Non-Intrusive Characterization of the 618-10 and 618-11 Burial Grounds at the Hanford Site, Washington - 10343

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ABSTRACT

Non-intrusive characterization activities will provide data and information needed for planning future intrusive characterization activities and remediation strategies for the Hanford Site's 618-10 and 618-11 burial grounds. Planning for intrusive characterization and remediation requires additional understanding of the quantity and condition of the material deposited in these burial grounds, which includes very high dose rate and very highly alpha contaminated items. The term "non-intrusive" is meant to indicate that the vertical pipe units, caissons, and trenches present in these burial grounds will not be opened or exposed in a manner in which the contents of these features will be accessible to personnel or the surface. Non-intrusive characterization activities include geophysical delineation, in situ radionuclide characterization using a multidetector probe assembly, and soil sampling from below select disposal areas. The data and information collected through these activities will be used to develop decision logic to evaluate grouping strategies for future intrusive sampling and remediation tasks (e.g., grouping disposal areas based on similarities such as high dose rates or construction methods).

INTRODUCTION

Washington Closure Hanford, LLC, under contract to the U.S. Department of Energy (DOE), Richland Operations Office, is currently conducting deactivation, decontamination, decommissioning, and demolition of excess facilities; placing former production reactors in an interim, safe, and stable condition; and remediating waste sites and burial grounds in support of the closure of the Hanford Site River Corridor. The Hanford Site River Corridor consists of approximately 210 square miles of the Hanford Site along the Columbia River, in the State of Washington.

The remediation of two large Hanford waste burial grounds present unique and unparalleled challenges with respect to waste characterization, retrieval, and packaging for disposal. The 618-10 and 618-11 burial grounds operated from 1954 to 1967 and contain waste generated primarily from Hanford's 300 Area, where fuel metallurgical analysis was performed and new methods were developed to separate plutonium from nuclear fuel. These wastes consisted of metallurgical sample residues, samples from experiments, and other very high dose rate, high alpha contamination wastes. This waste was placed at the 618-10 and 618-11 Burial Grounds for the purpose of non-retrievable disposal.

These burial grounds are located directly upwind and only a few hundred feet from either Hanford's main highway access (618-10), or an operating commercial nuclear plant (618-11).

Washington Closure Hanford (WCH) submitted a Remediation Design Solution for the 618-10 and 618-11 Burial Grounds to the Department of Energy, Richland Operations Office (DOE/RL) in 2007. DOE/RL reviewed the design solution and determined that the approach was reasonable, but had some recommendations and concerns that needed to be addressed prior to authorizing design and remediation of these burial grounds. The recommendations were as follows:

- Perform characterization of the trenches, caissons, and vertical pipe units (VPUs) in terms of further record searches, non-intrusive sampling, and intrusive sampling.

- Based on the characterization results, refine the remediation approach to provide a detailed design that would include environment, safety, and health controls; radiological controls; confinement strategy; and development of any new instrumentation that will be required.

- Provide a more defensible life-cycle cost for transuranic (TRU) waste, which should include the extent of TRU waste processing that will be required after it arrives at interim storage facility to meet waste acceptance criteria for disposal and include the appropriate escalation and contingency costs

- Reexamine the assumption that no discrete, separable, and identifiable spent nuclear fuel will be exhumed from the burial grounds and provide life-cycle costs and disposition of spent nuclear fuel as appropriate

Non-intrusive characterization is required to respond to the recommendations associated with further record searches, non-intrusive sampling, and development of a confinement strategy.

Burial Grounds Description

The 618-10 Burial Ground is located approximately 6.4 kilometers (four miles) north of the Hanford 300 Area and approximately 400 meters (1300 feet) upwind of the primary Hanford highway. It was activated in March 1954 and closed in September 1963.

