authority is EPA Headquarters, a draft PCB disposal permit is written as soon as the permit application is acceptable. The length of time from permit application to draft permit can take from three to six months. The time from draft to issuance depends on conditions at the location of activities.

At the time of this writing, 16 permits had been issued under TSCA by both the EPA Regions and EPA Headquarters for the bioremediation of PCBs. All permits, except one, were for R&D.

Six of the current TSCA R&D permits were issued by EPA Headquarters for pilot scale and in-situ research on bioremediation of PCBs in soils and sediments. Research on in-situ remediation of PCBs in river sediments is of particular interest because it neatly solves many problems, both economic and aesthetic, associated with dredging and incineration. On May 14, 1991, General Electric (GE) was granted an R&D development approval by EPA Headquarters to conduct R&D on bioremediation of PCBs in-situ in sediments in the upper Hudson River in Saratoga County, New York. On July 23, 1990, an R&D permit was issued to GE by EPA Headquarters for a similar in-situ facility to be located in Woods Pond, Massachusetts on the Housatonic River. While the design of both facilities is similar, the factors affecting anaerobic degradation of PCBs in river sediments will be studied in the Woods Pond facility, and the factors affecting aerobic degradation of PCBs in river sediments will be studied in the Hudson River facility.

In addition, EPA Headquarters has issued four other TSCA bioremediation permits. In May of 1991, Texas Eastern was granted approval to conduct R&D on a pilot scale on a biodegradation process to treat soils containing PCBs at a compressor station site at St. Francisville, LA. In 1988, the first Headquarters R&D permit was issued to Safetec, an Australian Company, to remediate PCBs in soil with white rot fungus at a Richfield, Utah site.

Other Headquarters TSCA R&D permits were issued to International Technologies Corporation, for a process that uses UV light and bioremediation to clean-up PCBs in soils, and to GE, for use of a bioreactor to treat PCBs in soils and sediments. Except for Safetec (now Pacificorp), all bioremediation processes permitted from EPA Headquarters are in the initial stages, and none have yet produced any conclusive data. While bioremediation shows great promise, it has yet to be demonstrated that it can be used successfully on a large scale for remediation of PCBs in the environment.

For further information on bioremediation of PCBs or on PCB Disposal Permitting, contact Joan Blake FTS 382-6236 or (202) 382-6236.

TREATABILITY EXCLUSION AND RESEARCH, DEVELOPMENT AND DEMONSTRATION PERMITS UNDER RCRA

EPA's RCRA permitting program provides different opportunities to do treatability studies pertaining to biotechnology. The regulated activities range from bench scale studies to pilot scale treatability demonstrations.

The Treatability Exclusion Rule (40 CFR 261.4(e)) was promulgated on July 19, 1988, as a RCRA exemption for small scale treatability studies (53 FR 27290). The rule allows for the generation or collection of samples and standards for treatability studies for 1 kg of acute hazardous waste, 250 kg of soils, water or debris contaminated with acute hazardous waste, and 1000 kg of non-acute hazardous wastes. A request for an additional 500 kg of non-acute hazardous waste and 250 kg of soils, water or debris contaminated with acute hazardous waste and 1 kg of acute hazardous waste may be granted by the Regional Administrator or State Director (in an authorized State). For the purpose of treatability studies, neither the RCRA regulatory requirements pertaining to listing, generating and transporting hazardous waste (40 CFR Parts 261 through 263), nor the notification requirements of Section 3010, are required. However, the transportation of each sample shipment must comply with U. S. Department of Transportation, U. S. Postal Service, or any other applicable shipping requirements. Facilities must comply with recordkeeping requirements and the Agency or State may conduct inspections. The laboratory or testing facility conducting the treatability study must have an EPA ID Number. No more than 250 kg of an "as received" hazardous waste can be subjected to initiation of treatment in all treatability studies conducted in a single day. Unused samples and residues from a treatability study must still be managed as a hazardous waste.

The Treatability Exclusion Rule can be implemented by the Regions in those States that do not have final RCRA authorization. In a RCRA authorized State, this regulation will not be applicable until the State revises its program to adopt equivalent regulations under State law and is granted authorization by EPA. As of August 1, 1991, four States have been granted treatability exclusion authorization: Connecticut, Georgia, Mississippi and Ohio. Minnesota is pending final authorization with an Immediate Final Rule Federal Register Notice.

RCRA Research Development and Demonstration (RD&D) Permits (40 CFR 270. 65) can apply to a pilot scale study. Since these regulations are optional , States are not required to become authorized for them, however, RD&D permits can be issued by a Region in an unauthorized consenting State. This RD &D permit may require dual administrative permit procedures for both a Federal and State permit.

The RCRA RD&D permits were created to develop and demonstrate treatment technologies, and were not intended to treat or cleanup a whole unit. RD&D permits may be issued by the Regional Administrator or State Director (in an authorized State). For the purpose of expediting review and issuance of RD&D permits, the Regional Administrator may modify or waive permit applications and permit issuance requirements; however, statutory requirements and regulations pertaining to procedures regarding public participation and financial responsibility (including insurance) may not be waived or modified, and may be costly and time consuming to implement.

The RD&D permit provides for the construction of the facility and its operation for no longer than one year unless the permit is renewed. A permit may not be renewed more than three times. The one year time frame pertains to the days of operation. Therefore, if a facility is in operation for seven days in a month, only the seven days and not a month are accrued to the total days of operation.

As of August 1, 1991, thirteen states have been authorized for RD&D permitting authority: Colorado, Connecticut, Georgia, Idaho, Illinois, Michigan, Minnesota, North Dakota, Nebraska, New Mexico, South Dakota, Texas and Utah.

Subpart X ("Miscellaneous Units," 40 CFR 264.600) provides another avenue for issuing RCRA permits to the diverse universe of innovative technologies. The preamble to the Subpart X regulations (52 FR 46961) describes this policy and discusses acceptable Subpart X permitting options for a multi-stage demonstration project, where the outcome of one stage may radically change the subsequent stage, as is common in testing an innovative technology. Subpart X, therefore, can be used as a complement to the RD&D permit program. As of August 1, 1991, 8 States have been authorized for Subpart X permitting authority: Colorado, Georgia, Minnesota, Mississippi, New Mexico, North Carolina, Ohio and Oklahoma.

Treatability variances may be granted to a facility for which the Land Disposal Restrictions' Best Demonstrated Available Technologies standards (BDAT standards were based on data from the treatment of industrial process wastes) for that waste can not be achieved. Recently, the authority to grant a presumptive site specific treatability variance for contaminated soils and debris has been delegated to the Region. These variances may prove to be extremely useful in implementing bioremediation activities in the RCRA Corrective Action Program.

In the Corrective Action Program, the facility and EPA, in collaboration with the State, can implement a variance for onsite demonstrations through two mechanisms: Temporary authorization under the Permit Modification Rule, or 3008(h) orders for interim-status facilities.

Temporary authorizations may be granted for up to 180 days to initiate or complete certain activities, such as corrective actions and closures. These activities must conform with the applicable waste management regulations. The facility must notify the public within seven days of making the request.

A facility may renew a temporary authorization only by requesting a permit modification. There would be either a public hearing or public meeting, in addition to a public comment period.

Section 3008(h) of RCRA allows EPA to issue an order requiring corrective action at an interim status facility where there is evidence of a release of hazardous waste or constituent into the environment.

For further information, contact Michael Forlini, TIO, (703) 308-8825 or FTS 398-8825

EPA Bioremediation Publications

The Federal Technology Transfer Act: Opportunities for Cooperative Biosystems Research and Developement with the U.S. EPA (CERI-90-114)

A Field Evaluation of Bioremediation of a Fuel Spill Using Hydrogen Peroxide (NTISPB88-130257)

Bioremediation of Hazardous Waste (EPA/600/9-90/041)

Bioremediation of Contaminated Surface Soil (NTIS PB90-164047)

Enhanced Bioremediation Utilizing Hydrogen Peroxide as a Supplemental Source of Oxygen (NTIS PB90-183435).

Interactive Simulation of the Fate of Hazardous Chemicals During Land Treatment of Oily Wastes: Ritz User's Guide (NTIS PB88-195540)

In Situ Bioremediation of Spills from Underground Storage Tanks (NTIS PB89-219976)

Microbial Decomposition of Chlorinated Aromatic Compounds (EPA/600/S2-90/018)

Removal of Volatile Aliphatic Hydrocarbons in a Soil Bioreactor (NTIS PB88-170568)

Transformation of Halogenated Aliphatic Compounds (NTIS PB88-249859)

Understanding Bioremediation: A Guide Book for Citizens (EPA 540/2-91/002)

For EPA documents call (513) 569-7562 or FTS 684-7562
For NTIS documents call 1-800-553-6847

Bioremediation Field Initiative Contact

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CERCLA/RCRA/UST SITES PLANNING, OPERATING, OR CONSIDERING BIOREMEDIATION

REG	SITE/ LOCATION/ LEAD	CONTACT/ PHONE NUMBER	MEDIA/ CONTAMINANT	STATUS	CLEAN-UP LEVELS	TREATMENT	PROBLEMS
I	Baird & McGuire* Holbrook, MA CERCLA Fund Lead	Paula Fitzsimmons (617) 573-5738 (FTS) 833-1738	Ground water: Pesticides (chlordane), dioxin, arsenic. Volume: 200 gpm	Installation: Full-scale. Remediation start: June 1990. Remediation completion: January 1992.	Ground water: MCLs	Ground water: Slurry-phase bioremediation (bioreactor) and chemical extraction. Soil: Incineration	None
I	Charles George Landfill* Tinsboro, MA CERCLA Fund Lead	Dave Dickerson (617) 573-5738	Ground water: Pesticides (chlordane), dioxin, arsenic. Volume: ultimately, 30 gpm ground water and leachate.	Pre-design: Pilot-scale. Remediation expected start: 1994. Remediation expected completion: 2020.	Ground water: Arsenic, 30 ug/l; benzene, 5 ug/l	Activated sludge with metals precipitation; activated carbon and inorganic polishing being considered	None
I	Charlestown Navy Yard* Boston NHP National Park Service Boston, MA CERCLA State Lead	Stephen Carlson (617) 242-5680	Creosote/sediments: PAHs.	In-design Laboratory scale. Planning pilot scale for FY'91.	Not yet established	Aerobic attached growth process, anaerobic attached growth process, and in-situ bioremediation	None
I	Coakley Landfill** North Hampton, NH CERCLA Enforcement Lead	Steve Calder (617) 573-9626 Dan Coughlin (617) 573-9620	Groundwater Ammonia, BOD. Volume: 100 gallons per hour	Pre-design. Remediation expected start 1994. Remediation expected completion: 2000.	NH3, Biotreatment used only to meet NPDES requirements	Biotreatment. Other technologies Treatment train (metal precipitation, air stripping)	None
I	General Electric (Woods Pond)* Pittsfield, MA RCRA Lead (Federal)	Joan Blake (202) 382-6236 (FTS) 382-6236	Pond/river sediments: PCBs. Volume: 250 gallons of sediment and water.	Operational: Pilot scale since May 1991.	2ppm per peak	In-situ bioremediation: with 2-3 years of sediment where flotation separation is permitted; Other technologies: incineration	None
I	General Electric* Pittsfield, MA TSCA Lead (Federal)	Joan Blake (202) 382-6236 (FTS) 382-6236	Soil and river sediments: PCMs. Volume: 12 per batch.	Operational: Pilot scale since November 1, 1990. RCRA corrective action.	2ppm per peak	Slurry-phase bioremediation; Other technologies: incineration	None
I	Hamilton Standard Windsor Locks, CT RCRA Lead	Gina Snyder (617) 573-9674 (FTS) 833-1874	Soil: PCBs, Petroleum hydrocarbons.	Planning to conduct treatability studies in FY'91.	Not yet established	In-situ bioremediation	None
I	Iron Horse Park* Billerica, MA CERCLA Enforcement Lead	Don McElroy (617) 223-5518 (FTS) 833-1518	Soil/sludges: Petroleum hydrocarbons. Volume: 20K+ cu. yd.	In-design stage: to be completed by Summer 1991. Treatability studies completed.	PAH, 60-80% removal or less than 1ppm; PHCs, 50-60% removal; nC17/pristane ratio ≤ 0.2	Solid-phase bioremediation: excavate to treatment cell-surface treatment, land farming within treatment cell-optimizing natural microbes	Effective operation occurs only in warm seasons.
I	Pine Street Canal* Burlington, VT CERCLA Fund Lead	Ross Gilleland (617) 573-5766 (FTS) 833-1766	Ground water/Soils/ Sediments: PAHs, VOCs, BTX, Cyanide. Volume: 100,000 cu. yd. to 800,000 cu. yd.	In-design. Laboratory-scale. Started July 1990 and completed May 1991	Not yet established	Soil: In-situ bioremediation and solvent extraction. Groundwater: Aerobic attached growth process (fixed film reactor). Other technologies: solidification, incineration, oil/water separation, metals removal by slag, carbon adsorption	None
I	Sylvester* Nashua, NH CERCLA State Lead	Chet Janowski (617) 573-9623 (FTS) 833-1623	Ground water: Phenols, MEK, acetone, toluene, benzene, vinyl chloride, chloroform. Volume (ground water): 3,000 gpm by air stripping, 50 gpm by activated sludge.	Operational: Full-scale. Remediation start: June 1986. Remediation expected completion: July 1994. Costs: $2.5 million per year.	State of NH drinking studies	Slurry-phase bioreactor by activated sludge with extended aeration; Other Technologies: vacuum extraction	None

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CERCLA/RCRA/UST SITES PLANNING, OPERATING, OR CONSIDERING BIOREMEDIATION

REG	SITE/ LOCATION/ LEAD	CONTACT/ PHONE NUMBER	MEDIA/ CONTAMINANT	STATUS	CLEAN-UP LEVELS	TREATMENT	PROBLEMS
II	Alcoa Massena, NY CERCLA Enforcement Lead	Lisa Carson (212) 264-6857 (FTS) 264-68857	River sediments: PCBs	Pre-design Currently in RI stage.	Not yet established	Undetermined may consider bioremediation	None
II	American Linen* Stillwater, NY CERCLA Enforcement Lead	Frank Peduto NYSDEC (518) 457-2462	Soil: BTX, PAHs, VOCs, VTX Volume: 4375 cu yd	Operational Full-scale Start: July 1990. Expected Completion: Fall '92. Bioremediation of first lift section complete; preparation beginning for second lift.	TCLP extract compared to meet groundwater standards	Solid-phase bioremediation. 100% of site under bioremediation	Odor detection level was a concern due to the leaking of semi-volatiles, however the odors are no longer present and are under control.
II	FAA Technical Center*, Atlantic County, NJ CERCLA Enforcement Lead	Carla Struble (212) 264-4595 (FTS) 264-4595	Soil/ground water/floating product: JP-4 jet fuel, BTEX-Napthalene, phenols Volume 360,000 gals of free product Volume(soil): 33,000 cu yd	In-design Laboratory scale Capital cost: $286K. O&M cost $200K	NJ Soil Action Level, NJ MCLs for Drinking Water	In-situ bioremediation (free product extraction, cement kiln incineration, and addition of nutrients for subsequent reinjection); Soil venting: off-gas treatment with catalytic incinerator combustion or activated carbon absorption of VOCs	None
II	GEMS Landfill Camden County, NJ CERCLA State Lead	Matt Westgate (212) 264-3406	Ground water/leachate. Various organic and inorganic compounds	Design Phase I (Feasibility studies underway), Phase II (Construction of remedial action)	Not yet established	Phase I cap, Phase II: groundwater pre-treatment and disposal at publicly owned treatment works	None
II	General Electric* Hudson River TSCA Lead (Federal)	Jim Harrington/ Ajay Shroff NYSDEC (518) 457-3957 William Ports (518) 457-5677	River sediments. PCBs Volume: 150 cu. yd	Installation: Treatability Study (Expected start August 1991. Expected completion November 1991). Laboratory scale. Expected cost $2.6M	Not yet established	In-situ bioremediation	Dechlorination of PCBs
II	General Motors - Central Foundry Division* Massena, NY CERCLA Enforcement Lead	Lisa Carson (212) 264-6857 (FTS) 264-68857	Soil/ground water/sludge/sediment PCBs, PAHs, volatiles, phenols Volume: 350K cu. yd.	Treatability studies Laboratory-scale. Several full-scale treatments being considered Expected Start. Spring 1993	Soil 1-10ppm PCBs Sediment: 1 ppm PCBs Sediment on reservation. 0 1 ppm PCBs	Sequencing batch reactors, slurry phase bioremediation, Other Technologies: Chemical extraction and thermal desorption will be considered in the event that bioremediation is unsuccessful	Oil and grease in samples is hindering efficiency of bioremediation; Material may require pretreatment.
II	Kniopel Construction Site* Horseheads, NY UST Lead (State)	Frank Peduto (NYSDEC) (518) 457-2462	Soil/ground water: Gasoline, benzene. Site area: 200 ft2; Volume (ground water). 10 ft. shallow at 74 cu. yd	Completed October 1989. Cost: $250K+ with 1-4 years of pump and treat.	Drinking water standards	In-situ bioremediation; Other technologies: Pump and Treat	None
II	Mobile Terminal** Buffalo, NY CERCLA Enforcement Lead	Bob Leavy, Mike Hinton (716) 847-4590 Frank Peduto (NYSDEC) (518) 457-2462	Soil: BTEX, PAH, VOC Volume: 2 acre bioremediation cell, approximately 5K cu. yd. per treatment phase.	Operational Full-scale Started: August 1990	Soil: Benzene,1.5 ppb; Toluene, 37.5 ppb; Ethylbenzene,137.5 ppb, Xylenes, 30.0 ppb; VOC, 212.5 ppb. Ground water: Drinking water standard. Volume: 2 acre bioremediation cell, approximately 5,000 yd3 per treatment phase	Solid-phase bioremediation, 100% of site under bioremediation	None
II	Nascolite* Millville, NJ CERCLA Fund Lead	Farnaz Saghafi (212) 264-4665 (FTS) 264-4665 Kim O'Connell (FTS) 264-8127	Ground water/soil: Volatiles, methylmethacrylate, semi-volatiles. Volume: all underlying ground water under biotreatment.	Pre-design Treatability studies-soil completed September 1990 and ground water underway. Remediation expected Start. June 1994. Remediation expected completion: March 1996.	NJ interim soil action levels for methylmethacrylate; 5 ppm(surface soil); 50 ppm (subsurface soil); and 350 ppb (groundwater)	Soil: Aerobic attached growth process (extraction/solidification or soil washing), Groundwater: undetermined, but considering bioremediation	None

