# Balancing Cleanup and Future Land Use at the Idaho National Laboratory - 11186

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## ABSTRACT

The Idaho National Laboratory (INL) cleanup mission will be completed soon; however, the INL is not a closure site. Completing the INL cleanup mission is critical to ensure that facilities and infrastructure are available to support the INL's efforts to create an environmentally sustainable nuclear energy option for the nation and other research and development efforts.

This paper describes what the end state of the INL will be following implementation of current cleanup agreements. It defines how INL cleanup has been balanced to reduce risk and protect human health and the environment while completing accelerated cleanup and allowing areas to be maintained for reuse to support long-term INL missions. While most remediation decisions are based on risk data, other competing factors, such as reducing footprint, thereby reducing long-term Department of Energy surveillance and maintenance costs, are considered.

The potential for discovering new contaminated sites and periodic review of old sites is also addressed. Because the INL will continue to operate with new missions, special allowances must be made as past decisions are periodically revisited.

## INTRODUCTION

The history of nonagricultural activity in the Idaho desert began on April 2, 1943, when the Naval Proving Ground was established to test-fire 16-inch guns refurbished at nearby Pocatello, Idaho. For several years, the range also was used for practice runs from B-24 Liberator Bombers and B-17 Flying Fortresses; testing the performance of different kinds of projectiles, fuses and explosive loads; and various "detonation research" projects [1]. In 1949, the U.S. Atomic Energy Commission established a presence at the "Site," which was named the National Reactor Testing Station at that time. The primary purpose was to conduct nuclear energy research and related activities. Since the National Reactor Testing Station was established 61 years ago, the Site has been known by several names, and a variety of projects and buildings have come and gone, including nuclear-powered airplane testing, 52 reactors, a chemical reprocessing plant for spent nuclear fuel, waste processing and disposal facilities, and state-of-the art research and development.

Like the majority of U.S. Department of Energy (DOE) sites established under the Manhattan Project, the rich history of the Idaho National Laboratory (INL) ultimately contributed to the need to address the historical environmental issues. Although the cleanup mission is nearly complete, the INL is not a closure site. Various missions are expected for many years at the Idaho desert.

In 2005, to better focus the INL's activities, DOE established the Idaho Cleanup Project to complete the environmental management mission. At the same time, DOE redesignated the Idaho National Engineering and Environmental Laboratory as the Idaho National Laboratory to better identify the laboratory's new research directions and established a separate operating contractor to fulfill the research and development mission. Completing the INL cleanup mission is critical to ensure that facilities and infrastructure are available to support the INL's efforts to create an environmentally sustainable nuclear energy option for the nation and to support other research and development.

Currently, several major regulatory-based agreements define the end state of the INL following implementation of the current cleanup mission. This paper briefly describes those agreements and defines how the INL waste management and cleanup activities have been balanced to reduce risk and protect human health

and the environment while completing accelerated cleanup, thus allowing areas to be maintained for reuse to support long-term INL missions.

## OVERVIEW OF THE IDAHO NATIONAL LABORATORY SITE

The INL Site, managed by DOE, occupies 890 $mi^2$ of the northeastern portion of the Eastern Snake River Plain (see Fig. 1). There are nine major areas at the INL Site, which occupy only a small portion of the 890 $mi^2$. The rest of the area is primarily undeveloped and provides a large buffer zone around the nine areas. The INL Site is divided into 10 waste area groups to facilitate remedial design/remedial action. Waste Area Groups 1 through 9 correspond to the primary facility areas at the INL Site. Waste Area Group 10 corresponds to the portion of the Snake River Plain Aquifer beneath the INL Site and to surface and subsurface areas not included with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites identified in facility-specific records of decision (RODs).

DOE controls all land within the INL Site. Public access is restricted to public highways, sponsored tours, special-use permits, the Experimental Breeder Reactor I National Historic Landmark, and the Shoshone-Bannock tribal members. The INL Site is located primarily in Butte County; however, it also occupies portions of four other counties. According to the 2000 census, populations of cities surrounding the INL Site range from approximately 50,000 for Idaho Falls and Pocatello to 25 for Atomic City.

Surface water flows on the INL Site consist mainly of three streams draining intermountain valleys to the north and northwest. These streams are the Big Lost River, the Little Lost River, and Birch Creek. All of the channels terminate on the INL Site. Flows from Birch Creek and the Little Lost River seldom reach the INL Site because of irrigation withdrawals upstream. The Big Lost River and Birch Creek may flow onto the INL Site before the irrigation season or during high-water years, but the terminal reaches are usually dry. In those few wetter years when the Big Lost River carries water to the end of its channel, the water sinks into the ground.

Cultural resources are numerous on the INL Site [2] and include prehistoric archaeological sites representing aboriginal hunter-gatherer use spanning over at least 13,500 years, late 19th and early 20th Century historic archaeological sites representing settlement and agricultural development, ranching, and other activities, historic architectural properties that tell the history of the INL Site, and areas of cultural importance to the Shoshone-Bannock Tribes and other local or regional stakeholders (e.g., historical societies, historic trail organizations).

The INL Site lies within the upper Snake River Plain sagebrush steppe ecosystem. Throughout the west, resource managers find much of the sagebrush steppe ecosystem segmented and lost to development and agriculture and the remaining sagebrush steppe ecosystem threatened with irreversible conversion to non-native annual weeds and wildland fires. In 1999, DOE signed a memorandum of agreement with the Bureau of Land Management, Fish and Wildlife Services, and Idaho Department of Fish and Game to set aside 74,000 acres of the INL Site as a sagebrush steppe ecosystem reserve. This reserve conserves unique habitat in the northwestern portion of the INL Site and contains some of the last sagebrush steppe ecosystem in the United States. This action recognized that the INL Site has been protected and secure for 60 years, and those parts of the INL Site are valuable for maintaining this endangered ecosystem [3].

