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UNCONTROLLED HAZARDOUS WASTE SITE CONTROL TECHNOLOGY EVALUATION PROGRAM

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY CONTROL TECHNOLOGY PROGRAM

In anticipation of the passage of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund)[1], the Office of Research and Development, of the United States Environmental Protection Agency (USEPA) began a program in 1980 to support the Agency's activities concerned with uncontrolled hazardous waste sites. In the area of environmental engineering and technology, the Agency looked to the ongoing and established program in the Solid and Hazardous Waste Research Division of the Municipal Environmental Research Laboratory. This Division had a base of expertise that could quickly relate to the uncontrolled hazardous waste problem.

The Oil and Hazardous Materials Spills Branch (OHMSB), located at Edison, New Jersey, had been actively pursuing research on the identification, containment, control, removal, and ultimate disposal of hazardous spills since 1971. These activities could be directly related to the removal aspects of Superfund. The Disposal Branch, located in Cincinnati, Ohio, has been actively pursuing research in the area of waste disposal control to the land since 1965. These activities could be directly related to the remedial action aspects of Superfund.

Since CERCLA only provided for a five year program for the uncontrolled hazardous waste site problem, time was not available to establish a fundamental research and development program. The approach taken by the Agency for the Office of Research and Development was one of technical support to the Office of Emergency and Remedial Response. Technologies that had been developed under the Clean Water and Solid Waste programs were adapted to the uncontrolled hazardous waste site situations. In addition, construction techniques, e.g., slurry trench cutoff walls, injection grouting, and chemical stabilization, that had been used for other purposes, were evaluated to determine their applications to uncontrolled sites. It was also concluded that there were very limited data available on the cost and effectiveness of various remedial techniques. The task of collecting and analyzing the available data was initiated.

Once CERCLA became law, the Office of Research and Development developed, in consort with the Office of Emergency and Remedial Response, a five year support strategy which is updated each year. The strategy outlined a program

with peak funding in the early years to meet the immediate needs of the program; the latter years concentrates on technical assistance.

The environmental engineering and control technology research program divides activities along the lines of CERCLA, i.e., removal and remedial actions. In the following sections, details of each program are presented.

REMOVAL TECHNOLOGY PROGRAM

Approach

The overall goal of the Oil & Hazardous Materials Spills Branch (OHMSB) is to provide scientific and engineering expertise in the area of removal (emergency response) activities. Specifically, the OHMSB evaluates and demonstrates new or improved equipment, devices, systems, and data analysis techniques for the prevention, identification, containment, control, removal and ultimate disposal of hazardous substances released to the environment. This includes the cleanup and recovery of hazardous substances from accidental releases as well as from uncontrolled hazardous waste sites, and is consistent with the definition of "removal" in Section 101 of the Superfund legislation. Additionally, the OHMSB demonstrates the equipment and systems to actively encourage the commercial use of cost-effective, advanced technologies during cleanup operations. Once an item is completed and has undergone various field testing, the plans, specifications, and other information are made available

publicly for the purpose of encouraging commercialization of the new technology. Numerous systems, including a mobile water treatment unit and a mobile laboratory, have been completed and are now available commercially.[2]

The OHMSB also provides input into the regulation development, enforcement, and technical support needs of the USEPA's Program Offices and the ten Regional Offices. Regulation development is being assisted through technical background investigation, such as updating the list of Superfund designated hazardous substances and attendant "reportable quantities." Regulation support is also provided by evaluating new cleanup techniques that will be incorporated in the regulations by reference. In this area, the OHMSB provides user manuals for emergency reponse, including sampling and analysis, monitoring techniques, technology evaluation, and guidance for on-scene response personnel. In addition to specific projects addressing decontamination of personnel and equipment, and specialized protective clothing for personnel, all projects in this program area place special emphasis on personnel health and safety.