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II	Osmose* Buffalo, NY CERCLA State Lead	Jim Harrington/ Ajay Shroff NYSDEC (518) 457-3957	Soil: Creosote, fuel oil. Volume. 670 cu. yd.	Operational: Full-scale. Remediation start: September 1990 Expected costs: $125K.	Not yet established	Solid-phase bioremediation; 30% of site under bioremediation	None
II	Renora Inc.* Edison, NJ CERCLA Enforcement Lead	Joyce Harney (212) 264-6313 (FTS) 264-6313	Soil: PAHs, petroleum hydrocarbons.	Treatability study completed in January 1991. Phase II feasibility study in progress Incurred Cost: $129K	Soil: 10ppm PAHs, 100 ppm petroleum hydrocarbons	Solid-phase bioremediation, Slurry-phase bioremediation	Bioremediation ineffective for site.
II	Reynolds Metals Co * Massena, NY CERCLA Enforcement Lead	Lisa Carson (212) 264-6857 (FTS) 264-6857	Sediments PCBs Volume. 80K cu. yd	Pre-design RI/FS Stage. No treatability study under way	Not yet established	Undetermined. Considering bioremediation, chemical extraction, chemical treatment and thermal desorption.	Oil and grease in samples hindering efficiency of bioremediation Material may require pretreatment(s)
II	Syracuse* Syracuse, NY UST Lead (State)	Harry Warner (315) 426-7519	Soil: Petroleum hydrocarbons, jet fuel Volume· 5K-6K cu. yd.	Operational. Full scale. First Phase: Started July 1990 Completed Spring 1991. Second Phase: Started Spring 1991 Expected completion Fall 1991.	NY Soil Cleanup Levels	Solid-phase bioremediation. soil removal at other half of site	Late start for first phase, cold weather slowed use of bioremediation.
III	ARC* Gainesville, VA RCRA Lead (Federal)	Robert Stroud (215) 597-8214 (FTS) 597-8214	Soil: Chlorobenzene. Volume. 2K cu. yd.	Completed Full-scale Started October 1989. Completed June 1991	Not yet established	Bioaugmentation aboveground, volatize, 5% of site under this treatment. Other technologies pump and treat, soil shredding technology	None
III	Atlantic Wood* Portsmouth, VA CERCLA Enforcement Lead	Drew Lausch (215) 597-1727 (FTS) 597-1727	Soil/Sediments: PCP, PAH from wood preserving, dioxins (furans), heptaoxane.	Pre-design RI/FS on-going Laboratory-scale. ROD Second Quarter FY 1992.	Not yet established	Soil: Solid-phase bioremediation, in-situ bioremedation, white rot fungus Sediments Solid phase bioremediation	None
III	Avtex Fibers* Front Royal, VA CERCLA Enforcement Lead	Bonnie Gross (215) 597-9023 (FTS) 597-9023	Ground water: Arsenic, zinc, lead, carbon disulfide, hydrosulfide, phenol, cadmium	In-design Expected start 4th Quarter of 1992 Expected cost. $9 million	0.05 mg/l arsenic; 5 mg/l zinc, 0 05 mg/l lead, 0.7 mg/l carbon disulfide, 0 3 mg/l phenol, 0.01 mg/l cadmium; not established for hydro-sulfide	Biological and chemical waste water treatment	None
III	Drake Chemical* Lock Haven, PA CERCLA Fund Lead	Roy Schrock (215) 597-0517 (FTS) 597-0517	Soil/ground water Pesticides, DCE, fenac (herbacide).	Pre-design Laboratory-scale Start May 1991 Expected completion. September 1991.	MCLs	Aerobic attached growth BACT	None
III	L.A. Clarke & Son* VA CERCLA Enforcement Lead	Gene Wingert (215) 597-0517	Soil: Creosote Volume 119K cu. yd.	In-design· Pilot-scale. Started August 1991. Installation· 1992. Cost: $23 million for entire site.	10 ppm carcinogenic PAHs	Soil: In-situ bioremediation, Creosote recovery, soil flushing, 25% of site under bioremediation	None
III	Ordnance Works Disponsal Area WV CERCLA Enforcement Lead	Drew Lausch (215) 597-1727 (FTS) 597-1727	Soil: PAHs.	Currently conducting treatibility studies. Unilateral administrative order issued June 1990.	Carcinogenic PAHs, 45 ppm	Solid-phase bioremediation	None
III	Whitmore Labs Myerstown, PA CERCLA Fund Lead	Tony Dappolone (215) 597-3153 (FTS) 597-3153	Soil/ground water/sludges: Arsenic, aniline, still bottom wastes (only certain soils are targeted for bioremediation)	Limited treatability study completed June 1990.	Arsenic above backgound levels; Saturated soils (mg/kg): benzene, .002; trichloroethene .004, tetrachlorothene .012; aniline .002 ; Unsaturated soils (mg/kg): benzene .009; trichloroethene 017; tetrachloroethene .051; aniline .009	Biological treatment (treated soils will be disposed of offsite); clay and soil capping	None

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IV	Alabama State Docks* Mobile, AL RCRA Lead (Federal)/soil RCRA Lead (State)/ground water	Jason Darby (404) 347-3433 (FTS) 257-3433	Ground water/soil: PCP, creosote.	Pre-design: Full scale began December 1990.	Not yet established	Ground water: Aerobic attached growth process on creosote and in-situ bioremediation on both PCP and creosote. Soil: Solid-phase bioremediation. Slurry-phase bioremediation may be used if levels are low enough. 100% of the site under bioremediation.	Regulatory cleanup levels have not been determined.
IV	American Creosote Works* (O U. 1) Jackson, TN CERCLA Fund Lead	Tony DeAngelo (404) 347-7791 (FTS) 257-7791	Soil: Creosote. Volume. 50K+ cu. yd with 50K+ cu yd later	Completed by1991. Partial removal of sludges (creosote) and highly contaminated soils for off-site incineration has occurred	100 ppm for 6-8 indicators	Solid-phase bioremediation, Other technologies: Partial removal of sludges (creosote) and highly contaminated soils for off-site incineration has occurred.	Remedial action contingent upon receiving 10% cost share from State Funds available for treatability studies only.
IV	American Creosote Works* (O.U. 3) Jackson, TN CERCLA Fund Lead	Tony DeAngelo (404) 347-7791 (FTS) 257-7791	Soil: Creosote Volume· 50K+ cu yd with 50K+ cu yd later	Planning Partial removal of sludges (creosote) and highly contaminated soils for off-site incineration has occurred	100 ppm for 6-8 indicators	Solid-phase bioremediation dealing with process area contained soils and "fixed" creosote sludges in a large capped lagoon	Remedial action contingent upon receiving 10% cost share from State Funds available for treatability studies only.
IV	American Creosote Works* Pensacola, FL CERCLA Fund Lead	Madolyn Streng (404) 347-2643 Secondary Beverly Houston	Soil Creosote, PAHs, PCP, dioxin. Volume 20,000-20,000 cu. yd	In-design Laboratory-scale Remediation expected start: October 1992. Remediation expected completion: September 1994. Expected cost· $5 million.	Soil PCP, 30 mg/kg, PAHs, 50 mg/kg, dioxin on-site, 2.5 ug/kg; dioxin off-site, 1 0 ug/kg	Soil Slurry-phase bioremediation	Bioremediation not effective for remediation of dioxins
IV	Brown Wood Preserving* Live Oaks , FL CERCLA Enforcement Lead	Martha Berry (404) 347-2643 (FTS) 347-2643	Soil: Creosote, PAHs, PCP, dioxins. Volume. 9K cu. yd	Operational Full-scale Monitoring for 3 yrs Treatability study completed Remediation start. October 1988 Remediation expected completion· December 1991	Soil 100 ppm PAHs	Solid-phase bioremediation· Surface treatment lined with clay berms 5-6'	None
IV	Cape Fear Wood Preserving* Fayetteville, NC CERCLA Fund Lead	Jon Bornholm (404) 347-7791 (FTS) 347-7791	Soil/gound water: PAHs, arsenic, creosote, chromium Volume: 2K to 4K cu yd	Treatability studies completed. Design completed ESD to be prepared, capacity assurance issue to be resolved	Soil (mg/kg) arsenic, 94, carcinogenic PAHs, 2 5; total PAHs, 100, Chromium, 88; Goundwater (ug/l): carcinogenic PAHs, 10; noncarcinogenic, 14,350; Surface water: arsenic, 12 ug/l; Sediments (mg/kg): arsenic, 94; total PAHs, 3	Sequencing batch reactor preceeded by soil washing	None
IV	Carolawn Carolawn, SC CERCLA Enforcement Lead	Al Cherry (404) 347-7791 (FTS) 347-7791	Gound water: VOCs.	Planning bench-scale studies. on-going remedial design.	Acetone, 710 ug/l; cis-DCE, 70 ug/l; trans-DCE,120 ug/l; TCA, 200 ug/l; TCE, 5 ug/l; Pb, 5 ug/l	Not yet established	None