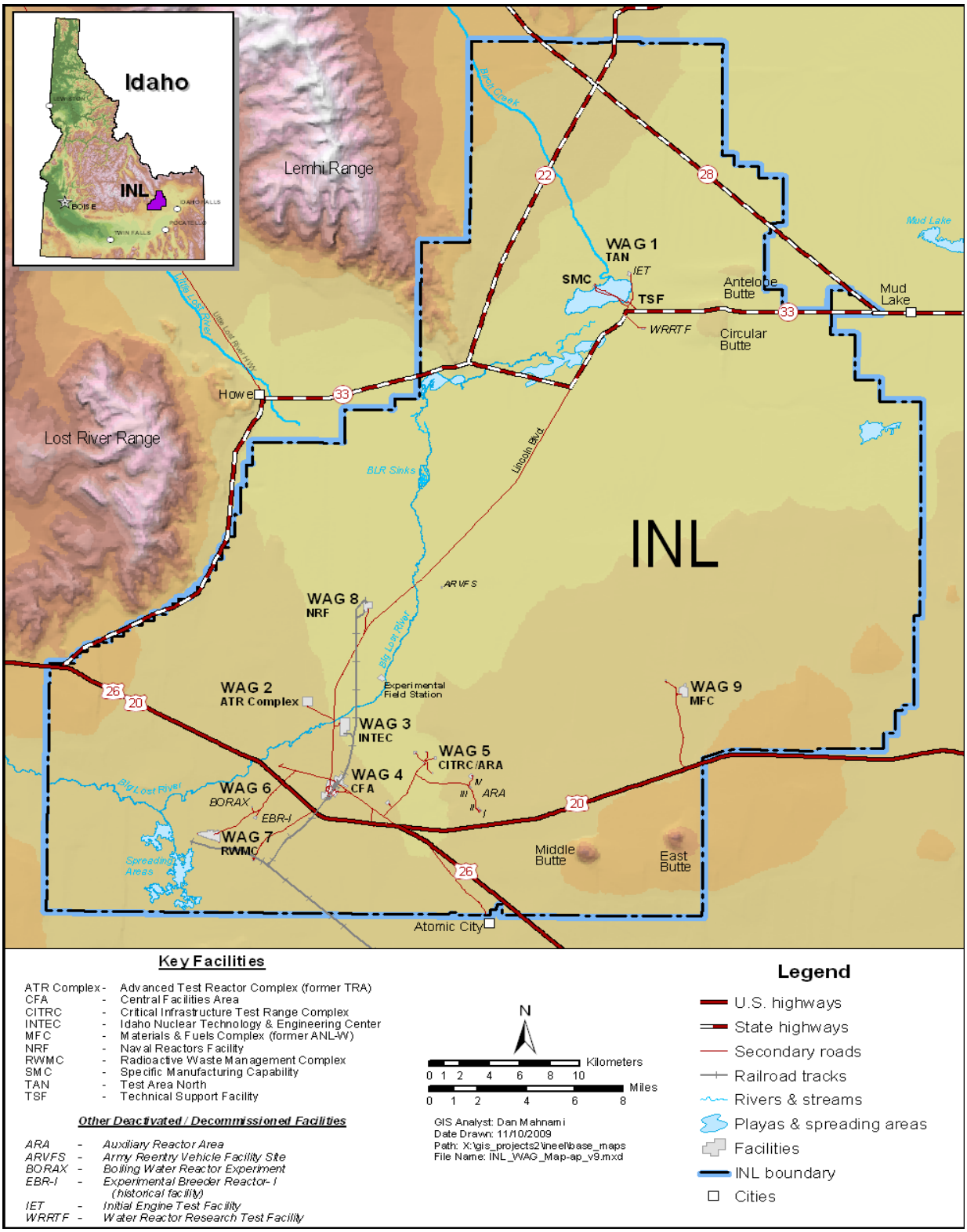


Fig. 1. Map of the Idaho National Laboratory Site showing major facilities and waste area groups.

## OVERVIEW OF THE CURRENT CLEANUP AGREEMENTS AND APPROACHES

### Federal Facility Agreement and Consent Order

In 1989, the INL Site was placed on the National Priorities List of CERCLA hazardous substance release sites and became subject to the provisions of CERCLA governing remedial action at federal facilities. In 1991, the regulatory agencies signed a Federal Facility Agreement and Consent Order and Action Plan [4] governing CERCLA cleanups and Hazardous Waste Management Act/Resource Conservation and Recovery Act corrective actions on the INL Site. Under the terms of CERCLA as implemented through the Federal Facility Agreement and Consent Order, DOE will carry out the cleanup and fund the associated costs.

The Federal Facility Agreement and Consent Order divided the INL Site into 10 waste area groups to facilitate environmental remediation efforts. Waste Area Groups 1 through 9 generally correspond to facility areas. The waste area groups were further divided into operable units to address specific environmental challenges. As identified in the Federal Facility Agreement and Consent Order Action Plan, Waste Area Group 10 "…includes regional Snake River Plain Aquifer concerns related to INL that cannot be addressed on a WAG-specific basis…The boundary of WAG 10 is the INL boundary, or beyond as necessary to encompass real or potential impact from INL activities, and any areas within the INL not covered by other WAGs" [4].