The burial ground includes 12 trenches of various sizes which are up to 23 meters (75 ft) wide and 92 meters (300 ft) long by up to 7.6 meters (25 feet) deep. It also contains 94 vertical pipe units (VPUs), which are bottomless 55-gal drums that were welded together and buried vertically (Fig. 1). The burial ground received a broad spectrum of low- to high-activity, dry, radioactive waste. The waste was primarily fission products and some plutonium-contaminated waste from the 300 Area. The trenches received low level waste in cardboard boxes; concreted drums containing higher activity waste, including some liquids; and large miscellaneous items (i.e., laboratory hoods, vent filters, and glove box trays). Non-radioactive beryllium was also disposed in the trenches. In 1959, the 327 Metallurgy Laboratory began using a cask truck to transport hot cell waste in aluminum "milk pails," which were remotely dropped into the unit. These "milk pails" were sealed with gelatin and had no lids. Another cask, known as the "Gatling Gun," deposited l-liter "juice" cans of high-activity waste from a rotating chamber into the pipe units. Few records documenting solid waste burial activities were kept until 1960.

The 618-11 Burial Ground is located approximately 12 kilometers (7.5 miles) northwest of the Hanford 300 Area, just upwind and within the controlled area of an operating commercial nuclear plant (Columbia Generating Station). The 618-11 burial ground was operational from October 1962 through December 1967. The site is 114 meters (375 ft) wide by 305 meters (1,000 ft) long, appearing as a long rectangular area that is oriented east to west. The burial ground consists of three burial trenches, fifty VPUs (similar in design to 618-10), and five 2.4 meter (8 ft) diameter 3.1 meter (10 ft) tall caissons, which are buried 4.6 meters (15 feet) deep and connected to the surface by an offset 0.9 meter (three foot) diameter pipe designed to reduce radiation dose rates at grade level (Fig. 2). Trenches are 275 meters (900 ft) long, 15.3 meters (50 ft) wide, 7.6 meters (25 ft) deep, and are V-shaped with a 1:1 sides slope. Based on process knowledge, the site contains a vast spectrum of low radionuclide concentration to high concentration wastes. Contaminants that may be present include technetium, zirconium, uranium, americium, cesium, curium, Sr^{90}, C^{14}, plutonium metals, and plutonium nitrates. Other contaminants may include thorium, beryllium, aluminum-lithium, and carbon tetrachloride. The waste would also have included laboratory items. It is known that some waste containing plutonium was deposited at the 618-11 burial ground. Radiological survey records indicate wastes disposed are similar to waste disposed in 618-10; however, records indicate waste disposal practices changed in the mid 1960s when high dose rate, high plutonium concentration wastes were disposed in the 200 Area of Hanford's Central Plateau.

When waste was disposed, higher dose rate items were generally transported to the 618-10 and 618-11 Burial Grounds in bottom-opening shielded casks and placed in either vertical pipe units (VPUs) or caissons (618-11 only) by remotely opening a trap door in the bottom of the cask and allowing the waste to fall to the bottom of the VPU or caisson. Remaining waste was disposed in trenches. Some high-dose-rate waste was disposed in trenches by either loading cardboard boxes of waste into shielded load luggers or centering small quantities of waste in a drum and pouring either concrete or a combination of concrete and lead around the waste, some of which was containerized liquid waste. These "concreted" waste drums were primarily generated at the 325 Building and most were disposed in 618-10 (436 of the 544 recorded). While use of the concreted/lead-shielded drums resulted in a significant dose rate reduction for personnel disposing of the waste when generated, they present characterization and handling challenges when the waste is exhumed.