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IV	Cabot Koppers** Gainsville, FL CERCLA Enforcement Lead	Martha Berry (404) 347-2643 (FTS) 347-2643	Soil PAHs, Organics (phenols, naphthalene, florine, pyrene, pentachloro-phenol, etc., Metals (arsenic, chromium) Volume 6700 cu yd.	In-design Laboratory scale Design work plan started April 1991 Expected completion October 1991	Carcinogenic PAHs, 0.59 ppm; Organics: phenols, 4 28 ppm, naphthalenes, 211 ppm, florine, 323 ppm; pyrene, 673 ppm, PCP, 2 92 ppm, Metals arsenic, 27 ppm; chromium, 92 7 ppm	In-situ bioremediation. PAHs and organics; Institutional controls· arsenic and chromium, Other technologies. Soil washing with bioremediation or solidification, 50% of site under bioremediation	None
IV	Celanese Fibers Operations* Shelby, NC CERCLA Enforcement Lead	Ken Mallary (404) 347 7791 (FTS) 257-7791	Ground water Ethylene glycol, benzene, acetone chromium. Soil chromium, antimony, acetone Sediments Bis(2-ethylhexyl)pthalate. Volume (soil): 2K cu yd	Treatability studies complete Bioreactor on-line since August 1989	State of North Carolina MCLs, ground water all RCRA constituents, both state and federal levels	Sequencing batch reactor O U 1 In addition to bioremediation, carbon adsorption and air stripping are used for groundwater remediation O U 2 Implements rotary kiln incineration, solidification/stabilization to treat sludges/soils	Biomass upsets decreasing operating efficiency of treatment system Cause of upset unkown to date COD removal efficiency for seventh operational quarter was 92% for wells located close to source TOC was 87% removal efficiency
IV	City Industries* Winter Park, FL CERCLA Fund Lead/ CERCLA Enforcement Lead	Diane Scott (404) 347-2643 (FTS) 257-2643	Ground water Acetone, MEK, TCE, TCA	Pre-design Treatability study to be initiated second Quarter FY 1991. Remediation expected start June 1992 Remediation expected completion March 1995	Groundwater 200 ug/l TCA, 5 ug/l Methylene-Chloride, Varied based on reference dose limits and federal and state drinking water standards 700ug/l acetone, 200ug/l MEK; 3 0 ug/l TCE	Aerobic attached growth process pump and treat by air stripping, carbon absorption, and/or biological oxidation The treatability study to be used has not been determined. Other Technologies Chemical oxidation, filtration being considered	Biological oxygen demand may not be adequate
IV	Coleman-Evans* White House, FL CERCLA Fund Lead	Tony Best (404) 347-2643 (FTS) 257-2643	Soil/ground water/sediments PCP. Voume: 27K cu yd	In-design. September 1990 to June 1992 Laboratory-scale with pilot study planned Remediation expected start September1992. Remediation expected completion: March 1994. Remedial action expected cost: $8.6 million	Soil/Sediments. 25 ppm Ground water: 1 ppm	Slurry-phase bioremediation in treatment train. soil washing, bioremediation, solid stabilization, Landfill 100% under bioremediation; Operations 50% under bioremediation	Wood chip removal from soils, dioxins have been identified and are being evaluated.
IV	Dubose Oil* Cantonment, FL CERCLA Enforcement Lead	Mike McKibben (404) 347-2643	Soil: PCP, oil. Volume: 15K cu. yd.	Pre-design. Currently in technology selection phase Treatability study within a year. Remediation expected start. December 1992. Remediation expected completion: March 1995 Expected cost· $3 million	50 mg/kg Total TPNA; 50 mg/kg PCPs; 1.5 mg/kg xylene; 10 mg/kg benzene, 0.05 mg/kg TCE, 0.07 mg/kg DCE	Solid-phase bioremediation	None
IV	Koppers/Florence* Florence, SC RCRA Lead (Federal)	Mike Arnet (404) 347-7603 (FTS) 257-7603	Soil/ground water· Creosote, PCP, arsenic.	Pre-design started March 1, 1991.	Not yet established	Soil: Bioremediation treatment not yet determined. Ground water: Pump and treat; preliminary treatment before discharge to sanitary sewer system. 33% of site under bioremediation	None
IV	Langdale Facility Sweetwater, TN RCRA Lead	Charles Burroughs (615) 741-3424	Soils/sludges: creosote (K001 waste).	Contaminated soil and sludge excavated. Site capped after biotreatment.	Not yet established	Solid-phase bioremediation: land treatment using bacteria, nutrients, and cometabolite	None

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IV	Shavers Farm Shelby County, GA Removal Lead	Chuck Eger (404) 347-3931 (FTS) 257-3931	Soil: Dicamba, benzoic acid, dichlorosalicyclic acid, benzonitrile.	Pilot bench-scale treatability studies being reviewed Workplans in place, comments to go over in April/May 1991.	25 ppm for all constituents	Undetermined	None
IV	Stallworth Timber* Beatrice, AL RCRA Lead (Federal)/soil RCRA Lead (State)/ground water	Jason Darby (404) 347-3433 (FTS) 257-3433	Ground water/Soil: PCP, creosote. Volume (soil): 1 acre with uncertain depth. Volume (ground water): 5 acres with contaminated plume.	Pre-design: Full-scale.	Not yet established	Solid-phase bioremediation on soil. Sequencing batch reactor on ground water. Considering slurry-phase bioremediation. 100% of the site under bioremediation.	Regulatory cleanup levels have not been determined.
IV	White House Waste* White House, FL CERCLA Fund Lead	Tony Best (404) 347-2643 (FTS) 257-2643	Ground water/soil/sediments: Acids, PCB, waste oil, creosote. Volume: Re-evaluation underway @120K cu. yd. and may be reduced by half.	Pre-design: Laboratory-scale completed. Risk and treatability study ongoing. Expected start of design: January 1992. Remediation expected start: March 1993. Remediation expected completion: March 1995.	Not yet established	Treatment Train Soil washing, bioremediation, solid stabilization 100% under bioremediation (laboratory scale)	None
V	Allied Chemical* Ironton, OH CERCLA Enforcement Lead	Jim Van der Kloot (312) 353-9309 (FTS) 353-9309	Soils and wastes: PNAs Volume: 500K cu yd.	Pre-design. Pilot studies (April 1992-Summer 1992). Enhance bioavailability through use of surfactants, and to facilitate the delivery of oxygen to the waste matrix Incurred cost for testing >$1 million. Expected cost: $2 million	Soils/waste 1-100 ppm 1 ppm total carcinogenic PAHs	In-situ bioremediation and prepared pad bioremediation Lab testing of surfactants Other technologies: Incineration with onsite reuse of waste heat (waste fuel recovery), ground water pump and treat, 50% of site under bioremediation	None
V	Allied Signal/Bendix* St. Joseph, MI CERCLA Enforcement Lead	John Kuhns (FTS) 353-6556	Ground water: TCE, DEC, VC.	Pre-design Treatability study to be completed end of 1992. Pilot Scale Remediation expected start late 1993. Remediation expected completion date. 1998.	Not yet established	In-situ bioremediation: using indigenous methanotrophs, 75% of site under bioremediation	None
V	Aristech Chemicals Haverhill, OH RCRA (Federal) Lead	Jim Saric (312) 886-7569	Gound water/soil: Cumene, phenols	Conducting treatability studies	Phenol, 4.1 mg/kg; Cumene, 4.67 mg/kg	Undetermined	None
V	Autostyle Kentwood, MI UST Lead (State)	Bonnie White (616) 456-5071				Aerobic attached growth process	None
V	B&F Trucking Company* Rochester, MN UST Lead (State)	Pat Hanson (612) 297-8578	Soil/Ground water: BETX, gasoline.	Operational: Full-scale. Started June 1991, additional equipment needs to be installed. Incurred cost: $341K.	Not yet established	In-situ bioremediation; pump and treatment; reinfiltration gallery; 100% of site under bioremediation	Increase in iron concentration in ground water is causing iron bacteria and resulting in "slime" to accumulate on the surface of pipes and other process equipment.
V	BP Oil Company* Lima, OH RCRA Lead (Federal)	Don Heller (312) 353-1248	Soil: Petroleum	Pre-design: discussing bioremediation as an option; no studies underway;. Expected Start: 1992. Expected costs: $2.50-3.50 per1000 gallons of water; $75-125 per yard of soil.	Not yet established	Solid-phase bioremediation	None

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V	BP Oil Company* Toledo, OH	Stephen Bouchard (312) 886-7569	Soil: Petroleum.	Permit for land farming denied; biotreatment no longer being considered.	Not yet established	Solid-phase bioremediation	None
V	Burlington Northern* MN RCRA Lead (state): Permitting; CERCLA State Lead: Remediation	Tony Rutter (312) 886-8961 Fred Jenness (612)297-8470	Soil/ground water: carcinogens, non-carcinogens, creosote. Volume: 10K cu. yd.	Operational: Full-scale started in1987. Expected completion: 1993. Incurred cost: $725K. Expected costs of Operation & Maintenance: $38.6K per year for 30 years.	Ground water: carcinogens, 28 mg/l; non-carcinogens, 300 mg/l. Soil: detoxification levels	Treatment train: In-situ and solid-phase bioremediation. Other technologies: Thermal desorption, ground water monitoring; 20% of the site under bioremediation	Degradation rate is longer than expected for the more complex contaminents.
V	Cliff/Dow Dump* MI CERCLA Enforcement Lead	Lida Tan (312) 886-5993	Wood tar, Acetic acid, Phenol, Benzene, PAHs.	Pre-Design: Laboratory-scale. Actual start: 7/91.	Not yet established	In situ forced aeration; 30% of site under bioremediation	Volume increase (100%); Temperature control; Mixture efficiency
V	Duell and Gardner* Muskegan, MI CERCLA State Lead	Karla Johnson (312) 886-5993	Soils: Volatiles, semi-volatiles, pesticides, PCBs, inorganics.	Pre-design	Not yet established	In-situ biodegradation· involves using native or mutant strains of aerobic bacteria to degrade organic compounds in the soils. Nutrients and oxygen supplied to contaminated soils to enhance microbial degradation.	Degradation can be inhibited by halogenated organics, and elevated levels of metals and inorganics
V	Fisher-Calo* LaPorte, IN CERCLA Fund Lead	Brad Bradley (312) 886-4742	Soil/ground water: TCE, DCE, DCA, PCBs.	Design· Laboratory-scale	5ppb TCE, 70ppb DCE; 200 ppb DCE, drinking water standards used where possible	Undetermined; 1% of site may under bioremediation	None
V	Galesburg/Koppers IL CERCLA State Lead	Brad Bradley (312) 886-4742	Soil: Phenols, chlorophenol, PNAs, PCP, PAHs.	Pre-design Pilot-scale.	Not yet established	Solid-phase bioremediaton; in-situ with amendments which have not yet been determined	None
V	Hentchells* Travers City, MI UST Lead (State)	Bob Kettner (616) 775-9729 Anne Emington	Ground water: Gasoline.	Completed: Full-scale started September 1985. Completed: March 1989. Some contamination remains. Agency requested further cleanup.	Non-detection levels	In-situ bioremediation (air sparging; nutrient addition; in-situ pump and reinfiltration gallery; pursuing final cleanup of residue at leading edge of plume. Also need soil verification	None
V	Josyln MFG* Brooklyn Center, MN CERCLA State Lead	Cliff Twaroski (612) 296-7827 John Betcher (MPCA) (612) 296-7821 Carl Grabinski (312) 454-2865	Soil: PAHs, PCP, dioxin, furans. Volume: 67K cu yd.	Operational: Full-scale remediation started: August 1989. Expected completion: September 1992.	150 ppm total PAHs; 100 ppm total PCP	Solid-phase bioremediation, 35% of site undergoing bioremediation	Extreme rainfall in May caused flooding and Lift 2 soil treatment delayed.
V	Juliet Army Ammunition Plant** Elwood, IL Federal Facility	Dion Novak (312) 886-4737	Soil: Explosives; Organics.	Pre-design. Solid-phase treatment. In-design for Slurry-phase work plan. Pilot-Scale. Remediation expected start: June 1992. Remediation expected completion: July 1992.	Not yet established	Soil: Solid-phase, 4 months; slurry phase, 3 months; 4 out of 23,040 acres under bioremediation in pilot program	None
V	K & L Avenue** MI CERCLA Enforcement Lead	Dan Cozza (312) 886-7252	Ground water: (Organics) acetone, benzene, vinyl chloride, toluene, xylene, trans-1,2-DCE, ethylbenzene, 1,1-dichloroethane, 1,2-dichloroethene.	In-design: Expected start in October 1991. Expected cost: $2.2 million.	Acetone & 1,1-Dichloroethane, 700 ppb; benzene, 1.0 ppb; 1,2-Dichloroethane, 0.4 ppb; Vinyl Chloride, 0.02 ppb; Xxylene, 20 ppb; Toluene, 40 ppb; Trans-1,2-DCC, 100 ppb; Ethylbenzene, 30 ppb	Aerobic attached growth process. Other technologies: Depending on the results of ground water samples during the pump test, precipitation of metals, and a carbon filter for the vinyl chloride may need to be added	Treatment of vinyl chloride, handling of water after treatment, no POTW (passable with 3 miles of sewer line), no surface water available, need to reinject.

