SITE NEED STATEMENT

General Reference Information

Need Title: **Long-Term Monitoring of Moisture Content as a Precursor to Contaminant Transport in the Vadose Zone and Closure Covers**

Need Code: NV18-0200-05S

Need Summary: Monitoring of low-level radioactive waste, mixed waste and hazardous disposal sites is required under DOE Order 435.1, as well as under the Resource Conservation and Recovery Act (RCRA). Contaminated industrial sites and operating low-level radioactive and mixed waste sites are located in arid alluvial valleys where the groundwater table is between 500 to 1600 feet below the surface. The exceptionally thick vadose zone at these locations mandates development of efficient monitoring systems that can: 1) verify site conditions documented in site characterization and performance assessment studies; and 2) provide early warning of an increased potential for migration of hazardous and radioactive contaminants. Pursuant to agreement with the State of Nevada, downward advances of moisture or "wetting" fronts, or increased moisture content at particular depths in the vadose zone are considered precursor evidence that contaminant migration *may* also be occurring. Cost-effective monitoring systems that meet the needs of assessing changes in moisture fronts or content need to be designed, demonstrated, and deployed at hazardous and radioactive waste management site(s) on the Nevada Test Site. Many of the components of such monitoring systems are available currently in the commercial sector, with the exception of a method for measuring the concentration of tritium (see Technology Need NV01). The emphasis of this information need is on: 1) designing optimum geometric configurations for monitoring systems to potentially reduce the number of devices, yet improve overall efficiency for release detection; 2) assembling and testing monitoring components; 3) evaluating long-term effectiveness of existing and still to be deployed monitoring equipment, including the effects of subsidence on them; 4) refining and optimizing instrument packages; 5) developing cost-effective deployment arrays; 6) optimizing detection capability for the specific hydrogeological setting of the arid western sites; and (7) providing for means of remote data collection, particularly for remote sites, and as the number of sites requiring post-closure monitoring in NV214/Industrial Sites increases.

Origination Date: August 1, 2001

Need Type: Science

Operations Office: NNSA/NV

Geographic Site Name: Nevada Test Site, Areas 3 & 5 Radioactive Waste Management Sites (RWMS)

Project: NV370/Low-Level Waste, NV214/Industrial Sites

National Priority: Medium

Operations Office Priority: 5 of 13

Problem Description Information

Operations Office Program Description: The primary mission of the NNSA/NV Waste Management Program is to manage radioactive and hazardous waste generated by DOE and defense industry activities that is stored or disposed at the Nevada Test Site. The Waste Management Program must ensure that the acceptance, treatment, storage, and/or disposal of waste is carried out in accordance with federal, state, and local regulations.

Need/Problem Description: Monitoring of low-level radioactive waste, mixed waste and hazardous disposal sites is required under DOE Order 435.1, as well as under the Resource Conservation and Recovery Act (RCRA). Contaminated industrial sites and operating low-level radioactive and mixed waste sites are located in arid alluvial valleys where the groundwater table is between 500 to 1600 feet below the surface. The exceptionally thick vadose zone at these locations mandates development of efficient monitoring systems that can: 1) verify site conditions documented in site characterization and performance assessment studies; and 2) provide early warning of an increased potential for migration of hazardous and radioactive contaminants. Pursuant to agreement with the State of Nevada, NNSA/NV measures for advances in a soil moisture/wetting front and increases in

	soil moisture content as evidence that contaminant migration may also be occurring. TDR and neutron probes are the current baseline soil moisture measurement instruments being used for closures on the NTS. Cost-effective monitoring systems that meet these requirements need to be designed, demonstrated, and deployed at hazardous and radioactive waste management site(s) on the Nevada Test Site. Many of the components of such monitoring systems are available currently in the commercial sector, with the exception of a method for measuring the concentration of tritium (see Technology Need NV01). The emphasis of this information need is on: 1) designing optimum geometric configurations for monitoring systems to potentially reduce the number of devices, yet improve overall efficiency for release detection; 2) assembling and testing monitoring components; 3) evaluating long-term effectiveness of existing and still to be deployed monitoring equipment, including the effects of subsidence on them; 4) refining and optimizing instrument packages; 5) developing cost-effective deployment arrays; 6) optimizing detection capability for the specific hydrogeological setting of the arid western sites; and (7) providing for means of remote data collection, particularly for remote sites, and as the number of sites requiring post-closure monitoring in NV214/Industrial Sites increases.
Functional Performance Requirements:	The Long-Term Monitoring of Moisture Content as a Precursor to Contaminant Transport in the Vadose Zone and Closure Covers system must be capable of performing or conveying information on the following functions: • Measure soil moisture levels. • Measure moisture and contaminant concentrations at specific depths. Performance requirements in telemetry would include the following: • Improved reliability of retrieving data remotely. • Improved ability to collect large amounts of data remotely.
Definition of Solution:	Develop an acceptable system for monitoring the vadose zone at sites on the NTS containing low-level radioactive, mixed and hazardous waste. The monitoring system must meet the regulatory requirements of DOE/NV M 435.1 and RCRA. Cost-effective methods for *in situ* detection and quantitative measurement of tritium are needed for both soil-water and pore gases in the vadose zone.
Targeted Focus Area:	Subsurface Contaminants
Potential Benefits:	Traditional monitoring methods would cost significantly more than the alternative technology. The traditional monitoring methods may also not provide useful data on the actual performance of the disposal system. Use of the alternative technology could provide indicators of adverse disposal system performance prior to an impact to the groundwater. Early warning of a potential for groundwater contamination could allow sufficient time to establish a mitigation action effort to preclude, or reduce impacts.
Potential Cost Savings:	$10.2 Million
Potential Cost Savings Narrative:	When compared to the estimate for a traditional monitoring system, the total cost savings, for a 100-year period, is approximately $10.2 million
Technical Basis:	The existing monitoring technology needs to be optimized with respect to the device placement and monitoring frequency, instrumentation packages, data acquisition programs, and deployment geometry for long-term in situ monitoring in the vadose zone. Technology development is needed to design and test a tritium detector.
Cultural/Stakeholder Basis:	There is increased confidence of the protection of the public from hazardous and radiological exposure through systematic efforts to reduce uncertainty and verify conceptual models of disposal systems. Vadose zone monitoring provides both an early warning detection system and real-time measurements of the performance of a waste isolation system. Stakeholder confidence should be increased by deployment of monitoring systems that detect changes in a system before the occurrence of significant contamination. Measurement confirmation of expected system performance provides increased confidence that a disposal site is safe and protective of human health and safety.
Environment, Safety, and Health Basis:	Monitoring improves the confidence in the performance assessment models that establish waste-acceptance criteria for ongoing operation of low-level, mixed, and hazardous waste sites. Monitoring data are required for regulator approval of site-cleanup strategies. Onsite monitoring provides tangible measurement of the presence or absence of contaminants and specifically tests conclusions from analytical and numerical modeling. If soil moisture measurements indicate there