MAJOR OUTPUTS TO DATE

Major outputs in the removal program to date include the following:

o Mobile Incineration System:

The OHMSB recently completed construction of a mobile incineration system[3] designed for field use to destroy hazardous organic substances

collected from cleanup operations at spills and at uncontrolled hazardous waste sites. The system is designed to the USEPA's PCB destruction specifications (under the Toxic Substances Control Act) to provide state-of-the-art thermal detoxification of long-lived, refractory organic compounds. Hazardous substances that could be incinerated include compounds containing chlorine and phosphorus (i.e., PCB's, kepone, dioxins, and organophosphate pesticides) which may be present in sludges or in soils. In order to systematically evaluate and demonstrate the equipment, a trial burn is currently underway.

o Ultrasonic Submerged Pollutant Detector:

Using existing ultrasonic reflectometry technology, a detector--a sophisticated "fish-finder" for locating insoluble hazardous sinkers (chemicals that sink instead of float or are soluble) at the bottom of waterbodies-has been developed. The detector measures variations in acoustic return echoes, and can be used to uniquely identify the acoustic "signature" of a sunken pollutant. During its development, the device was used to profile a spill of approximately 350,000 gallons of toxic ethylene dichloride into Lake Ferguson near Greenville, Mississippi.[4] The device performed exceptionally well and located pools of pollutant ranging in depth from less than 1/2 inch to 20 inches.

o Hazardous Material Spill Case History Computer System:

A computerized data base system[5], which provides a centralized information bank of past hazardous substances incident response experiences has been developed and is currently being evaluated. This system will serve to aid on-scene personnel in deciding what treatment or technique to use, what degree of cleanup to employ, and what priorities to initiate for cleanup in relation to environmental fate and effects. The system is based upon a standardized after-action data report form which is to be filled out by On-Scene Coordinators, their advisors, or a trained interviewer at the conclusion of a hazardous material incident. The report is in a format and arranged in such a way that the experiences can be subsequently retrieved for use by others who may be facing the same or similar situations. The computerized data base is continually updated with after-action report forms.

o Field Test Kit for Measuring Redox Potentials of Waste Chemicals

A field test kit, for measuring oxidation-reduction (redox) potentials of organic and aqueous waste chemicals, has been developed and evaluated. The test kit permits measurements of the redox potential of environmental samples through use of a portable, battery-operated instrument containing electrode probes, and electrolyte solutions. The entire procedure for obtaining redox measurements requires only a few minutes and can be performed by inexperienced operators. The redox kit

was developed as a screening procedure for segregating drums at uncontrolled hazardous waste sites to preclude the danger of an explosion due to a reaction between oxidizing and reducing agents. Field evaluations of the redox kit were successfully performed during January and November 1981.

MAJOR FUTURE OUTPUTS

Major future outputs of the removal program include the following:

- Mobile Soils Washer:

  A mobile treatment system has been designed for on-site extraction of a broad range of hazardous materials from excavated soils.[6] The system is expected to be an economical alternative to the current approach of excavation, hauling off-site to a landfill, and replacing the excavated soil. The system can be used to extract contaminants from soils--"artificially leaching" the soil using water--and enabling operators to leave the treated soil on-site. The extracted hazardous materials are separated from the washing fluid using physical/chemical treatment procedures. The cleaned washing fluid is recirculated, and the separated and concentrated hazardous materials are disposed of by appropriate means. The system is currently undergoing shakedown tests and is expected to be available for field demonstration during FY-83.

o Mobile Carbon Regenerator:

Water contaminated with hazardous substances has been successfully cleaned using water decontamination equipment such as the USEPA's mobile physical/chemical treatment system.[7] This system, which utilizes granular activated carbon to concentrate dilute dissolved organic contaminants, can be made more cost-effective with on-site regeneration of the spent carbon as opposed to transporting the carbon for off-site regeneration or placing it in a secure landfill. In order to provide a safe and effective method for handling contaminated carbon, the OHMSB has developed a mobile unit for detoxifying/regenerating the carbon at the cleanup site.[8] The system has recently undergone initial shakedown and preliminary testing, and is expected to be ready for field demonstration and evaluation during FY-83.

o Mobile In-Situ Containment/Treatment System:

The OHMSB has developed an innovative, mobile system for treating contaminated soils in place at reduced costs, in terms of dollars per pound of contaminant removed.[9] The technique employs flushing with additives and detoxification by chemical reaction. In-situ containment is accomplished by the mobile unit through direct injection of grouting material into the soil around the contaminated area in order to isolate the released chemicals. The chemicals are then treated in place by water flushing with additives, or by other methods such as oxidation/reduction,

neutralization, or precipitation. The collected chemically contaminated wash solution can be processed through a mobile water treatment unit where contaminants are removed. The mobile in-situ containment/treatment system is currently undergoing shakedown tests and will be available for field evaluation during mid FY-83.

o Manuals

The OHMSB is currently preparing documents for release to the user community during FY-83/84. Each of these user-oriented field manuals is being prepared in close cooperation and coordination with representatives of private organizations who would potentially use the manuals. These manuals are the following:

- Environmental Emergency Control Handbook for First Responders which will cover specific environmental-related practices to assist first-on-scene personnel, such as firefighters, in their decision-making process during the first critical minutes of a hazardous substance spill or release incident, where fire is not involved.

- Manual on Physical and Chemical Countermeasures which will provide general recommendations for using physical and chemical countermeasures to mitigate frequently occurring hazardous substance

releases in subsurface soils and in large, relatively quiescent waterbodies such as lakes, ponds, canals, and slowly moving rivers. These recommendations will take the form of a matrix of countermeasures versus release types and will be applicable to the cleanup of spills as well as uncontrolled hazardous waste sites.

- Spill Prevention Manual, which will provide a matrix for various classes and groups of chemicals and spill-prevention techniques for these chemicals. This matrix will be developed primarily through communication with trade associations (such as the Chemical Manufacturers Association and others) and organizations engaged in producing, storing, and transferring hazardous substances. The manual will also be developed into a training course/workshop.

REMEDIAL TECHNOLOGY PROGRAM

Approach

The overall goal of the Disposal Branch is to assess and validate new or improved remedial action technologies or schemes to minimize pollutant release from uncontrolled hazardous waste disposal sites. More specifically, the remedial activity includes site survey and assessment studies, bench and pilot studies, field verification studies, cost-effectiveness and model studies. These studies are being performed to validate control technologies as they

relate to surface water control, groundwater control, plume management, chemical immobilization, and excavation and reburial. The activities are consistent with the definition of remedial action in Section 101 of Superfund (CERCLA). The Disposal Branch has pursued activities for new landfill design in the research areas of pollutant identification, pollutant generation, pollutant transport, pollutant control, and economics. These activities have direct relationships to the remedial action schemes for uncontrolled landfill sites. These research areas include bench, pilot, and field studies accompanied by the predictive modeling work. This research activity has produced eight technical resource documents (TRD's)[10-17] which reflect best engineering judgement for the design of waste disposal facilities as relate to landfills, land treatment, and surface impoundments.

The Disposal Branch also assists the Office of Emergency and Remedial Response and several of the Regional Offices in the areas of regulation development, technical and enforcement support, and assistance in the development of the National Contingency Plan[(18)]. This support typically includes the development of technical documents describing the design and construction of a variety of remedial action schemes which could be utilized as control measures at uncontrolled landfill sites.

Major Outputs to Date

Major outputs in the remedial program to date include the following:

o Handbook - Remedial Action at Waste Disposal Sites

The Disposal Branch, in consort with the Office of Emergency and Remedial Response, recently published the subject technology transfer document.[19] With this information the reader can then develop a preliminary remedial action plan and cost estimate. The objectives of the Handbook are twofold: (1) to provide the reader with a generalized understanding of the pollutant pathways involved in waste disposal sites, the remedial actions as they apply to each pathway, and the process of selecting the appropriate remedial actions; and (2) to provide detailed information on specific remedial actions including applications, state-of-the-art, design, construction, and/or operating considerations, advantages, disadvantages and costs.