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CERCLA/RCRA/UST SITES PLANNING, OPERATING, OR CONSIDERING BIOREMEDIATION

REG	SITE/ LOCATION/ LEAD-	CONTACT/ PHONE NUMBER	MEDIA/ CONTAMINANT	STATUS	CLEAN-UP LEVELS	TREATMENT	PROBLEMS
V	Marathon Station-Ervines** Kentwood, MI UST Lead (State)	Bonnie White (616) 456-5071	Ground water: Gasoline; Volume: 3-5 gpm.	Operational: Full-scale. Remediation start date: 1988.	Ground water: Gasoline (Background non-detection levels or risk-based levels)	Aerobic attached growth process. Other technologies: Carbon polish unit to ensure compliance with NPDES permit; 95% of site under bioremediation	No major problems relating to treatment process. Performing better than anticipated relative to removals. This system was designed as a decay phase reactor, so does periodically have to shut down to allow regrowth of cultures. Has only occurred once.
V	Mayville Fire Department Mayville, MI UST lead	Sue Kaelber Matlock (517) 771-1731	Soil/ground water: BTEX	Operational.	Soil: 10 ppb BTEX. Ground water: 1 ppb BTEX	Bioremediation using oxygen with no addition of nutrients	None
V	McGillis Gibb* MN CERCLA Fund Lead	Darryl Owens (312) 886-4071	Ground water: PAHs; PCP.	Pre-esign Treatability studies and pilot completed December 1989. Full-scale. Remediation expected start· March 1993. Remediation expected completion· March 1995. Cost for phase 1: $600K -800K.	Not yet established	Ground water Aerobic attached growth process, fixed film	None
V	Moss American Milwaukee, WI CERCLA Fund Lead	Betty Lavis (312) 886-7089	Soil/sediments: PAHs.	Pilot study completed. Design Summer 1991.	PAHs, 6.1 ppm	Slurry-phase bioremediation bioreactor using indigenous bacteria	None
V	New Lyme Landfill* New Lyme, OH CERCLA Fund Lead	Ted Smith (312) 353-6571	Ground water: Ethyl benzene, methylene chloride.	Installation/Operational Conducted pilot-scale in January 1988. Remediation expected start: November 1991 Expected cost: $5-6M.	Ground water: Ethyl benzene, 68 ug/l, methylene chloride, 473 ug/l, phthalate, 9.2 ug/l	Ground water. Rotating biological reactors	None
V	Onalaska Municipal Landfill** La Crosse County, WI CERCLA Fund Lead	Kevin Adler (312) 886-7078 Robin Schmidt (608) 267-7569	Soil: Naphthalene, BTEX. Volume: 19,400 cu. yd.	Pre-design: Full-scale Remediation expected start. June 1992. Remediation expected completion: June 1994.	Not yet established	In-situ bioremediation. Other technologies: pump and treat. 30% of site under bioremediation	Adjacent landfill generates CH_4
V	Organic Chemical* MI CERCLA Fund Lead	Tom Williams (312) 886-6157	Ground water: Oil, TCE, toluene.	Design: Waiting for feasibility study to do remediation on TCE and toluene. Working on additional workplan for oil. Ground water pump and treat expected start: September 1992.	Not yet established	Pump and treat as interim action until levels of organic are reduced	None
V	Rasmussen** Livingston County, MI CERCLA Enforcement Lead	Ken Glatz (312) 886-1434	Ground water: HETP, 2-butanone, isophorone, 2-methylphenol, 4-methylpentanone.	Pre-design.	Not yet established	Considering pump and air stripping/carbon absorption treatment with added micro-organisms and nutrients; fixed film reactor, immobilized. Other technologies: Chemical treatment. 100% of site under bioremediation	None
V	Parke-Davis Holland, MI RCRA Lead	Dave Petrovski (312) 886-0997	Soil/ground water: benzene, methanol, isopropanol, fuel.	Pre-design.	Not yet established	Undetermined	None

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V	Reilly Tar & Chemical* St. Louis Park, MN CERCLA Enforcement Lead	Daryl Owens (312) 886-4071 Secondary: Doug Beckwith (612) 296-7301; Mike Scott (612) 296-7297	Soil: PAHs. Ground water: Creosote.	Pre-Design: Laboratory-scale. Remediation expected start: September/October 1991. Remediaton expected completion: September/October 1993. Expected cost for treatability studies $140K	Not yet established	Soil. In-situ bioremediation; surface and subsurface; using additional nutrients (N, P). Ground water: pump and treat with discharge to POTW. Other technologies: carbon adsorption	None
V	Reilly Tar* IN CERCLA Enforcement Lead	Dion Novak (312) 886-4737	Soil: creosote, PAHs, metals, semi VOAs. Ground water: benzene, ammonia, pyridine, chlorinated organics. Volume: 1.6 mgd extraction rate.	Pre-design: Laboratory-scale. Remediation expected start: December 1991. Expected cost: $25M.	Not yet established	Ground water: In-situ bioremediation	None
V	Seymour Recycling (Unit 1)* IN CERCLA Enforcement Lead	Jeff Gore (312) 886-6552	Ground water: VC, TCE, DCE, benzene, chloroethane Volume· 500K gallons	Operational. Full-scale Remediation start: June 1991 Expected completion date. 1996 Incurred Cost: $1M Expected Cost· $1M	VC, TCE, DCE, Benzene Drinking water standards; Chloroethane - Not yet established	Aerobic attached growth process: TCE, DCE, benzene, chloroethane In-situ bioremediation VC, TCE, DCE, benzene, chloroethane. Other technologies: Vacuum extraction, chemical treatment	None
V	Seymour Recycling (Unit 2)* IN CERCLA Enforcement Lead	Jeff Gore (312) 886-6552	Soil: VC, TCE, DCE, benzene, chloroethane. Volume: 111K cu. yd.	Operational: Full-scale Remediation start: June 1991. Remediaiton expected completion date. 1993.	Not yet established	In-situ bioremediation Other Technologies· Vacuum extraction	None
V	Sheboygan River and Harbor* Sheboygan, WI CERCLA Enforcement Lead	Bonnie Eleder (312) 886-4885	Sediments: PCBs.	RI/FS· Laboratory-scale bioremediation to be completed by Summer 1991 Pilot-scale bioremediation to be completed by Fall/Winter 1992.	Not yet established	In-situ bioremediation capped sediments; natural and enhanced biodegradation in enclosed contaminents structure Other technologies in consideration· chemical extraction and treatment, thermal desorption, sediment capping	Evaluation of process and data difficult; goals difficult to determine and not yet developed
V	Sleeping Bear Dunes National Lakeshore* Federal Facility	John Wilson (405) 332-8800 Secondary: Guy Sewell	Soil/Ground water: gasoline. Volume: 1,000 gal.	Full-scale: Remediation start: February 1991. Remediation expected completion: February 1992.	Not yet established	Soil: In-situ Bioremediation, passive natural bioremediation. 100% of site under treatment	None
V	Speigelberg Landfill** Livingston County, MI Federal Facility	Ken Glatz (312) 886-1434	Ground water: 2-butanone, 2-hexanone. Volume: 140K cu. yd.	Pre-design.	2-butanone, 350 ppb; 2-hexanone, 50 ppb	Pump and air stripping/carbon absorption treatment with added micro-organisms and nutrients; 100% of site considered for bioremediation	None
V	St. Louis River Duluth, MN CERCLA State Lead	Debbie Siebers (312) 353-6756 Cliff Twaroski (612) 296-7821	Soils/Sediments: VOCs, PAHs.	Pre-design: RI/FS. Remediation expected start. 1993.	Not yet established	Undetermined	None
V	Union Carbide, OH CERCLA Enforcement Lead	Kathleen Warren (312) 353-6756	Soil/ground water: VOCs, dioxin, monodichlorinated bipheyls.	Remedial investigation completed.	Not yet established	Undetermined	None
VI	Atchinson* Santa FE, NM CERCLA Enforcement Lead	Susan Webster (214) 655-6730 (FTS) 255-6730	Soil/Sludge: Hydrocarbons, diesel. Volume: 28K cu. yd.	Operational: expected start: October 1991. Pilot scale being planned. Expected costs: $3M.	Not yet established	In-situ and combined bioprocesses: surface and subsurface, sludges treated separately. 100% of the site under bioremediation	High chloride content in soil and sludges.