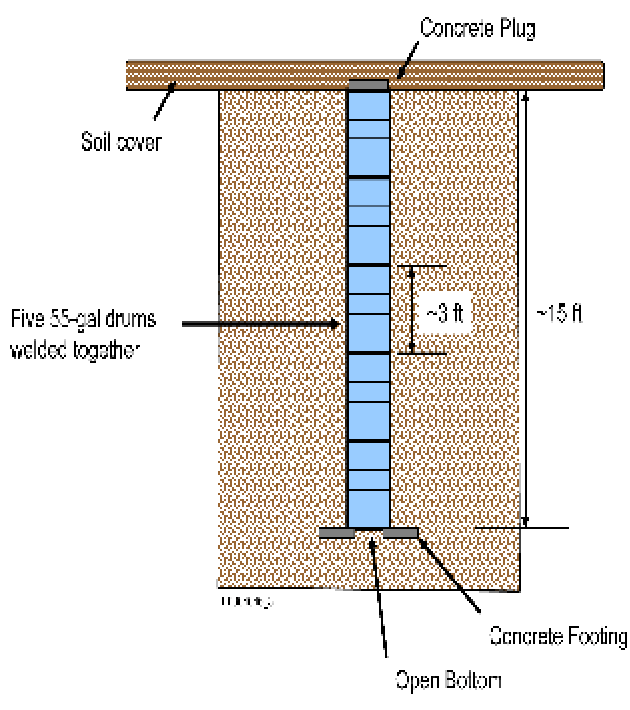

Figure 1. Typical 618-10 and 618-11 Site Vertical Pipe Unit

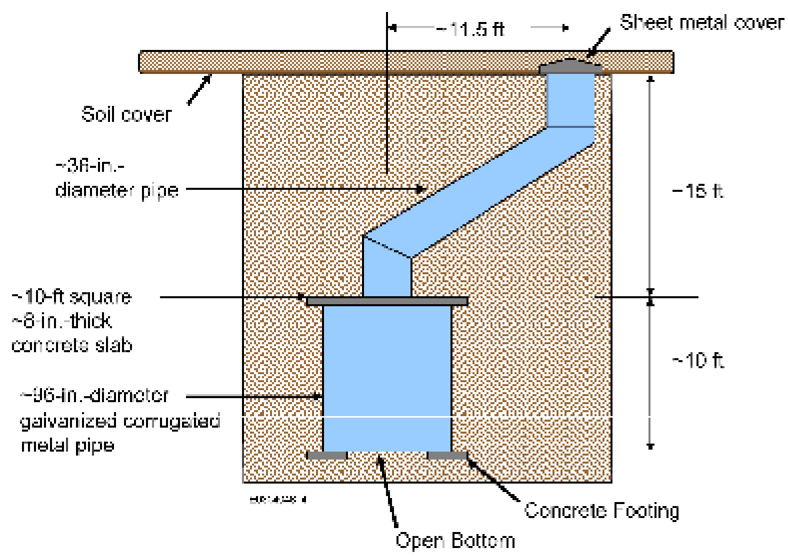

Figure 2. 618-11 Site Caisson

NON-INTRUSIVE CHARACTERIZATION DESIGN

At the start of the project, it was known that specific documentation of waste disposal activities had been destroyed in the early 1990s. Because waste disposal records were unavailable, other methods for characterization needed to be developed. A document search identified over 3000 radiological surveys from facilities that generated and disposed waste at the 618-10 and 618-11 burial grounds. These surveys were used for a number of purposes, including identification of the primary facility contributors of waste disposed to the two burial grounds. Because the surveys frequently identified the method of conveyance, they were used to identify if the wastes were disposed in the VPUs, caissons, or trenches. Two buildings, the 325 building (radiochemistry building) and 327 building (fuel metallurgical analytical laboratory), generated a majority of waste. Radionuclide distribution was identified from single-pass reactor data from an operating reactor that operated throughout the timeframe the burial grounds operated. Because waste disposal records were unavailable, other methods for characterizing the waste needed to be developed. Non-intrusive sampling is defined as characterization activities that can be performed without removing materials from inside the VPUs, caissons, or trenches.

The VPUs, caissons, and trenches will be evaluated using an in situ radiological multi-detector probe (MDP) through sealed, metal-cased probe points located just outside each of the VPUs and caissons, and within the boundaries of each trench structure. Up to four probe points will be installed at approximately equally spaced positions outside the perimeter of each VPU, and up to six equally spaced probe points will be installed outside the perimeter of the caissons for radiological logging purposes. Each of these probe points will be installed as close as possible to the VPUs and caissons. Sealed, metal-cased probe points will also be installed along the approximate centerline of each of the trenches. Geophysical surveys will be performed to precisely locate each of the VPUs and caissons, and geophysics data from surveys previously performed at the sites will be used to locate the approximate centerlines of the trenches.

Based on the geophysics survey and in situ MDP data, approximately 10% of the VPUs will be selected as locations for soil sampling. One soil sample will be collected for radiological and chemical analysis from below each of the selected VPUs. Two soil samples will be collected from beneath each of the caissons. The soil sample locations at each caisson will be selected based on the in situ radiological monitoring data. Probe points with removable drive tips will be used to access the soils immediately outside the perimeter and approximately 0.6 m (2 ft) below the bottom of the VPU and caisson structures. