CHALLENGES FOR REMEDIATING WASTE BURIED AT THE IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

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ABSTRACT

The Idaho National Engineering and Environmental Laboratory's (INEEL's) Environmental Restoration Program staff have devised an effective strategy for investigating how to best remediate waste buried before 1970 at the site's Radioactive Waste Management Complex (RWMC).

The U.S. Department of Energy, U.S. Environmental Protection Agency, and the state of Idaho have initiated a remedial investigation/feasibility study, which will describe remedial alternatives and provide information that decision-makers will use to compare remedial alternatives. A record of decision could be signed in late 2003.

Today, the Subsurface Disposal Area (SDA), a 97-acre area of the RWMC where wastes were buried, is one of the world's best-documented landfills, in terms of waste inventory knowledge and the locations of its wastes. For each of the waste types in the SDA, INEEL has detailed disposal records that indicate disposal locations and quantities. This information has been compiled into a comprehensive database. Process knowledge of how the wastes were generated also is relatively complete.

In addition to historical knowledge, current technical approaches to verify waste content and locations include magnetic surveys, shallow surface soil vapor surveys, and probing. Extensive groundwater and vadose zone monitoring is underway to gain information about contaminant migration and potential migration. Data from waste retrievals performed as early as 1968 are part of the project file.

Additional data-gathering tasks include work to determine: the nature and extent of the contamination; the mass of volatile organic compounds remaining in the waste; the rates that uranium and carbon-14 are being released from the waste; influence of the nearby Big Lost River system on waste migration; locations of specific waste streams; and implementability and costs of remedies.

This knowledge will allow a technically defensible remedial investigation/feasibility study to serve as the foundation for selecting the best approach to remediate the SDA.

Depending on the remedy approach selected, remediating the SDA could cost billions of dollars. This decision will be the most closely watched of any cleanup project to date at the INEEL and will continue to attract national attention.

INTRODUCTION

The Idaho National Engineering and Environmental Laboratory's (INEEL's) Environmental Restoration Program staff have devised an effective strategy for investigating how to best remediate waste buried before 1970 at the site's Radioactive Waste Management Complex (RWMC).

During the past decade, the INEEL has removed thousands of cubic feet of radioactively contaminated soil, capped two reactor burial grounds, removed thousands of World War II-era unexploded ordnance devices, removed and treated mixed waste, and collected and properly disposed of heavy metal- and PCB-contaminated soils. Approximately 68 percent of the legacy has been addressed. Despite these successes, the INEEL's cleanup mission is far from over. The U.S. Department of Energy-Idaho Operations Office (DOE), Region 10 of the U.S. Environmental Protection Agency (EPA), and the Idaho Department of Environmental Quality (state of Idaho) are applying what they have learned over the last 10 years to tackle one of the most challenging contaminated areas at the 890-square-mile lab in eastern Idaho.

Of great concern is the buried transuranic waste at the RWMC. The INEEL buried the nation's pre-1970 nuclear weapons production waste at a 97-acre area of the RWMC known as the Subsurface Disposal Area (SDA). Over time, the waste containers have degraded, and volatile organic compound (VOC) contaminants have migrated to the underlying aquifer.

To assess the problem, INEEL is constructing a comprehensive waste disposal database. The SDA today is one of the world's best-understood landfills, in terms of waste inventory knowledge and the locations of its wastes. It is this knowledge that will allow a technically defensible remedial investigation/feasibility study to serve as the foundation for selecting the best remedy array to remediate the SDA.

INEEL AND RWMC HISTORY

The INEEL was established in 1949 in the remote Arco Desert to build and test nuclear reactors for generating electricity, irradiating materials, and propelling U.S. Navy submarines, aircraft carriers, and other Navy ships. Originally called the National Reactor Testing Station, the INEEL built 52 reactors during its history. Three reactors are operating today.

The first reactor at the INEEL, the Experimental Breeder Reactor-I, was completed in 1951 and went critical in August of that year. In December of 1951, the reactor was used to generate electricity, powering four light bulbs. This was the first time that usable amounts of electricity were created through the use of the atom. The reactor operated until 1964, was decommissioned, and is now a Registered National Historic Landmark.

The RWMC, located in the southwest portion of the INEEL, was established in 1952 as a disposal site for radioactive waste generated by INEEL operations. Beginning in 1954, and continuing through 1970, transuranic waste also was buried in the SDA; however, after 1970, shallow land disposal of transuranic waste was discontinued in favor of above-ground storage at an area now known as the Transuranic Storage Area. Today's challenge focuses on approaches for remediating the transuranic waste buried in the past.

DOE, EPA, and the state of Idaho have initiated a remedial investigation/feasibility study, which will provide data toward a decision in 2003 on what cleanup methods will be needed to remediate the SDA. Depending on the remedy selected, remediating the SDA could cost billions of dollars. This decision will be the most closely watched of any cleanup project to date at the INEEL and will continue to attract national attention.

REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR THE RADIOACTIVE WASTE MANAGEMENT COMPLEX

In 1995, DOE, EPA, and the state of Idaho initiated a comprehensive remedial investigation/feasibility study of the 97-acre SDA, which consists of 20 pits, 58 trenches, and 21 soil vault rows (refer to Fig. 1).

A comprehensive remedial investigation/feasibility study represents the last planned Superfund environmental investigation for a facility. In terms of the RWMC, this environmental investigation will determine what, if any, risks are posed by the buried waste and what actions are necessary to appropriately address those risks.

Potential options for dealing with the buried wastes could include: institutional controls; containment; in situ treatment; retrieval followed by ex situ treatment and disposal; or a combination of these approaches.

Fig. 1. Outlined areas represent buried waste locations

An extensive vadose zone and groundwater monitoring campaign will help determine if any radionuclides have migrated, and if so, to what extent. The VOC carbon tetrachloride has migrated and is of particular concern. An estimated 1.08 million pounds of carbon tetrachloride was disposed of in the SDA. This estimate is being revised and is expected to increase. It is present in the vadose zone and aquifer beneath the complex in levels that exceed federal drinking water standards. Carbon tetrachloride accounts for approximately 75 percent of the VOCs buried in the SDA.

Floods occurred at the SDA in 1962, 1969, and 1982. To prevent future flooding, in 1983 the capacity of a diversion channel was doubled, a drainage channel inside and outside the SDA was widened, additional culverts were installed, sump pumps were installed, and moisture-exclusion soil was placed and graded over disposed waste. In 1984, surrounding dikes were raised and reinforced with riprap.

Organic vapors were released to the vadose zone from drums and boxes of waste containing VOCs, such as degreasers and solvents that were buried at the RWMC. As the containers deteriorated over time, the vapors migrated through porous soil and basalt rock fractures.

A project to contain VOC migration called Organic Contamination of the Vadose Zone (OCVZ) is operating at the RWMC. A vapor vacuum process that extracts hazardous vapors from soil and basalt rock is being used to remove VOC vapors from the vadose zone and destroy the vapors using thermal oxidation. Since the technology went online in 1996, it has removed and destroyed more than 82,000 pounds of VOCs.

INVENTORY RECORDS AND PROCESS KNOWLEDGE

Much is known about the composition of waste types that went into the SDA's pits, trenches, and soil vault rows. Much is also known about the specific locations where each waste type was deposited.

Extensive knowledge of the SDA waste types is comprised of the following documentation. For each of the waste types in the SDA, INEEL has detailed disposal records that indicate waste locations and quantities. This information has been compiled into a comprehensive database. For each waste shipment, INEEL knows from the Rocky Flats and INEEL records:

- What wastes were in each shipment and which Rocky Flats building and process each waste type came from.
- Numbers and types of containers in each shipment.
- Weights of each container in each shipment.
- Where and when workers put each shipment in the SDA.

For example, the SDA disposal records reveal that shipment "RFO-DOW SR1 06/11/69 820" was shipped from Rocky Flats on June 11, 1969. This shipment was buried in the SDA's Pit 10 on June 18, 1969, at a rectangular-shaped location 415 feet to 420 feet east and 60 feet to 70 feet south of Pit 10's northwest monument.

According to the trailer load list for this shipment, it contained 33 fifty-five-gallon drums of first-stage wastewater sludges (known as 741 sludges) from a weapons production recycling and treatment process that occurred at Rocky Flats in Building 741. This list also tells us the individual drum weights, which for this shipment totaled 16,414 pounds.

Process knowledge from the waste generation at Rocky Flats shows that the 741 sludge wastes contain plutonium and americium.

A network of probes placed into Pit 10 as part of an SDA probing program corroborated the waste boundaries, by identifying changes in moisture known to occur from the soil overburden to the waste and from the waste to the soil overburden. Pit 10 probing data also defines areas of alpha radioactivity, elevated chlorine, and transuranics. Probing continues in the SDA to learn more.

An analysis of mass balance of actinides that went in and out of the Rocky Flats plutonium warhead pit production process is the basis for the estimate of the total amount of actinides disposed of at the RWMC.

In another example, records tell that the VOC sludges were generated during lathe operations at Rocky Flats. They tell there are no free liquids in these sludges because Rocky Flats solidified them to a consistency of peanut butter, using calcium silicate.

To further illustrate the degree of disposal record detail, records tell for example that one group of organic sludges from Rocky Flats contained the solvents carbon tetrachloride, tetrachloroethylene, tetrachloroethene and 111-trichloroethane, a machine oil called Texaco Regal oil, and calcium silicate absorbent. They tell that these wastes were generated from machining and degreasing of plutonium metal in Buildings 707 and 777.

