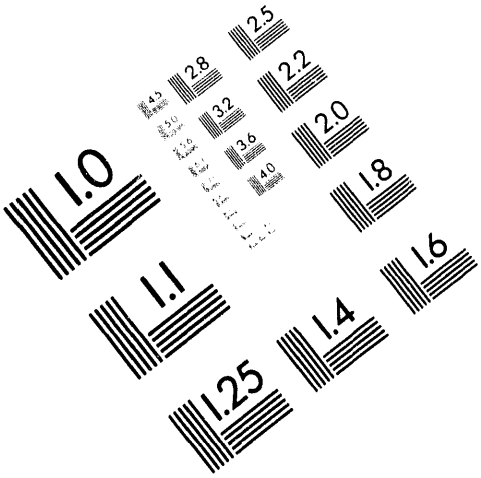

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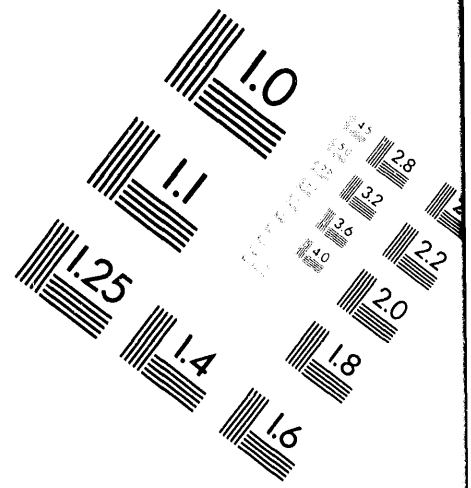

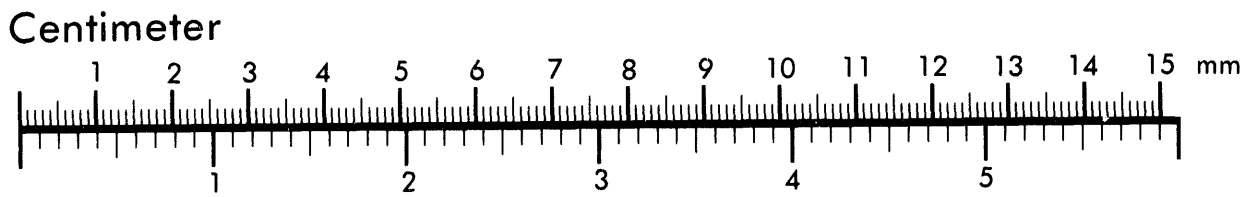

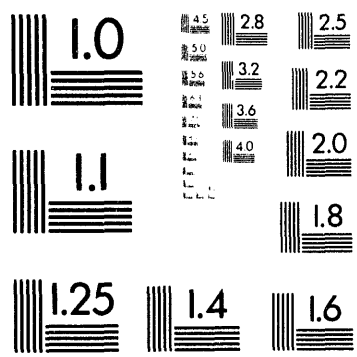

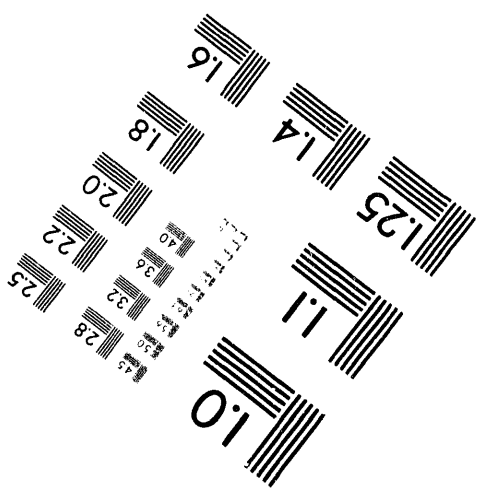

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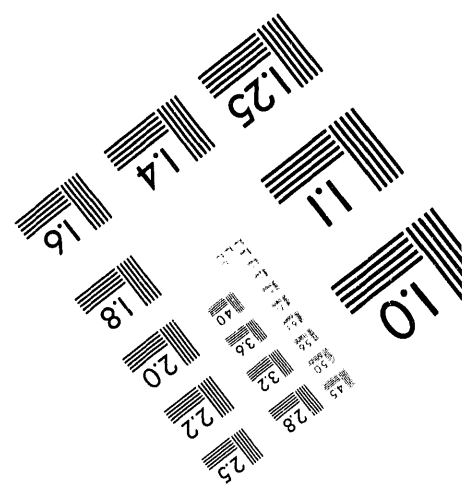

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THE MIXED WASTE LANDFILL INTEGRATED DEMONSTRATION

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ABSTRACT

The US Department of Energy's Office of Technology Development (OTD) has a mission to rapidly develop, demonstrate, and transfer needed environmental technologies to Environmental Restoration, Waste Operations, and Defense Programs. As part of this initiative, OTD is supporting a network of Integrated Demonstrations (ID) that "integrate" the "demonstration" of innovative technologies that are proposed by federal laboratories / universities / industry research partnerships. Each ID is focused upon a different environmental need aimed at resolving specific problems representative of generic DOE environmental issues.