A comprehensive Remedial Investigation/Feasibility Study for Waste Area Group 10 (Operable Unit 10-04) [5] was already completed, which addressed Site-wide ecological risks, miscellaneous sites (including ordnance sites), and Shoshone-Bannock tribal perspective on risk assessment. The regulatory agencies deferred completion of the Site-wide groundwater investigation until the nine other waste area groups had completed their groundwater investigations. The regulatory agencies created Operable Unit 10-08 to address additional miscellaneous sites and potential commingling of groundwater plumes from two or more waste area groups. The Operable Unit 10-08 ROD was completed in September 2009 [3] and was the last ROD under CERCLA at the INL Site. In addition to addressing groundwater, this ROD included a process for handling CERCLA sites discovered in the future.

Another major ROD, the Operable Unit 7-13/14 ROD [6], primarily dealt with remediation of buried radioactive waste at the Radioactive Waste Management Complex. The final remedy was multiphased, consisting of exhumation of transuranic waste for disposal at the Waste Isolation Pilot Plant, continuation of a vapor extraction system to remove volatile organic vapors, in situ grouting to immobilize some contaminants, and ultimately capping using an engineered evapotranspiration soil cover. After years of negotiation among DOE, the Environmental Protection Agency, and the Idaho Department of Environmental Quality, an agreement entitled *Agreement to Implement, U.S. District Court Order dated May 25, 2006* [7] quantified the amount of targeted waste to be retrieved and other features of the remedy. This agreement was incorporated into the ROD, thus becoming the basis for the CERCLA remediation.

### Non-Time Critical Removal Actions

In July 2002, DOE, the Environmental Protection Agency and the State of Idaho signed a letter of intent to pursue accelerated risk reduction and cleanup in the Environmental Management Program at the INL Site. The letter of intent established a focused vision for the accelerated cleanup strategy biased toward real risk reduction within the framework of the existing compliance agreements and regulatory requirements that address cleanup at the INL Site.

One of the major aspects of the accelerated cleanup strategy included consolidating Environmental Management activities at the Idaho Nuclear Technology and Engineering Center, thereby reducing the actively managed Environmental Management footprint by over 51%. The accelerated cleanup approach took advantage of opportunities to dramatically reduce the footprint within the INL's major areas through the

decontamination and demolition (D&D) of several facilities. The major footprint reduction not only reduces risk but also significantly reduces infrastructure, surveillance, and maintenance costs.

In May 2005, the Idaho Cleanup Project earnestly began D&D of approximately 230 INL facilities and structures. These ranged from small noncontaminated support structures to inactive nuclear reactors and spent nuclear fuel reprocessing facilities. It was decided to complete the INL D&D consistent with the joint DOE and Environmental Protection Agency *Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* [8], which establishes the CERCLA non-time critical removal action decommissioning process. The 230 facilities were divided into high-risk and low-risk facilities. Following the CERCLA non-time critical removal action approach, an individual Engineering Evaluation/Cost Analysis and Action Memorandum was completed for each high-risk facility. D&D of the low-risk facilities are being addressed under a single general Site-wide Engineering Evaluation/Cost Analysis and Action Memorandum [9]. The 11 high-risk facilities include a remote analytical facility, fuel storage basins, hot shop, hot shop decontamination facility, hot cells, spent fuel reprocessing facility, and five inactive nuclear reactors.

### Resource Conservation and Recovery Act Closures

Various Resource Conservation and Recovery Act (RCRA) treatment storage and disposal facilities have operated at the INL Site in the past. As facilities and processes are decommissioned, and as legacy backlog waste is treated, these RCRA-permitted and interim status facilities are no longer necessary and require closure under applicable regulatory requirements. In addition, in the mid-1990's, potential compliance issues were identified for more than 1,000 tanks at the INL Site. The status of the tanks and whether they were empty or contained hazardous or mixed waste were uncertain. To address these potential compliance issues, the INL and the Idaho Department of Environmental Quality finalized a Voluntary Consent Order in 2000 [10]. These tanks were characterized, and any tank systems determined to contain hazardous or mixed waste are being addressed under the terms of the Voluntary Consent Order. Finally, the waste from processing spent nuclear fuel was stored in eleven 300,000-gallon tanks at the Idaho Nuclear Technology and Engineering Center Tank Farm Facility. The waste is considered mixed waste regulated under RCRA. Because these tanks could not meet all of the substantive RCRA requirements, waste treatment and ultimate closure of the Tank Farm tanks are addressed under the terms of a 1992 Notice of Non-Compliance Consent Order [11].

## CLEANUP PROGRESS TO DATE

### Federal Facility Agreement and Consent Order

The INL has progressed significantly since it was placed on the National Priorities List in 1989 and became subject to CERCLA provisions. RODs have been completed and remediation implemented for all 10 of the waste area groups. Beginning with the first remediation of naval ordnance following the Operable Unit 10-05 ROD in 1992 [12] and concluding with the September 2009 signing of the Operable Unit 10-08 ROD [3] addressing site-wide groundwater, miscellaneous sites, and future sites, many sites containing hazardous or radioactive waste or both have been cleaned up. All remediation followed the typical CERCLA process by defining the problem, performing risk assessments, evaluating alternatives, involving the public, and culminating in signing a ROD. Using the ROD as the decision document, subsequent documents were generated for the design and execution of the remedy. Where needed, a long-term monitoring plan was established and institutional controls placed on the site to protect the public, workers, and the environment.

The typical INL site addressed by a ROD involved cleanup of hazardous or radioactive waste resulting from past laboratory operations or spills, leaks, or legacy solid waste management units. Remediation has included effluent ponds, injection wells, windblown contamination, septic tanks, contaminated soils, buried waste, ordnance removal, vapor extraction from the vadose zone, and groundwater cleanup.