o Remedial Actions at Hazardous Waste Sites: Survey and Case Studies

A survey[20] of one hundred and sixty-nine waste disposal sites was performed to identify what type of remedial action was implemented. Technologies employed at these sites included: (1) containment, (2) removal of wastes for incineration or secure burial, (3) institution of surface water controls, and (4) institution of groundwater controls. A major deficiency of this study was that only 9 of the 169 sites were able to be investigated in detail. The other 160 sites were given only a cursory survey investigation. Remedial measures usually consisted of containment of contaminants or waste

removal. The survey determined that a lack of sufficient funds and/or selection of improper technologies was responsible for remedial actions having been applied effectively at only a few of the uncontrolled waste disposal sites. This survey is currently being updated.

o Guidance Manual for Minimizing Pollution from Waste Disposal Sites

The purpose of this manual[21] was to provide guidance in the selection of available engineering technology to reduce or eliminate leachate generation at hazardous waste disposal sites. The manual emphasizes remedial measures for use during or after closure of the sites. Some of the measures are passive, that is, they require little or no maintenance once emplaced. Others are active and require a continuing input of manpower or electricity.

o Block Displacement Technique of Waste Isolation

A field demonstration of a technique to construct a clay isolation barrier around hazardous waste sites was recently completed. The block displacement technique is accomplished through a phase sequence of drilling, fracturing, and bentonite slurry injection around the bottom and sides of a waste disposal site with the resultant upheaval of the waste site to form a block, isolated by an impermeable bentonite barrier. We were unable to demonstrate the

full isolation at the study site, especially in the vertical plane, because of certain site specific anomalies such as the presence of tree roots below the local groundwater level and the presence of a variable iron-cemented strata immediately overlying the horizontal plane of bentonite injection across the bottom. However, there was evidence that the bentonite slurry did penetrate the horizontal fracturing plane.

o Guidance Manual for Slurry Trench Design and Installation

A Guidance Manual for slurry trench cut-off wall design, construction, and performance evaluation is near completion. It provides recommendations on a variety of scientific and technical parameters relevant to using this approach to isolate hazardous chemicals in near-surface groundwater regimes. The accomplishment of this effort required extensive information gathering and integration of technical data gathered from a diverse array of experience and authorities. Conclusive recommendations reported within the Guidance Manual were determined by investigating areas of influence. These areas included historical perspective, present methodology, chemical compatibility tests, shortcomings of common backfill materials, positive recommendations for resistant backfill materials, detailed site soil and geologic characteristics which impact cut-off wall success, vegetation, checklists of design construction, performance factors, and documenting the quality and performance of completed construction.

Major Future Outputs

- Physical and Hydrogeologic Models for Hazardous Waste Sites

  Remedial action alternatives for uncontrolled hazardous waste sites must be described in terms of attenuation or mitigation of existing or eminent public health/environmental problems, capital costs, O&M costs, design life, and risk of failure. This task will develop two complimentary levels of modeling. Level 1 will be a relatively detailed modeling level for specific site engineering, and will consider detailed site factors, contaminant migration, detailed models of technologies, interrelationship among technologies, costs, design lifes, and risk of failure. Level 2 will be simplified desktop procedures for use primarily by state and federal personnel for problem assessment, preliminary screening of the cost and effectiveness of remedial actions, and rapid review of remedial action plans. Level 2 will be based on sensitivity and factor analysis of key site and technology characteristics using the detailed Level 1 models. Both levels will describe the effectiveness of remedial actions considering site factors and characterization of the control technologies.

- Cost Analysis of the Effects of Human Safety and Degree of Hazard as They Affect Remedial Actions at Uncontrolled Hazardous Waste Sites

  This study will seek to determine the factors which contribute to the increased costs and ascertain the magnitude of additional

costs associated with various components of remedial action unit operations. Primary source for data will be the private contractors and project officials having knowledge of the specific elements of project costs, and the manner in which these vary as a result of proximity to hazardous waste materials. Estimates of the additional costs incurred will be indicated in terms of percentages of ordinary or usual costs, and in absolute terms where appropriate. The information produced will be valuable to program offices and others in evaluating costs of remedial actions.

- o Update of Survey Information on Completed and Ongoing Remedial Action Efforts

Since the time the study "Remedial Actions at Hazardous Waste Sites: Survey and Case Studies"[20] was made more recent information on remedial actions has become available. There is an obvious need to bring together and analyze the current up-to-date information, including effectiveness and cost. This information will serve as a foundation for future decision making with regard to presently uninitiated remedial action efforts.