SUBJECT

The Mixed Waste Landfill Integrated Demonstration (MWLID) focuses on "in-situ" characterization, monitoring, remediation, and containment of landfills in arid environments that contain hazardous and mixed waste. The MWLID mission is to assess, demonstrate, and transfer technologies and systems that lead to faster, better, cheaper, and safer cleanup. Most important, the demonstrated technologies will be evaluated against the baseline of conventional technologies and systems. The comparison will include the cost, efficiency, risk, and feasibility of using these innovative technologies at other sites. Key goals and measures of success of the MWLID are commercialization of these technologies to the private sector and routine use of these technologies by environmental restoration groups throughout the DOE complex. The MWLID is demonstrating technologies at Sandia National Laboratories' Chemical Waste Landfill, Mixed Waste Landfill and an Air Force Weapons Laboratory Hazardous Solid Waste Amendments (HSWA) site. These sites were selected because they are representative of many sites throughout the southwest and other arid climates. The MWLID program is divided into four areas: Characterization Remediation, Containment, and Technology Integration.

Characterization must answer the question: What is happening beneath the waste site? Detailed information must be known about the contamination including the source, types, mobility, and amounts as well as the spatial distribution of each contaminant. Quantitative information about the geologic and hydrologic properties of the site also must be determined so environmental scientists can accurately predict how contaminants behave underground. Multiple technologies are required to fully characterize and

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monitor a site. The MWLID utilizes a systems approach that incorporates compatible and complementary technologies for site investigation.

One of the MWLID's primary goals is applying innovative technologies to minimize disturbance and worker exposure at landfills while maximizing information gathered by characterization methods. For source characterization, non-intrusive technologies that do not require holes to be drilled or samples to be taken include *electromagnetic* measurements and *magnetometry*. The ID is employing a *computerized sampling plan* using geostatistics that optimizes historical and field data to aid in the formulation of a sampling strategy. New methods of *directional drilling* and *horizontal boring* are being demonstrated to eliminate the problem of drilling-induced contaminant migration and contaminated drilling by-products. A rapid field screening method for the detection of heavy metals in soil, *stripping voltammetry*, is being demonstrated on samples retrieved during drilling operations. The *SEAMIST*™ membrane liner that can replace the rigid casing found in most boreholes, can be used for sample collection, in situ measurements, and transporting sensors downhole reducing exposure to the instruments from the contaminated soils. Many of the characterization technologies being evaluated are also compatible with long-term monitoring activities. A *Landfill Characterization and Monitoring System* (LCMS) is being developed that emphasizes monitoring of the vadose zone. It is the intent of the LCMS to integrate these technologies and provide as many of the necessary pieces as possible to the characterization and monitoring puzzle.

Site characterization provides the information necessary for the MWLID to tackle the technology development for remediation of mixed waste landfills using in-situ technologies that will minimize the risk from the landfill contents. This innovative remediation mission is based on the premises that (1) moving the landfill to another location only transfers the risk and (2) the national capacity for permitted mixed-waste is limited, thus encouraging management of mixed-waste landfills at their current location.

Few in-situ technologies are available to remediate contamination located in the area between the landfill and the groundwater. This "vadose zone" is an important area because it provides a barrier between the landfill and groundwater. While the vadose zone can effectively isolate and contain some contaminants, other contaminants may move quickly through this zone. When the vadose zone becomes contaminated with fast-moving pollutants, such as volatile organics, scientists are concerned that pollutants may reach groundwater before intervention can take place. The MWLID focuses on safe, efficient, and effective new methods to remediate fast-moving contamination in the critical vadose zone. These remediation technologies can provide the basis for an advanced clean-up strategy. The MWLID is demonstrating innovative extraction technologies including *Thermal Enhanced Vapor Extraction System* (TEVES) and *Electrokinetics* - a method where subsurface chromium contamination is moved through the soils by the forces of a small electric field. Technologies are also being evaluated to find ways to transform more mobile chromium to a less mobile state by a chemical reduction process.