	may be potential for contaminant migration, then soil water samples can be collected to test whether contaminants are present. Development and deployment of early warning monitoring devices preserve the opportunity to modify a disposal system prior to significant releases of hazardous and/or radioactive contaminants.
Regulatory Drivers:	DOE/NV M 435.1 - Radioactive Waste Management, RCRA - Hazardous Waste Management
Milestones:	Not applicable
Material Streams:	LLW Sludge, Contaminated Soils & Liquid (1019); Technical risk score 3. Not on critical path to closure. For Industrial Sites, includes inactive tanks, drains and sumps, spill sites, material disposal sites, decontamination sites, and D&D facilities; for LLW and mixed LLW includes drums, cargo containers, crates, and "burrito wraps".
TSD System:	Includes engineered caps and covers and covers constructed over contaminants left in place (e.g., GCD disposal). No other on-site treatment of waste except for sizing of material to place in waste containers (e.g., D&D wastes).
Major Contaminants:	For Industrial Sites, includes organic and inorganic chemicals, petroleum products, metals, unexploded ordnance and related contaminants, and radionuclides including tritium, mixed fission products, and actinides (although at levels below classification of waste as TRU waste).
Contaminated Media:	Soil, concrete, construction material, sludges (e.g., at industrial sites), paper, etc. Soil and sludges are the only waste forms not in containers (from Industrial Sites closed in place).
Volume/Size of Contaminated Media:	Mixed Low Level Waste: 230 cubic meters; Low Level Waste: 365,453 cubic meters; Industrial Site Waste: 11,209 cubic meters (mostly hazardous waste).
Earliest Date Required:	2001
Latest Date Required:	2008

Baseline Technology Information

Baseline Technology Process:	Current baseline monitoring technology consists of groundwater monitoring in drill holes, an unrealistic and costly approach given the 500-to-1600 foot-depth to groundwater beneath industrial and waste disposal sites. Baseline radiotelemetry systems on the NTS are limited in the amount of data that can be downloaded from them. In addition, there is man-made interference because of limitations on bandwidths. Other telemetry systems besides radio may be worth evaluating.
Life-Cycle Cost Using Baseline:	$15.2 Million for monitoring. Cost savings for improved telemetry cannot be calculated at this time. It will depend on what systems appear feasible for the NTS. And because of fixed costs for any telemetry system, cost savings per site will be greater as the number of sites served by a system increases.
Uncertainty on Baseline Life-Cycle Cost:	The estimated total cost for the deployment of Long-Term Monitoring of Moisture Content as a Precursor to Contaminant Transport in the Vadose Zone and Closure Covers including borehole installation, plus 100-years of monitoring, data analysis, and modeling for each unit or facility (depending on the approved application of the monitoring configuration) is approximately $5 million.
Completion Date Using Baseline:	2002-2006

Points of Contact (POC)

Contractor End User POCs:	Don Van Etten, Bechtel Nevada, Environmental Monitoring Manager - Office: 702-295-2446; Fax: 702-295-1313; E-mail: vanettdm@nv.doe.gov Michael Young, Desert Research Institute, Technical Support - Office: 702-895-0489; Fax: 702-895-0427; E-mail: michael@dri.edu
DOE End User POCs:	Frank Di Sanza, WMD - Office: 702-295-5855; Fax: 702-295-1153; E-mail: disanza@nv.doe.gov Janet Appenzeller-Wing, ERD - Office: 702-295-0461; Fax: 702-295-1113; Email: wing@nv.doe.gov