- o Reliability of Available Technologies when Considered with Cost-Effectiveness

This study has been initiated to develop procedures for

conducting the cost-effectiveness analysis at uncontrolled hazardous waste sites. Various remedial action options are available for any uncontrolled hazardous waste site. In broad categorical areas they are: alternative measures, active measures, and passive measures

The "alternative measures" category is meant to include such actions as moving the affected population away from the site or providing alternative water supplies. The "active measures" would include treatment scenarios applied directly to the site such as excavation and reburial in a secure site, waste stabilization, neutralization, treatment and/or elimination of problem. "Passive measures" would include entombment or isolation techniques using slurry walls, grout curtains, capping, bottom sealing, etc.

o Collection of Data on Compatibility of Grouts with Hazardous Wastes

Available data from the literature and industrial sources will be collected on the compatibility of various types of suspension and chemical grouts with various classes of hazardous wastes and leachates. In addition, information will be collected on the procedures available to test the durability of grouts in the presence of hazardous wastes and leachates.

o In Situ Treatment Techniques Applicable to Large Quantities of Hazardous Waste Contaminated Soils

The project addresses detoxification of large quantities of hazardous waste contaminated soils located at Superfund or other uncontrolled hazardous waste sites. In situ chemical and/or biological treatment methods presently available will be identified and evaluated. The feasibility and effectiveness of these methods will be assessed based on waste, soil type, site conditions and economic considerations. The output, a technical handbook, will include pertinent information concerning soil sorption and chemical and soil interaction influences on waste degradation. The remedial action identified as the most promising of the evaluated methods may be applied in a follow-up study (Phase II) on a full scale basis at a Superfund site.

o Field Evaluation of Drum Encapsulation Techniques

A process for encapsulating drums containing hazardous waste is being demonstrated. Efforts will include evaluating the overpack/cover weld, resistance to physical stress (drop test, puncture resistance, etc.), and equipment performance. Mobility of the process and equipment is important and evaluations will develop criteria for mounting the hardware on a flat bed tractor/trailer vehicle.

o Development of Methods and Pilot Test for In Situ Hazardous Waste Stabilization by Injection Grouting

This project will provide pilot scale tests to predict applicability to specific sites with specific waste compounds and expand the state-of-the-art to hazardous waste in situ stabilization The pressure injection of grout to a variety of waste types will be investigated to develop a matrix of grout types to waste types with appropriate grout pressures and tube spacings included.

o Manuals

The Disposal Branch is currently preparing documents for release to the user community during FY'83 and FY'84. Each of these user-oriented field manuals is being prepared in close cooperation with representatives of private organizations, and State and Federal agencies who would potentially use them. These manuals include the following:

- User Guide for Evaluating Remedial Action Technologies

The objective of this task is to produce a Remedial Action Technical Resource Document (TRD) describing how the technologies and methods for evaluating proposed RCRA new hazardous waste disposal sites can be applied to site-specific remedial response activities for uncontrolled hazardous waste sites. The Remedial Action Document

will be based on the state-of-the-art technical and cost information in eight TRDs[10-17] for design and evaluation of new hazardous waste disposal sites under RCRA. That information will be reviewed for relevance to remedial response at uncontrolled hazardous waste disposal sites, and will be edited and refocussed to address the needs of personnal involved in response and remedial action planning under CERCLA.

- Guidance Manual for Fixation/Solidification of Wastes in Surface Impoundments

This project will define the limits of applicability of fixation/solidification techniques to remedial actions at uncontrolled sites when considered in perspective with alternative or competing options. Information will be drawn from available fixation/solidification technology. The major problem with using these techniques at uncontrolled hazardous waste sites is that the composition of the waste is often unknown.

- Guidance Manual for Cover Design and Installation

A specification manual for the selection, design, and installation of covers or surface caps for uncontrolled hazardous waste sites is being prepared. Much of the information developed from two existing EPA reports[10 & 22] will be incorporated into this manual that will be specific to the problems of uncontrolled sites.

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