Typical actions during 2010 included:

- Cleanup of the last two known soil sites at the INL Site requiring remediation: the destruction of trinitrotoluene/royal demolition explosive and unexploded ordnance found across the desert
- Construction of ditches to collect surface runoff
- In situ grouting of radioactive buried waste
- Exhumation and shipment of transuranic waste to the Waste Isolation Pilot Plant.

**Non-time Critical Removal Actions**

As of November 2010, 198 of the 220 low-risk structures and facilities being D&D'd under the single general Site-wide Engineering Evaluation/Cost Analysis and Action Memorandum [9] have been completed. High-risk facilities completed include three inactive nuclear reactors, the Test Area North Hot Shop and Decontamination Facilities, a remote analytical laboratory facility, and a fuel storage basin.

**Resource Conservation and Recovery Act Closures**

Since 2005, 25 RCRA closures have been completed, including storage tanks, analytical laboratory facilities, container storage areas, waste treatment facilities, and portions of the Tank Farm Facility tanks. All the facility closures since 2005 have been clean-closed except the CPP-601 spent nuclear fuel reprocessing facility, which is being closed as a RCRA landfill.

**CLEANUP AFTER 2010 (EXPECTED END STATE AFTER CLEANUP)**

**Federal Facility Agreement and Consent Order**

Since all of the RODs are complete, the extent of the CERCLA cleanup has been defined. Long-term maintenance and monitoring will continue for at least 100 years. The remaining physical remediation is consolidated around two areas where existing operations or long-term cleanup will require several years, specifically at the Idaho Nuclear Technology and Engineering Center and the Radioactive Waste Management Complex. A third area, groundwater at Test Area North, will be actively remediated for at least 20 years.

The first area that still requires remediation is at the Idaho Nuclear Technology and Engineering Center. Significant CERCLA projects have cleaned up the majority of the contaminated soil over the last three years. The remaining CERCLA remedial action work scope at the Idaho Nuclear Technology and Engineering Center is addressed in the Operable Unit 3-14 ROD [13]. Part of the remaining remedy is a two-stage effort to limit infiltration through the contaminated soils near the Tank Farm Facility. Since the 1950s, leaking pipes and vaults have contributed to groundwater contamination in the area. The first stage of the remedy is to place low-permeability asphalt over the area and construct or improve the many drainage systems. The asphalt cap is expected to be completed in 2012. The long-term remedy is to construct an earthen evapotranspiration cover with a biointrusion layer. Currently, this area is technically still an operating facility, and early infrastructure development intertwined the utilities, roads, and functions together for the entire site. The Tank Farm Facility consists of a series of underground tanks used to store radioactive wastes; the infrastructure used to transfer, monitor, and control the liquid wastes; and the surrounding soil within the Tank Farm boundary. The final action to remove and treat the waste and close the Tank Farm system will be completed in December 2012. Following closure, Idaho Nuclear Technology and Engineering Center cleanup and waste management activities will continue to support the 1995 Settlement Agreement between DOE and the State of Idaho [14]. The Settlement Agreement mandates that by 2035 all spent nuclear fuel be removed from Idaho and that waste stored at the INL Site be prepared for removal from Idaho. The final evapotranspiration cap is expected to be placed in 2035 unless the project is accelerated. Maintenance of the ditches and cap and groundwater monitoring will continue at least until 2095. As additional buildings undergo D&D, soil contamination

requiring remediation may be discovered. Additional remedial actions are likely as more of the facility is dismantled, exposing contaminated soils and drains [13].

The second major area that will take longer to remediate is the Subsurface Disposal Area at the Radioactive Waste Management Complex. Completion of the Operable Unit 7-13/14 remedy is somewhat funding constrained and could be significantly accelerated to reduce long-term liability. The Operable Unit 7-13/14 ROD included the following remedies [6]:

- Retrieving targeted radioactive waste and high-concentration organic solvent waste from 5.69 acres of buried trenches in the Subsurface Disposal Area. Approximately 2.5 acres will be competed by the end of Fiscal Year 2012. The remaining acreage could take several years unless the retrievals are accelerated.
- In situ grouting of soil vaults and trenches totaling approximately 0.2 acres to reduce the mobility of Tc-99 and I-129 to address future threats to the aquifer. This work was completed in 2010.
- Continued operation of the vadose zone vapor vacuum extraction and treatment system until agreement is reached that the system can be shut down. That decision will be made before the final evapotranspiration barrier is installed.
- Construction of an evapotranspiration barrier over the Subsurface Disposal Area to limit infiltration and for source control. The evapotranspiration barrier construction is currently scheduled to begin in 2021, and estimated to be completed in 2029.
- Long-term institutional controls, including surveillance, maintenance, and monitoring, likely will continue until 2095.

The Operable Unit 1-07B ROD [15] was developed to address groundwater contamination at Test Area North. The groundwater at Test Area North was contaminated by injecting trichloroethene-laden liquid waste through direct injection wells into the aquifer. The remedy consists of three components: pump and treatment unit to limit contamination migration, in situ bioremediation to address the “hot spot” or the area adjacent to the injection well, and monitored natural attenuation for those areas that are already below cleanup levels. The three remedies are anticipated to continue until remediation goals are reached and sustained, which could take up to 20 years.