Once the immediate threat of fast-moving contaminants is under control, the remaining landfill debris must be contained to minimize the long-term migration of slow-moving contaminants. Containment technologies involve: (1) the placement of *surface covers* to minimize precipitation infiltration into the landfill and leaching wastes into the surrounding soil; and (2) the placement of *subsurface barriers* to contain slow-moving soil contaminants. The MWLID is evaluating the materials and emplacement methods for subsurface barriers; but, more importantly, is evaluating methods to *verify the subsurface barriers* are meeting containment performance criteria. Current verification techniques include geophysical, hydrological, and observational methods. Above ground technologies, termed covers or caps, are required for the closure of all landfills in order to reduce leaching of wastes into the subsurface. Alternative cover designs which offer cost and

technical advantages in arid and semi-arid regions are being demonstrated. A *dry barrier* which utilizes air flow through course gravel layers in order to remove moisture from the cover system is being evaluated for cover and subsurface applications. A decision tool for environmental restoration professionals to evaluate optimal cover designs is under development. The ID is evaluating the feasibility of emplacement of subsurface containment structures. Using directionally drilled holes to gain access under a landfill, materials such as grouts can be emplaced to limit leachate movement from the site and also provide a contained area to assist transformation techniques. Other containment alternatives, such as permeable barriers which permit water flow but retain contaminants, are being evaluated

Technology Integration is an integral part of the MWLID mission. The focus of the technology integration effort is to facilitate the involvement of outside participants in the ID activities, to expedite the transfer of the technologies to the private sector for commercialization and to hasten the adoption of successfully demonstrated technologies throughout the DOE complex and by other Federal agencies. The ID is working with federal, state, municipal, and tribal governmental agencies to expedite the regulatory approval and the use of these technologies. The MWLID is aggressively developing partnerships with the State, municipalities, tribal groups, and private industry to broaden the knowledge and use of its achievements. The ID is working with The New Mexico Environmental Alliance to apply innovative technical solutions to industrial environmental problems. The MWLID is an active participant in the DOE-sponsored Waste Management Education and Research Consortium (WERC), a research partnership among the New Mexico universities, national laboratories and the Navajo Community College. The ID provides internships and graduate research opportunities for students and educators to challenge them to become involved with innovative solutions to environmental problems.

CONCLUSION

The Office of Technology Development has identified performance measures or metrics for technology development. The metrics and how the ID measures up is as follows:

OTD-1) Identify "Improved Technologies" (that show improvement over baseline technologies) that; lowers cost, reduces risk to workers and the public, provide cleaner final site, and are safer.

ID-1) The ID's technologies have reduced the number of boreholes and samples needed for site characterization. There have been sixty field demonstrations of ID technologies that have resulted in no personal injuries or exposures. There have been no releases or episodes which have placed the public or the environment at risk. The concept of identifying and then remediating the fastest moving constituants and containing the remaining contaminants will allow for a cleaner final site with reduced costs compared to conventional remediation.

OTD-2) To develop technologies that meet engineering and economic criteria after bench and pilot phases.

ID-2) The ID is demonstrating several technologies which come from the remediation Integrated Program and will be demonstrating another in FY95.

OTD-3) It is essential to have user involvement in the development process.

ID-3) The ID has in the past and will continue to work with Environmental Restoration (ER) in identifying needs and evaluating new proposals. ID technologies have been field tested on Sandia ER sites to assist in characterization and partial remediation of hazardous landfills.

OTD-4) Assure availability of technologies for transfer with full documentation and insure they meet the requirements of stakeholders.

ID-4) The ID has worked with OTD Headquarters Program Managers and Operations Office Program personnel in identifying deliverables, milestones, final reports and conducting commercialization workshops to insure that transfer of technologies can be done

smoothly and efficiently. The ID has Beta-tested PROTECH, a technology database, and been instrumental in collecting information for inclusion into it.

OTD-5) Technologies must meet the requirements of stakeholders and final decision documents.

ID-5) Stakeholders are constantly being made aware of progress of ID technology development through technology reviews, mid-years and during the technical reviews for future funded projects. The OTD also includes stakeholders in their mid-year reviews and publishes monthly status reports from the IDs and IPs.

OTD-6) Provide mechanisms for "Private Sector" to use their creativity and entrepreneurial spirit. Pull together the best talent and innovation available, leverage DOE dollars with private investment and improve technology transfer and implementation.

ID-6) The MWLID has twenty-five industrial partners working on FY94 projects. Two of these partners have CRADAs currently in place with two more close to signing agreements. The ID has 7 national laboratories, multiple research laboratories and 6 universities participating on technical projects. WERC, as previously mentioned, has also been very active on several different technology demonstrations. Leveraging of over 1 Million dollars from industrial partners, since the ID was started has reinforced their commitment to develop technologies to the OTD mission. To insure that technologies are transferred the MWLID will conduct commercialization workshops to aid the private sector in marketing their technologies. Small business workshops have been conducted to help those from the private sector understand the ways they can partner with the national labs.
MWLID technologies that have been commercialized are: 1) magnetometer towed array, a non-intrusive characterization technology, (GeoCenters, Inc.) 2) Siteplanner™, a sampling strategy software, (ConSolve, Inc. 3) SEAMIST™, a membrane used for sampling, sensor transport and maintaining borehole integrity. (Eastman Cherrington Environmental, Inc.)

The MWLID will continue to work closely with the Office of Technology Development in insuring that we continue to strive to meet their metrics throughout the lifetime of this demonstration.

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