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VI	French Limited Crosby, TX	Judy Black (214) 655-6735 (FTS) 655-6735	Sludges/soil/ground water: benzene, vinyl chloride, DCE, PCBs.	In-design.	Soils and sludges: BAP, 9 ppm; PCB, 23 ppm; VOCs, 43 ppm; arsenic, 7 ppm; benzene, 14 ppm. Ground water: MCLs	Soils/sludges: Treatment in a lagoon; Ground water: in-situ bioremediation and/or pump and treat	None
VI	Hudson Refining Company* Cushing OK RCRA Lead (Federal)	Keith Phillips (214) 655-6480 (FTS) 255-6480 Brent Truskowski	Soil/ground water: Oil, grease, hydrocarbons, PAHs, benzene. Volume: 145,500 cu. yd.	Operational: Full-scale since April 1988, ongoing.	Ground water: 30-50% reduction of contaminants through ground water recovery system	Solid-phase bioremediation (three phases). 1) active: requires monthly application of nutrients and monthly tilling; 2) enhanced: annual application of nutrients and no tilling; 3) augmented: no addition of nutrients or tilling	Lack of micro-organism; state order failed to specify clean-up levels; recontamination at nearby refinery.
VI	North Calvalcade* Houston, TX CERCLA State Lead	Deborah Griswold, Larry Wright (214) 655-6715 (FTS) 255-6715	Ground water: carcinogenic PAHs, benzene. Soil: carcinogenic PAHs. Volume (soil): 22,300 cu. yd. above 10'.	In-design: (October 1991 - October 1993). Pilot Scale. Expected start: October 1993. Expected completion: September 1996. Expected cost: $4.7M.	Ground water: benzene, .04 ppm; Ground water/soils: carcinogenic PAHs, 1 ppm	Composting: PAHs in soil. Other technologies: Pump and carbon absorption treatment; 50% of site under bioremediation	None
VI	Old Inger* Darrow, LA CERCLA State Lead	Paul Sieminski (214) 655-6710 (FTS) 255-6710 Steve Gilrein	Soil/sludge: Hydrocarbons. Volume (sludge): 600K gallons. Volume (soil): 200K cu. yd.	Installation: Full-scale. Remediation expected start: April 1992. Remediation expected completion: 1997 or 1999. Design completed 1986. Supplemental ground water RI being conducted. Costs: $10M.	Not yet established; expected to have standard dischard requirements; objective is to reduce contaminent concentration from 76% to 4%	Solid-phase bioremediation with GAC, 70% of site under bioremediation	None
VI	Sheridan Disposal Services Houston, TX CERCLA Enforcement Lead	Ruth Izraeli (214) 655-6735 (FTS) 255-6735	Soil/sludge/surface water: benzene, toluene, ethyl benzene, phenol, PCBs.	In-design. Pilot study.	PCBs, 25 ppm (PCBs as an indicator of other organics)	Slurry-phase bioremediation: Aqueous bioreactor	None
VII	Amoco Refinery* Sugar Creek, MO RCRA Lead (State)	Frank Dolan (314) 751-3176 Secondary: Alan Hancock (913) 551-7647	Soil/Sludge: K049, K050, K051, oil, PAHs, refinery sludges, metals. Volume: 137K cu. yd. at 27% to 40% oil and grease.	Operational: Full-scale. Remediation start: July 1990. Remediation expected completion: 1999. Expected cost: $23.5M.	Total PAHs, less than 300 mg/kg; Potentially carcinogenic PAHs, less than 160 mg/kg	Soil/Sludge: Solid-Phase bioremediation; Sequencing Batch Reactors; Liquid/solid reactor followed by land treatment cell; 5% of site under bioremediation	Material handling problems related to siting the facility and the rate of reaction in the full-scale; oxygen transfer has been slower than expected.
VII	Conservation Chemical* Kansas City, MO CERCLA Enforcement Lead	Steve Auchterlonie (913) 551-7778 (FTS) 276-7778	Ground water: Phenols. Volume: 150-200 gpm for approx. 30 years.	Operational: Full Scale. Remediation started: April 1990. Incurred Costs: $100K.	MO Drinking Water Standards	Aerobic attached growth process: Fixed film bioreactor (2 in series). Other technologies: Treatment train (carbon adsorption, lime precipitation, sulfide precipitation).	None
VII	Fairfield Coal & Gas* Fairfield, IA CERCLA Enforcement Lead	Steve Jones (913) 551-7755	Ground water: benzene, ethyl benzene, toluene, xylene, PAHs.	In-design: Pilot-scale planned (to Full-scale if successful). Remediation expected start: June 1992. Expected cost for construction: $149K.	Soil: Carcinogenic PAHs, 100 mg/kg; Total PAHs, 500 mg/kg; benzene, 241 mg/kg (not treated by bioremediation). Ground water: Benzene, 1 ug/l; Carcinogenic PAHs, 0.2 ug/l	Ground water: In-situ bioremediation (subsurface); thermal treatment of contaminant source areas; pump and treat of ground water using carbon adsorption with polymer injection and settling	None

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VII	International Paper (O.U. #1)* Joplin, MO RCRA Lead (State)	Frank Dolan (314) 751-3176 Secondary: Bob Stewart (913) 551-7654	Soil: 24 organic constituents from creosote, including PAHs, PCP. Volume: 20,000 cu. yd.	Installation: Pilot-scale & Full-scale. Remediation expected start: June 1992. Remediation expected completion: 2004. Expected cost: $9.5M.	Soil: Sum of the concentrations of 24 aromatic compound is less than 600 mg/kg	Soil: Solid-phase bioremediation; in-situ soil flushing. Other technologies: chemical treatment;. 20% of site under bioremediation	Bioremediation failed at this site due to lack of temperature and moisture control; the units were flooded, blocking oxygen transfer; steps are being taken to control moisture and temperature by covering basins (10+ acres under roof).
VII	International Paper (O.U. #2)* Joplin, MO RCRA Lead (State)	Frank Dolan (314) 751-3176	Soil: 24 organic constituents from creosote, including PAHs, PCP. Volume: 20,000 cu. yd.	Operational: Pilot-scale.	Not yet established	Solid-phase bioremediation: Land treatment (covered facility)	None
VII	International Paper (O.U. #3)* Joplin, MO RCRA Lead (State)	Frank Dolan (314) 751-3176	Soil: 24 organic constituents from creosote, including PAHs, PCP. Volume: 20,000 cu. yd.	Operational: Pilot-scale.	Not yet established	Solid-phase bioremediation: Land treatment (covered facility)	None
VII	International Paper (O.U. #4)* Joplin, MO RCRA Lead (State)	Frank Dolan (314) 751-3176	Soil: 24 organic constituents from creosote, including PAHs, PCP. Volume: 20,000 cu. yd.	Operational: Pilot-scale.	Not yet established	Solid-phase bioremediation: Land treatment (covered facility)	None
VII	Park City* KA No Lead	John Wilson (405) 332-8800 Secondary: Lonnie Kennedy	Aquifer Solids/Water: benzene, BTEX. Volume: 700,000 ft3 contaminated aquifer (actual volume will be larger).	Installation: September 1991. Full-scale. Remediation expected start: September 1991. Remediaton expected completion: June 1992. Incurred cost: $275K. Expected cost: $650K.	Ground water: benzene, 5 ug/l; BTEX, Drinking Water Standards	Aquifer solids/Ground water: In-situ bioremediation; In-situ soil flushing; bioremediation will be initiated using nitrate as well as oxygen to enhance rates of degradation	None
VII	Scott Lumber* Alton, MO CERCLA Fund Lead	Bruce Morrison (913) 236-3881 (FTS) 276-3881	Soil: Creosote compounds (PAHs, benzo-a-pyrene). Volume: 15,900 tons.	Operational: Full-scale. Remediation start June 1990. Expected completion: December 1991.	500 ppm total PAHs 14 ppm benzo-a-pyrene	Solid-phase bioremediation (no nutrients added); 75% of site under bioremediation	None
VII	Vogel Paint & Wax Maurice, IA CERCLA State Lead until Octber 1991, then CERCLA Enforcement Lead	Steve Jones (913) 551-7755	Soil: BETX, MEK. Volume: 710K cu. yd.	Installed July 1991. Full-scale. Actual start: July 1991; Cost: $2M expected.	Soil: Organic hydrocarbons, 100 mg/kg; Leachable organics, TCLP test	Solid-phase (Land treatment). Air stripping of contaminated ground water	None
VIII	Burlington Northern* Somers, MT CERCLA Enforcement Lead	Jim Harris (406) 449-5414	Soil: PAHs, zinc, phenol. Ground water: PAHs. Volume: (soil) Solid-Phase: 12,000 cu. yd., In-situ: 70,000 cu. yd.	In-design: 3Q/92. Installation: 1Q/93; Operational 1Q/93; Laboratory-scale since May 1991. Full-scale in 1992. Expected start: 3Q/92. Expected completion: 5-10 years from start. Expected cost: $11M.	Soil: PAHs, 36 mg/kg. Ground water: Carcinogenic PAHs, 0.030 ug/l	Soil: Solid Phase bioremediation; In-situ soil flushing. Sediment and ground water: In-situ bioremediation; 100% of site under bioremediation	Soils are silty, fine-grained with low transmissivity.