**Non-Time-Critical Removal Action**

The four remaining high-risk facilities to be completed between 2010 and 2012 include two inactive nuclear reactors (Materials Test Reactor and Experimental Breeder Reactor II), a hot cell, and the spent nuclear fuel reprocessing facility. Between 2012 and 2017, the remainder of the waste processing facilities at the Idaho Nuclear Technology and Engineering Center is anticipated to undergo D&D under the non-time critical removal action process. These remaining facilities include three liquid waste treatment facilities and the New Waste Calcining Facility.

**Resource Conservation and Recovery Act Closures**

Remaining RCRA closures to be completed between 2010 and 2012 include two tank systems at the Advanced Test Reactor Complex, completion of the interim actions for the CPP-601 spent fuel reprocessing facility RCRA landfill, and treatment of sodium in the Experimental Breeder Reactor II reactor. RCRA closures after 2012 will include the final four Tank Farm Facility tanks, three Idaho Nuclear Technology and Engineering Center liquid waste treatment facilities, the New Waste Calcining Facility, and the Calcine Solids Storage Facility Bin Sets. These facilities are expected to be RCRA clean-closed; however, if clean closure standards cannot be met, the facilities would be clean-closed as RCRA landfills.

**FUTURE LAND USE AT THE INL SITE**

The INL Ten-Year Site Plan for Fiscal Year 2012 [16] outlines the vision and strategy to transform the INL to deliver world-leading capabilities that will enable the DOE Office of Nuclear Energy, Science, and Technology (DOE-NE) to accomplish its mission. The result is a laboratory that is the core of DOE-NE's national nuclear capability and a DOE-wide national user facility, accessible to researchers and experimentalists from national laboratories, universities, industry, other federal agencies, and collaborators from international institutions. INL offers unique core capabilities and infrastructure that support development of nuclear fuels, reactors, and fuel cycle technologies. In addition, INL retains other resources to support fuel development, including transient testing and second-generation capabilities for developing and testing both wet and dry separations technologies. These capabilities complement specialized capabilities in the DOE complex and at universities that are also needed for nuclear energy research and development. As a multipurpose laboratory, INL also provides energy integration, environmental integrity, and national and homeland security capabilities to DOE and other customers.

As mentioned previously, buildings and structures at the INL Site are clustered within fairly small areas, which are typically less than a few square miles in area and separated by miles of open land. One of the areas (Waste Area Group 6, Boiling Water Reactor Experiment Area) has been completely remediated, no current infrastructure is available, and future development or reuse is not anticipated. All of the other eight major areas are expected to remain operational for the foreseeable future to support various missions and cleanup activities. Both the DOE Office of Environmental Management and DOE-NE have major activities ongoing at the INL Site. The Central Facilities Area, located centrally on the INL Site, is the main services and support area for the two main DOE-NE research and development campuses, the Advanced Test Reactor Complex and the Materials and Fuels Complex. The primary non-DOE-NE facility areas include the Idaho Nuclear Technology and Engineering Center, Radioactive Waste Management Complex, and Naval Reactors Facility. Other, smaller areas include the Critical Infrastructure Test Range Complex and Test Area North. Current and projected land uses for the INL Site and surrounding lands are summarized in the following paragraphs.

Following cleanup, future land use within the INL Site will be focused on supporting the core of DOE-NE's national nuclear capability and a DOE-wide national user facility, accessible to researchers and experimentalists from national laboratories. Areas surrounding the INL Site are expected to remain the same, with agricultural and open, undeveloped land. DOE addressed future land use in the Long-Term Land Use Future Scenarios document [17]. Because future land-use scenarios are uncertain, assumptions were made in the Long-Term Land Use Future Scenarios document for defining factors such as development pressure, advances in research and technology, and ownership patterns. The following assumptions were applied to develop forecasts for land use within the INL Site:

- The INL Site will remain under DOE ownership and control until at least 2095. The boundary is currently static. DOE will manage portions of the INL Site beyond 2095. Long-term management and control include surveillance, maintenance, monitoring, and institutional controls of areas that cannot be released for unrestricted land use.
- The life expectancy of current and new facilities is expected to range between 30 and 50 years. Decontamination and dismantlement will commence following closure of each facility if new missions are not determined.
- Residential development (e.g., housing) will not be allowed to occur within the current INL Site boundaries before 2095 and is not expected to occur after 2095.

Major, private developments (residential or nonresidential) are not expected in areas adjacent to the INL Site because the INL Site is distant from existing developed areas, infrastructure is not present adjacent to the INL Site to support development, existing urban areas in the region have large areas of undeveloped land nearby that are more suitable for residential development, and INL Site land cannot be transferred easily to private ownership.

Laws and regulations that govern the transfer of federal land are presented in the *INL Site-Wide Institutional Controls, and Operations and Maintenance Plan for CERCLA Response Actions* [18]. These will ensure future protection of human health and the environment through property transfer documentation required by CERCLA and Environmental Protection Agency institutional controls policy. However, transfer of any INL Site land is not expected until after 2095.

Future land use at the INL Site is influenced and possibly constrained by CERCLA and the Federal Facility Agreement and Consent Order. Many of the RODs made assumptions on the future land use of the remediated site. Generally the future land use was assumed to be residential, industrial use, institutionally controlled for a period of time, or institutionally controlled in perpetuity. Some of the areas at the INL Site were cleaned up to the extent that unrestricted use would be allowed. These areas were remediated to well below the cleanup levels and could be released to the general public without restrictions. This land, if the DOE chooses to release it, could be used for any purpose. Cleanup to residential standards typically meant that all the contamination was removed to at least 10 feet below ground level, which would be the maximum depth of a basement. A deed restriction or other warning may apply to these areas where remediation did not address deep contamination.