SURVEYS

Corroborating the disposal location of each of these shipments are magnetic surveys that have enabled mapping of the subsurface locations of metal containers and wastes with high metal content. Shallow surface soil vapor surveys confirm higher concentrations of VOCs corresponding to spots where these shipments are buried. These kinds of data also exist on the other types of SDA wastes.

To make the remedial investigation/feasibility study stronger, more work is under way to even better define contaminant locations and concentrations, waste composition, and what has happened to the wastes since disposal crews put them in the ground.

PROBES

Probing in the SDA started in December 1999 in Pit 9 and continues now into other pits. The initial probing phase uses sonic waves to drill hollow 6-inch-diameter steel probe tubes through the waste to the underlying basalt. Depths range from 10 to 27 feet. Geophysical instruments are lowered into the tubes and radioactivity, moisture, and chlorine are measured. These data provide vertical profiles of the waste and soils layers, and the apparent distribution of contaminants within the waste. Probing has given the team information indicating how deep the waste layer is, where the soil and basalt bedrock meet, and the apparent distribution of contaminants in study portions of the SDA. Probing also has demonstrated the capability to identify and characterize localized areas of plutonium contamination.

A second phase of probing will place more than 150 instrumented probes into selected areas. These probes are designed to collect leachate, and determine soil vapor composition, soil moisture content, matric potential gradients, and chemistry.

Information the team gathers using instruments lowered down present and future probe tubes is intended to give DOE, EPA, and state of Idaho decision-makers a much better picture of what's going on underground in the SDA, including:

- Rates of migration.
- Extent of infiltration of rainwater and snowmelt.
- Composition and condition of the wastes.

These data will be used to validate the results of the risk assessment, and to support the record of decision and remedial design/remedial action decision-making process. Because of ongoing data gathering work, when the remedial investigation/feasibility study is finished, it will include even more accurate data on the disposal locations of contaminants, their fate and transport, and the mechanisms that influence fate and transport.

Overall, the waste types and locations are as follows:

- Solidified volatile organic compound (VOC) sludges went into pits 2 through 6 and 8 through 10.
- Transuranic (TRU) waste went into pits 1 through 6 and 8 through 12.
- Low-level waste (LLW) went into all of the SDA's pits and trenches.
- Remote-handled low-level waste went into the SDA's soil vaults.
- Uranium and nitrate salts waste went into pits 1 through 6 and 8 through 12.
- Liquid organic and inorganic waste, some with low levels of radioactivity, went into the SDA's Acid Pit.

DATA NEEDED TO COMPLETE THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY

More data are necessary to build a remedial investigation/feasibility study that is scientifically sound and technically defensible. These tasks are under way to gain information about:

- The nature and extent of the contamination -- to refine risk estimates and identify contaminants of concern. Data collection methods are vadose zone and groundwater monitoring, laboratory analysis for uranium and plutonium solubility, and tests to estimate site-specific distribution coefficients for uranium and plutonium.

- The amount and timing of water infiltrating through the waste. This includes determining the lateral extent of influence of increased infiltration from drainage ditches on the perimeter of the pits. Data collection methods are tensiometers and soil probes.
- The mass of VOCs remaining in the waste -- to determine the need to remediate the VOC source. Data collection methods are soil vapor surveys, surface flux chambers, probing, and inventory updates.
- The rate that uranium is being released from the waste -- to determine the need to treat depleted uranium. Data collection methods are X-ray defraction and leach tests of Rocky Flats samples, and probing.
- The carbon-14 release rates from the waste -- to determine the need to remediate the soil vaults. Data collection methods are corrosion studies, probing, and inventory updates.
- The influence of the Big Lost River system on waste migration at depth in the vadose zone -- to determine the need to mitigate the system's influence on the contaminant migration. Data collection methods are geochemistry analyses, SDA tracer tests, and Big Lost River system tracer tests if water from the system is available.
- The implementability of remedies -- to support detailed analysis of remedial alternatives. Data collection methods include examination of commercial practices and cold testing of in situ grouting.
- The costs of remedies -- to support detailed analysis of remedial alternatives. Data collection methods are examination of commercial practices.
- The locations of specific waste streams -- to identify areas for selective remediation. Data collection methods are continued research and mapping of disposal locations, analysis of stored sludge, and probing.

These data will be developed, analyzed and formatted, to allow comparison of the available remedial approaches.

SUMMARY

Because of the complexity of this project, industry, the public, and ultimately Congress will be watching the outcome of our process for determining how to safely and cost-effectively mitigate the risks posed by the INEEL's buried waste. The end goal of this remedial investigation/feasibility study is to provide an array of viable remediation options and the relative merits of these options. It is the focus and commitment of the INEEL team to help decision-makers select a path forward for a sound cleanup supported by science and the public.