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VIII	Libby Ground water Site* Libby, MT CERCLA Enforcement Lead	Julie Daisoglio (406) 449-5414 (FTS) 585-5414	Soil/Ground water: PAHs, PCPs. Volume (soil): 45K cu. yd.	Operational: Full-scale. In-situ Phase I (1991-92). Solid-phase (Summer 91). Bioreactor (1991). Being Installed: Solid phase unit cell #2. Incurred cost: $4M.	Soil: 88 mg/kg total carcinogenic PAHs; 8 ppm non-carcinogenic PAHs; 7.3 ppm pyrene; 37 mg/kg PCP; 1 ppb dioxin; 8 mg/kg napthalene; 7.3 mg/kg pyrene. Ground water: 400 ug/l carcinogenic PAHs; 40 ug/l non carcinogenic PAHs	Soil: Solid-phase bioremediation. Ground water: In-situ bioremediation and aerobic attached growth process (fixed film reactor)	None
					1.05 mg/l PCP; 5 mg/l benzene; 50 mg/l arsenic; other compounds not greater than 10-5		
VIII •	Public Service* Denver, CO UST Lead (State)	Suzanne Stevenson (303) 293-1511	Soil/ground water: benzene, xylene, toluene. Volume 5,921,330 gals per year.	Operational: Full-scale. Remediation start: June 1989. Remediation expected completion: 1991. Incurred cost: $500K.	Not yet established; risk assessment based	In-situ bioremediation, combined bioprocess: nutrient gallery reinjection/pump recovery wells; Other technologies: Chemical treatment	None
VIII	Union Pacific* Laramie, WY RCRA Lead (Federal)	Felix Flechas (303) 293-1603	Soil/ground water: Creosote and PAHs. Volume (soil): 750k cu. yd. Volume (creosote in soil): 6M gallons.	Pre-design: Feasibility Study (1985-June 1992). Pilot scale bioremediation (completed September 1990). Recovery of dense non-aqueous bioremediation starts Fall 1991. Expected completion: 1996. Incurred costs: $50M. Expected costs: $100M.	Not yet established	Soil: Solid-phase and in-situ bioremediation; considering slurry-phase bioremediation. Ground water: Aerobic attached growth process (fixed film reactor) and Sequencing batch reactor; Pond bottoms: Solid-phase bioremediation.	Clay lenses with varying permiability zone which would continue to leach to the clean zones.
						Other technologies: thermal desorption, soil washing, chemical extraction, soil washing, chemical treatment, In-situ soil flushing (alcon agent for subsurface; 50% of site under bioremediation	
IX	BKK Landfill West Covina, CA CERCLA Enforcement Lead	Carmen Santos (415) 744-20??	Ground water: arsenic, cadmium, chromium, lead, mercury, dichloromethane, chloroform, 1-2 dichloropropane, carbon tetrachloride, TCE, benzene, phenol, toluene, cyanide, heavy metals.	Operational: Full-scale since 1987. Remedial study in progress.	Cadmium, .1ppm; arsenic, chromium, lead, .05 ppm; mercury, .002 ppm; dichloromethane, chloroform, TCE,150 ppb;1-2 dichloropropane, 700 ppb; carbon tetrachloride, 5 ppb; benzene, 550 ppb; heavy metals, 1.5 ppm; phenol, toluene, cyanide are not established	Slurry-phase bioremediation: bioreactor-leachate treatment plant with metal removal system using complexation with EDTA	None
IX	CAL TRANS* Lakeport & Garberville, CA UST Lead (State)	Ken Smarkel (916) 322-3910 John Wesnowski (916)324-1807	Soil: Oil (petroleum hydrocarbons). Volume: 70 cu. yd.	Completed: Full scale. Remediation start: November 1988; Remediation completed: January 1989.	Oil (petroleum hydrocarbons), 100 ppm	Solid-phase bioremediation	Degradation rate is dependent upon the pile's porosity, water content, type of waste, soil, and bacterial consortium

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IX	Citrus Heights Irrigation* Citrus Heights, CA UST Lead (State)	Ken Smarkel (916) 322-3910 John Wesnowski (916)324-1807	Soil: Diesel fuel (Petroleum hydrocarbons).	Completed: Full-scale. Remediation start: May 1989. Remediation completed: August 1989.	Petroleum hydrocarbons, 100 ppm	Solid-phase bioremediation	None
IX	Converse Montabello Corp. Yard* Montabello, CA UST Lead (State)	Paul Hadley (916) 324-1807	Soil: Gasoline, Diesel.	In-design since January 1991. Pilot-scale.	Not yet established	In-situ bioremediation	None
IX	CWX Feight Lines* Santa Rosa, CA UST Lead (State)	Mark Berschad (916) 322-3294	Soil: Diesel.	Operational: Pilot scale since October 1990.	Not yet established	Combined bioprocesses: sprinkler system to apply bioculture formulation; collected leachate treated in an aerobic biological reactor before circulation	None
IX	Former Service Station* Los Angeles, CA UST Lead (State)	Tonyt Palagyi (818) 505-2701 John Baldwin	Soil/Ground water: gasoline, benzene, HCS constituents. Volume (soil): 3K cu. yd.. Volume (groundwater): 800K gallons.	Completed: Remediation start: November 1988. Remediation completed: March 1991. Incurred Costs: $1.6M.	Soil: Total Petroleum Hydrocarbons,100 ppm; Ground water: benzene, 5 ppb	In-situ bioremediation: closed loop system; hydrogen peroxide as oxygen source; above ground holding tank for nutrient addition. Other technologies: In-situ soil flushing, vacuum extraction; 65% of site under bioremediation	During channeling overload reduced the reinjection process rate.
IX	Fort Ord Army Base* Montery, CA CERCLA Enforcement Lead	John Chestnutt (415) 744-2387 Vance Fong (415) 744-2392	Soil: Hydrocarbons.	Installation: Pilot scale. Remediation expected completion· FY 1993	Soil: Not yet established. Ground water: MCLs	Solid-phase bioremediation for MEK. Other technologies: Pump and carbon absorption treatment	None
IX	Growers Air Service/University of CA Davis, Medlock Field* Woodland, CA TSCA Lead (State)	John Wesnvosky (916) 324-1807 John Menke (916) 324-3773	Soil (Pesticides): Atrazine, BRAVO chlorothanol, dacthal, thiadine 1&2, DDT, Thiadine sulfate, trifulualin, methyl parathion, malathion, parathion, methyl trithion, thion, thithion paraxon.	Completed. October 1988 Report available.	Not yet established	In-situ and solid-phase bioremediation	None
IX	Harmon Field Tulare County, CA CERCLA State Lead	Tony Luan CA Dept of Health Service (916) 322-6872	Soil: 10 organic pesticides.	Pilot project completed. Evaluating field study results.	Not yet established	Solid-phase bioremediation	None
IX	Hercules Incorporated Hercules, CA CERCLA State Lead	Tony Luan CA Dept of Health Service (916) 322-6872	Soil: TNT, DNT, trinitrobenzene, nitrobenzene.	Pilot project completed. Evaluating field study results.	TNT, 30 ppm, DNT, nitrobenzene, 5ppm	Solid-phase bioremediation	None
IX	J.H. Baxter Weed, CA CERCLA Enforcement Lead	Mary Masters (415) 744-2370 Secondary: Jeff Rosenbloom (415) 744-2362	Soil/sediments/leachate/ ground water: arsenic, chromium, benzene, PCP, PAHs, dioxin, carcinogenic PAHs, furans, non-carcinogenic PAHs, zinc, TCP. Volume: organic soils, 12,500 cu. yd.; mixed organic/inorganic, 9,375 cu. yd.	Pre-design; In-design: March 1992; Expected Installation: March 1993. Operational: March 1995. Pilot-scale. Remediation expected start: March 1993. Remediation expected completion: March 1995 following 3 years of monitoring. Expected cost: $3.5M.	Soil (mg/kg): arsenic, 8; chromium, 500; PCP, 17; carcinogenic PAHs, 0.51; dioxin, 0.001; furans, 0.001; Sediments (mg/kg): arsenic, 8; chromium, 18; zinc, 26; carcinogenic PAHs, 0.5; PCP, 1; TCP, 1	Soil/sediment: (organics) solid-phase bioremediation. (inorganics) cement fixation; ground water: (organics) aerobic attached growth process, followed by GAC, if necessary. (inorganics) chemical precipitation, activated alumina, if necessary for arsenic	None

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CERCLA/RCRA/UST SITES PLANNING, OPERATING, OR CONSIDERING BIOREMEDIATION

REG	SITE/ LOCATION/ LEAD	CONTACT/ PHONE NUMBER	MEDIA/ CONTAMINANT	STATUS	CLEAN-UP LEVELS	TREATMENT	PROBLEMS
	J.H. Baxter (cont'd)				Leachate (mg/l): arsenic, 5; chromium, 5; PCP, 1.7; carcinogenic PAHs, 0.005 ; non-carcinogenic PAHs, 0.15; dioxin, 0.001; Ground water (ug/l): arsenic, 5; chromium, 8; benzene, 1; PCP, 2.2; PAHs, 5; dioxin, 0.000025		
IX	JASCO* Mt. View, CA CERCLA Fund Lead	Rose Marie Caraway (415) 744-2235	Soil/ground water: VOCs.	Treatability study being conducted while FS is on hold. Final FS will be produced following final treatability study. Laboratory-scale. Lab treatment study cost: $30K.	Not yet established	Soil/ground water: solid-phase, In-situ bioremediation, composting technologies being evaluated in treatability study. 75% of site under bioremediation	None
IX	Kopper Co. Inc.* Orville, CA CERCLA Enforcement Lead	Fred Schauffler (415) 744-2365 (FTS) 484-2365	Creosote/soil/ground water: arsenic chromium, PCDD/PCDF, PAHs, PCPs. Volume (soil): 110K cu. yd.	Pre-design: Pilot scale. Remediation expected start: Fall 1992. Remediation expected completion: Spring 1994. Currently in the last stage of the consent decree for RD/RA. Treatability studies to be done late 1991. Expected costs: $12.2M.	Soil: arsenic and chromium, background levels; PAHs, 0.19mg/kg; PCP, 17 mg/kg; dioxins, 30 ppt; Ground water: arsenic and chromium, background levels; PAHs, 0.007ug/l; PCP, 2.2 ug/l; dioxins, 0.53 ppg	In-situ bioremediation. Other technologies: soil washing, fixation of metal contaminated soil, pump and carbon absorption treatment	None
IX	Liquid Gold* Richmond, CA CERCLA State Lead	Rose Marie Caraway (415) 744-2235	Soil/ground water: Waste oils, metals (lead, zinc), phenol.	Site is in preliminary stages of considering the bioremediation technology; no decisions have been made and start of a treatability study is not planned.	Not yet established	Not yet established	Metals contamination on-site.
IX	Montrose Chemical Corp of California Torrance, CA CERCLA Enforcement Lead	Nancy Woo (415) 744-2394	Soil: DDT, Monochlorbenzene.	Pre-design: Pilot scale. Treatability study completed. Laboratory-scale for ground water proved inneffective for DDT, follow up planned.	Not yet established	In-situ bioremediation:	None
IX	Naval Civil Engineering Laboratory Port Hueneme, CA	Tej Pahwa CA Dept. of Health Services (916) 322-8224	Soil/ground water: Jet fuel, gasoline, diesel fuel, transmission fluid, aviation fluid.	Bench scale tests completed in October 1989; final consultant report submitted to Navy for approval; pilot tests are being planned; working on pilot design.	Not yet established	Hydrocarbon aeration	None
IX	Protek* Carson City, CA UST Lead (State)	Ken Smarkel (916)322-3910 John Wesnowski (916) 324-1807	Soil: diesel fuel (Petroleum hydrocarbons). Volume: 700 cu. yd.	Operational: Full-scale started August 1988.	Diesel, <10 mg/kg	Solid-phase bioremediation. 100 % of site under bioremediation	The control cell, which did not receive any nutrient supplements, propriety inoculate, or the benefit of vigorous aeration seemed as effective in reducing the contaminent level as the site.