Some of the areas within a facility were contaminated such that it would have been technically impractical or cost prohibitive to remove all contamination. An industrial designation was deemed appropriate for these areas and typically involved only remediating the area to a depth of 4 feet. These areas could be developed as industrial use areas, where controls would be placed on any future use. One restriction would preclude excavating deeper than 4 feet without certain restrictions. Warehouses, processing plants, storage areas, etc., may qualify for use in an industrial setting.

Institutionally controlled sites are sites where contamination was left in place for many reasons, such as inaccessibility (e.g., under a building), impracticability (e.g., below 20 feet or contamination that has migrated into the basalt), or areas still radioactive that will decay below action levels within the next 100 years. Some sites, such as the Subsurface Disposal Area, which contain long-lived radioactive waste buried in pits and trenches, will ultimately have a thick earthen cover and will be under institutional controls in perpetuity.

One of the unique challenges at the INL Site is the unexploded ordnance remaining from when the site was the Naval Proving Grounds in 1940. Also, many experiments were conducted with explosives over the years, and the site was used for disposal of old ordnance using both low-order and high-order detonation. Consequently, despite significant cleanup efforts, portions of the INL Site may never be completely cleared for unexploded ordnance. Currently, the three regulatory agencies (DOE, Environmental Protection Agency and State of Idaho Department of Environmental Quality) are trying to resolve this issue and trying to decide on future land use and the extent of institutional controls. For the most part, the unexploded ordnance is safe to handle because most of the rounds fired through the barrels were blanks. The remaining ordnance that was kicked out during the detonations is dangerous but considered unarmed because they were not fired through a barrel. All ordnance must be removed under the supervision of a trained explosive ordnance expert.

## RISK DECISIONS/STRATEGIES TO DATE

### Federal Facility Agreement and Consent Order

Most of the risk assessments performed to define the remedies were driven by impacts to human health and the environment, as well as future land use. This type of risk assessment was based on exposures to different contaminants, and the approaches are well documented. Many of the risk decisions were the result of negotiation with the regulatory agencies. For risk purposes, the INL sites were divided up between residential or industrial use to determine how much contamination to remove or allow too stay in place. Where contaminated media was removed, it was excavated to a depth of 10 feet for residential use or 4 feet for industrial use. For radiologically contaminated sites, the decay chain was taken into account to set cleanup

levels. Most of the INL Site is planned to remain under restricted use or be institutionally controlled for at least 100 years, meaning the land use likely will not change until 2095. Then, the allowable cleanup level was back-calculated based on the various decay rates of radionuclides.

Early in the CERCLA program, program personnel decided that an action should have a bias. In the early years, significant resources were spent to characterize the contamination. Decision documents relied on a lot of sampling and analysis data. Program personnel decided to direct more of the funding toward actually cleaning up a site rather than continuing to collect characterization data. As a result, sampling and analysis costs were directed more toward defining waste disposition paths rather than initial characterization, which expedited cleanup actions.

One challenge at the INL Site is determining how much monitoring is enough. During the early years, a significant amount of data, such as from soil and groundwater samples, had to be collected to define a baseline for the contamination. After risk assessments had been completed, feasibility studies prepared, and remediation decisions made in the RODs, monitoring requirements had to be reevaluated. The purpose of post-ROD monitoring is to determine effectiveness of remedies. With the signing of the last ROD, Operable Unit 10-08 [3], Site-wide groundwater monitoring was reduced by over 80%. Similarly, the vapor vacuum extraction sampling at the Subsurface Disposal Area and the in situ bioremediation cleanup of groundwater at Test Area North were also reduced. Currently, sampling is performed primarily to provide data to be used to optimize operations. One of the unintended consequences of this reduced sampling is that several monitoring wells and equipment primarily used for characterization are no longer needed. The regulatory agencies, U.S. Geological Survey, and other stakeholders worked together to identify instrumentation that is no longer useful. As a result, approximately 550 wells, monitoring holes, etc., have been abandoned over the last 5 years.

Because many facilities at the INL Site are still active, any CERCLA action requires significant coordination with the many affected personnel. Road closures, utility lockouts, and design modifications to allow facilities to keep operating are the norm.

**Non-Time-Critical Removal Action**

As discussed previously, it was decided to complete the INL D&D activities consistent with the joint DOE and Environmental Protection Agency policy, which establishes the CERCLA non-time critical removal action process as the approach for D&D. D&D for the majority of the 230 low-risk facilities essentially has removed all hazardous and radioactive substances, and those areas are available for future reuse.

For the high-risk facilities, risk assessments were completed to support alternative selection. The risk assessments evaluated the potential source term from the high-risk facilities to ensure that the remedial action objectives identified in the CERCLA RODs for each area were met. Although the risk assessments usually demonstrated that contaminants in the high-risk facilities would meet the remedial action objective if left in place, the alternative primarily selected was for complete removal to reduce the DOE Office of Environmental Management footprint and reduce long-term surveillance and maintenance costs. For example, several high-risk facilities were completely removed such that no institutional controls were necessary, thereby making the areas available for reuse, if necessary. Residual contamination remained at a few of the high-risk facilities such that some institutional controls were necessary.

To date, complete removal was not feasible for three facilities. The first was the CPP-603 Fuel Storage Basin. All nuclear fuel previously had been removed from the basin. However, other nonfuel objects and sludge that accumulated in the basin needed to be addressed under the non-time critical removal action. A majority of the sludge in the basin was removed by underwater divers and solidified for disposal at on-INL-Site facilities. The high-activity objects were consolidated in a single location, and the basin was grouted. This approach ensured that the remedial action objectives were met, while minimizing the potential impact to workers to handle the high-activity objects.

The second high-risk facility that will not be completely removed is the Experimental Breeder Reactor II reactor. While it was in active operation, Experimental Breeder Reactor II was an unmoderated, sodium-cooled reactor and power plant, with a power output of 62.5 megawatts of heat. The Experimental Breeder Reactor II reactor was built on site, and it was not feasible to remove the reactor vessel intact as was done for the Materials Test Reactor and Engineering Test Reactor under other non-time critical removal actions. The non-time critical removal action approach for Experimental Breeder Reactor II is to demolish the systems and structures above the reactor building floor, and grout most of the remaining systems and structures below floor level, including the Experimental Breeder Reactor II reactor vessel. These actions will be complete following RCRA closure of the system to address residual sodium. The final end state of Experimental Breeder Reactor II will be a concrete/grout monolith that contains the primary coolant tank with internal components, including the reactor vessel. Void spaces remaining will be grouted as practicable, including the basement, sub-basement, and interior of the primary coolant tank, resulting in encapsulation of the reactor vessel. The concrete/grout monolith will extend approximately 8 ft above ground level and will be finished with a concrete cover to facilitate drainage away from Experimental Breeder Reactor II. The risk assessment confirmed that residual radioactive materials at Experimental Breeder Reactor II remaining after D&D activities are completed meet the remedial action objectives

The third and most unique high-risk structure requiring D&D was the CPP-601/640 facilities. The CPP-601/640 facilities are located at the center of the Idaho Nuclear Technology and Engineering Center. The final end state for the facilities required extensive coordination among the CERCLA process, RCRA closure, and D&D under the non-time critical removal action. The CPP-601 facility was used for reprocessing spent nuclear fuel. It included dissolution, separation, chemical makeup and transfer, and liquid waste receiving processes. The uranium reprocessing mission for CPP-601 was terminated in 1992. The adjacent CPP-640 facility was originally built as a pilot plant for dissolving spent nuclear fuel, but the process was so successful that fuel dissolution activities were continued until operations ceased in 1984. Following the final process operations in each of these buildings, process vessels and process lines were rigorously flushed numerous times with acid and water to reduce radiological contamination and to support the accounting of special nuclear material. These flush solutions were collected in RCRA-regulated tank systems prior to being transferred for treatment in other RCRA facilities at the Idaho Nuclear Technology and Engineering Center.

CERCLA remedial actions adjacent to CPP-601/640 have occurred or will occur in accordance with the RODs for Operable Units 3-13 and 3-14 [19, 13]. The primary CERCLA remedial action that interfaces with the CPP-601/640 buildings is the Tank Farm Soil and Idaho Nuclear Technology and Engineering Center Groundwater Remedial Action (Operable Unit 3-14). Seven historical release points were identified beneath CPP-601. The releases were mainly acidic liquids primarily contaminated with radionuclides and metals from the dissolution of spent fuel. The source terms evaluated under the non-time critical removal action include the releases beneath CPP-601. Compliance with the remediation goals, as well as the remedial action objectives, was demonstrated in the CPP-601/640 risk assessment. This was consistent with the remedy selected for the CERCLA remedial action process for releases beneath buildings (i.e., preventing radiation exposure and limiting contaminant migration to the Snake River Plain Aquifer by placing the buildings above these release points in a stable condition, which will provide the infiltration protection necessary).

The final end state for the CPP-601/640 facilities included removing three process cells, including building and components, and a mechanical handling cave to 11 ft above grade, leaving most of the processing cells intact. Large void spaces without significant piping or vessels were filled with grout or other inert material. The remaining void spaces within the building were filled with flowable grout to minimize void spaces, leaving a grouted monolith approximately 11 ft above grade. The RCRA regulated waste collection tanks were addressed under a RCRA closure plan. Because the area was in the industrial use area at the Idaho Nuclear Technology and Engineering Center, it was decided to close the CPP-601/640 facilities as a RCRA landfill, and approximately 77 tons of lead determined impractical to remove was left in place. The top surface of the monolith was sloped to facilitate integration of precipitation control with the CERCLA remedial action in that area by directing collected precipitation toward lined ditches, which will divert the water to evaporation ponds. A soil weather protection barrier was placed over the concrete monolith and will require routine maintenance,

monitoring, and institutional controls to ensure that future worker risk remains acceptable and will be controlled under a RCRA landfill post-closure plan.

**Resource Conservation and Recovery Act Closures**

Over 25 RCRA closures have been completed in the past five years, and several more are under way. Several of the RCRA closures were legacy tank systems that were in or near buildings being D&D'd under a non-time critical removal action or CERCLA remedial action. The approach has been to address the closure under an approved RCRA closure plan. Any residual contaminants have been characterized and risk assessments performed. If risk meets the RCRA limits, no further actions to address the hazardous constituents are necessary. Soil is sampled for radionuclides concurrently with the RCRA sampling, and if the risk exceeds the CERCLA limits, the site is addressed under the terms of the Federal Facility Agreement and Consent Order.

## PERIODIC REVIEWS AND STRATEGY FOR ADDRESSING FUTURE SITES

The protectiveness of each CERCLA remedy is reviewed every five years. Sites where contaminants are to be left in place in concentrations higher than levels that allow unlimited use and unrestricted exposure will be reviewed at least every five years after the first remedial action is initiated. Remediated sites with institutional controls will be reviewed every five years until it has been determined through the CERCLA process that controls and reviews are no longer necessary.