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CERCLA/RCRA/UST SITES PLANNING, OPERATING, OR CONSIDERING BIOREMEDIATION

REG	SITE/ LOCATION/ LEAD	CONTACT/ PHONE NUMBER	MEDIA/ CONTAMINANT	STATUS	CLEAN-UP LEVELS	TREATMENT	PROBLEMS
IX	Romic Chemicals* East Palo Alto, CA RCRA Lead (Federal)	Jesse Bakir (415) 744-2036 Glenn Heyman (415)744-2044	Soil: toluene, PCE, zylene, MEK, VC, acetone. Ground water: acetone, DCE, toluene, VC, zylenes, MEK, MIBK, methylene chloride.	Pre-design. Treatability studies late FY 1992.	Not yet established	Soil: In-situ bioremediation (under consideration). Ground water: aerobic attached growth process, in-situ bioremediation, combined bioprocesses. 100% of site under bioremediation. Other technologies: Vacuum extraction, activated carbon, UV peroxidation.	High total dissoved solids (Fe, Mn) in groundwater; buildings on top of contaminated soil; facility borders on slough which will recharge ground water during pump and treat; type, concentration, and number of contaminents.
IX	San Diego Gas and Electric*, Main Street Facility San Diego, CA UST Lead (State)	Paul Hadley (916) 324-1807	Soil/ground water: petroleum fuels. Volume: 1,200 cu. yd.	Operational since October 1989. Full-scale.	Not yet established	In-situ bioremediation: emphasis on reducing levels of gasoline in soil rather than ground water. 100% of site under bioremediation.	None
IX	Seaside High School* Seaside, CA No Lead	Dick Erickson (916)322-7046 Secondary: Alan Ingham	Soil: Diesel fuel. Volume: 100 cu. yd.	Full-scale bioremediation completed 1988.	Soil: Diesel fuel, 500 mg/kg	Solid-phase bioremediation.	None
IX	SEGS Solar Project Kramer Junction, CA CERCLA State Lead	Bruce La Belle (916) 324-2958	Soil: Biphenyl, Diphenyl ether.	Full-scale operational since July 1990	Soil: Biphenyl, Diphenyl ether, 1000 mg/kg	Composting	None
IX	Solvent Service** CA CERCLA State Lead	Ron Jervason (415) 464-0688 Secondary: Martie Lacey	Ground water: F001, over 30 industrial solvents.	Operational since January 1991 Full-scale. Remediation expected completion: 2001. Incurred cost: $399K. Expected cost $844K.	Ground water (ug/l): 1,2-DEC, 5; Cis-1,2-DEC, 6, trans-1,2-DCE, 10; ethylbenzene, 400; 1,1,1-TCA, 200; Freon 113, 1200; Benzene, 0.7; Acetone, 400.0; 1,1-DEC, 1.0; Naphthalene, 2000	Vacuum extraction; steam enhancement of vacuum extraction	Permitting.
IX	Southern California Edison Visalia, CA CERCLA State Lead	Dave Roberts (415) 744-2227; New contact to be assigned	Ground water: PCP, VOCs.	Pre-design RI/FS currently in progress.	Not yet established	Not yet established; Considering bioremediation	None
IX	Southern Pacific Transportation Co.* SPTC Maintenance Yard Roseville, CA CERCLA State Lead	David Wright (916) 332-3910	Soil: Hydrocarbons, Diesel fuel. Volume: 240 tons.	Full-scale bioremediation system completed January 1991. Cost: $310K.	Soil: Hydrocarbons, Diesel fuel, 5000 mg/kg	Solid-phase bioremediation	None
X	American Crossarm* Chahailis, WA CERCLA Fund Lead	Lee Marshall (206) 553-2723	Soil: PCP.	RI/FS still underway. Expected completion: 1992.	Not yet established	Not yet established	None
X	East 15th Street Service Station* Anchorage, AK	Tony Palagyi (818) 505-2701		In-design.	Not yet established	In-situ bioremediation	None

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CERCLA/RCRA/UST SITES PLANNING, OPERATING, OR CONSIDERING BIOREMEDIATION

REG	SITE/ LOCATION/ LEAD	CONTACT/ PHONE NUMBER	MEDIA/ CONTAMINANT	STATUS	CLEAN-UP LEVELS	TREATMENT	PROBLEMS
X	Utah Power and Light* Idaho Falls, ID RCRA Lead (State)	Andrew Pentony (208) 334-5879 Secondary: Randy Steger (208) 334-5879	Soil: Creosote. Volume: 725 sq. yd. (2-3 feet deep).	In Design: 1991. Laboratory and Pilot-scale. Expected completion: October 1991.	Soil: PAHs, 50 ug/kg	Soil: In-situ bioremediation. Alternative cap. Ground water pump and treat. 33% of site under potential bioremediation	No reference to: volatilization, leaching, dilution of contaminants; No monitoring of ground water addition, mixing, and drying; Preliminary tests were determined to be unsuccessful.
X	Wyckoff Eagle Harbor Puget Sound, WA CERCLA Enforcement Lead	Rene Fuentes (206) 553-1599 (FTS) 399-1599 Lori Cohen (206)553-6523 (FTS)399-6523	Soil/ground water/surface water: Creosote, PCPs.	Operational: Full Scale started January 1990.	Not yet established	Slurry-phase bioremediation: bioreactor-activated sludge for treatment of ground water; aerobic attached growth process in series with aeration tank, clarifier, and biological sludge digestor; possible soil and sludge bioremediation	Insufficient data resulted from plant operation to determine ability of plant to increase its treatment rates. Total plant treatment rate (including carbon filters) ranges from 0-60 gpm. Some problems with biomass dying due to pentachlorophenol spikes

GLOSSARY OF BIOREMEDIATION TECHNOLOGIES

Aerobic Attached Growth Process: Examples including trickling filters, rotating biological filters, aerobic fluidized bed reactors, and other fixed film reactors used for the treatment of waste water, soil, and sludge.

Anaerobic Attached Growth Processess: Examples include anaerobic fluidized bed reactors and upflow anaerobic sludge blanket systems used for the treatment of soil and sludge.

Solid Phase Bioremediation: Contaminated soils spread over or incorporated into a prepared bed/area for treatment utilizing standard operation and management concepts of land treatment technology. Optimized conditions for biodegradation are maintained by tilling the soil regularly for aeration and contaiminant mixing, addition of required nutrients for microbial metabolism, and supplemental irrigation for moisture control.

In situ Bioremediation: Biodegradable contaminants are treated by microorganisms within the waste, soil, or groundwater matrix. Commonly, utilizes aerobic processes and involves delivery of electron acceptors and appropriate nutrients.

Sequencing Batch Reactors: Self-contained treatment system incorporating equalization, aeration and clarification using the draw and fill approach on waste water and sludges.

Composting: Process using microorganisms to biodegrade organic materials in soils and sludges which produce organic and inorganic byproducts and energy in the form of heat.

Slurry-Phase Bioremediation: Process for treating contaminated soils as an aqueous slurry often in a mobile reactor.

Combined Bioprocesses: Combination of biological treatments (e.g. aerobic, denitrification, sulfate reduction and methanogenic processes) used for hazardous wastes. Anaerobic treatment followed by conventional activate sludge treatment is an example of combined bioprocesses.

*U.S. Government Printing Office: 1991 — 548-187/40568

CLU - IN

Cleanup Information Bulletin Board

Number: (301) 589-8366 **Help Line: (301) 589-8368 9 a.m. - 5 p.m. EST**

The Cleanup Information Bulletin Board System (CLU-IN) is designed for hazardous waste cleanup professionals, including EPA, other Federal Agency and State personnel, consulting engineers, technology vendors, remediation contractors, researchers, community groups, and individual citizens to use for finding information about innovative technologies, consulting with one another online, and accessing databases.

Features of CLU-IN

CLU-IN provides the following features:

- Electronic message capabilities
- Bulletins that can be read online (such as summaries of *Federal Register* notices on hazardous wastes, descriptions of EPA documents and training programs, directories of EPA experts on hazardous waste cleanup)
- Files that can be downloaded and used on the user's own computer (such as documents, directories, databases and models)
- Online databases that can be searched on CLU-IN (such as a database on OSWER training courses)

Special Interest Group Areas

CLU-IN also has a number of special interest groups (SIGs) or sub-areas with all the capabilities listed above, but limited to a specific subject area. Examples of SIGs currently on CLU-IN are:

- Innovative Technologies
- Ground water and Engineering Forums
- Ground water Workstations
- Superfund Analytical Services
- On-Scene Coordinators/Removal Actions
- Air/Superfund Coordinators

How to Log On

To log onto CLU-IN, you need a computer, a modem, a phone line, and telecommunications software (such as CrossTalk™, Procomm™, or SmartCom™). Set your communications parameters to 8 data bits, no parity, and 1 stop bit. The phone number is 301-589-8366. If you have trouble logging on, contact the System Operator (SYSOP) at 301-589-8368.

The CLU-IN Bulletin Board was formerly known as the Office of Solid Waste and Emergency Response (OSWER) Bulletin Board.

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