The first five-year review for Operable Unit 10-08 is anticipated to be combined with the comprehensive five-year review for the CERCLA response action at the INL Site planned for 2015. If a five-year review concludes an existing remedy is not protective of human health or the environment, the regulatory agencies may consider new technologies that were not available when this ROD was finalized. The regulatory agencies can modify the ROD (e.g., ROD amendment) through the CERCLA process when necessary to ensure that the remedy is protective.

The last ROD, Operable Unit 10-08 [3], defined the process for addressing new CERCLA sites discovered in the future. A detailed process was negotiated with the regulatory agencies to follow if a new site was discovered that had characteristics of a similar site cleaned up previously. A summary of the process follows:

- **Make Initial Assessment.** After a new site is discovered, an initial assessment will be conducted to determine whether CERCLA hazardous substances have been or threaten to be released to soil. Existing information will be considered, such as site observations, field screening, limited sampling results, and process knowledge. If there is evidence that a CERCLA hazardous substance has been released to the environment, the New Site Identification process will be initiated. If the regulatory agencies approve, the site will be added to the Federal Facility Agreement and Consent Order and tracked in the CERCLA database. Sampling may be necessary to confirm the release of hazardous substances to the environment and determine if soil contamination is above risk-based levels. If sampling is required, an existing field sampling plan will be modified or an addendum to a global field sampling plan will be generated. The regulatory agencies will approve field sampling plans before sampling is conducted.
- **Determine if CERCLA Action Is Required.** The regulatory agencies then will evaluate if the concentration of CERCLA contaminants warrant no action, no further action with institutional controls, or remedial action.
    - **No Action Decision.** A no action site has no contaminant source or a contaminant source with an acceptable risk level (maximum of $10^{-4}$ or a hazard index of 1) for unrestricted land use. The regulatory agencies document that no action is warranted under CERCLA on Part B of the New Site Identification form and in an explanation of significant differences factsheet.
    - **No Further Action with Institutional Controls Decision.** For sites that do not pose an unacceptable risk to groundwater or ecological receptors, the regulatory agencies can decide that

no further action with institutional controls is appropriate for a site that cannot be released for unrestricted land use because of at least one of the following conditions:

- The site poses a current unacceptable human health risk from surface pathways, i.e., greater than $10^{-4}$ or hazard index greater than 1, but does not pose an unacceptable risk in the year 2095. The contamination in the top 4 ft in a future industrial area or in the top 10 ft in a hypothetical future residential area will meet acceptable risk-based levels by 2095 due to natural processes, such as radioactive decay, degradation, or volatilization.
- In a hypothetical future residential use area, the site has contamination at depths greater than 10 ft below ground surface.
- In a future industrial use area, the site has contamination at depths greater than 4 ft below ground surface.

- **Remedial Action or Further Investigation.** If a new CERCLA site cannot be released for unrestricted land use by 2095, the regulatory agencies will evaluate the site to determine if it fits the remedy profile for the plug-in remedy. If the site does not fit the remedy profile for the plug-in remedy, the regulatory agencies will indicate on the New Site Identification form how the site will be addressed (e.g., removal action, remedial investigation/feasibility study, ROD amendment, or explanation of significant differences to another existing ROD).

In the Operable Unit 10-08 ROD, the regulatory agencies selected a plug-in remedy for CERCLA releases within the entire INL Site. This process streamlines CERCLA remedial decision-making for newly discovered sites with certain types of releases, including threats of releases, of hazardous substances. The plug-in approach allows the regulatory agencies to apply or "plug in" a selected remedy to address releases of hazardous substances that are similar to releases already addressed under CERCLA at the INL Site and that fit the remedy profile. The regulatory agency decision on how to address newly identified sites depends on whether the site fits the remedy profile for streamlined remediation. Sites that do not meet the remedy profile for the plug-in remedy and require action will be candidates for other CERCLA responses, such as a time-critical removal action, non-time-critical removal action, remedial investigation/feasibility study, ROD amendment, or explanation of significant differences.

The regulatory agencies selected removal and disposal as the only plug-in remedy. As necessary, the remedy includes treatment at the disposal facility and institutional controls at the excavated site to protect human health and the environment. The regulatory agencies selected this plug-in remedy because potential future releases are expected to be similar to those addressed in previous cleanup actions at the INL Site. The plug-in remedy and the remedy profile are based on similar releases at the INL Site for which the removal and disposal remedy has already been selected and implemented under CERCLA. In developing the plug-in remedy, the regulatory agencies analyzed alternative remedies using the nine criteria specified by CERCLA. Based on this analysis, they selected removal and disposal as the plug-in remedy, which is limited in scope and can be readily implemented. Cleanup actions will proceed under the plug-in remedy without needing to reevaluate each release via the CERCLA remedial action process (i.e., a separate remedial investigation/feasibility study, proposed plan, and ROD will not be developed for each release) [3].

## CONCLUSION

The INL Ten-Year Site Plan for Fiscal Year 2012 outlines the vision and strategy to transform the INL to deliver world-leading capabilities that will enable DOE-NE to accomplish its mission. The result is a laboratory that is the core of DOE-NE's national nuclear capability and a DOE complex-wide national user facility, accessible to researchers and experimentalists from national laboratories, universities, industry, other federal agencies, and collaborators from international institutions.

This vision and strategy are supported by completing the INL cleanup mission. The majority of the INL cleanup is expected to be complete in the next 10 years. Some longer term actions, such as addressing groundwater at Test Area North and placing final caps at the Idaho Nuclear Technology and Engineering

Center and the Radioactive Waste Management Complex, are expected to be completed by 2035, but could be significantly accelerated if funding is available. Past decisions have been based on risk, and areas at the INL Site that have been remediated are available for future reuse to support the INL mission.

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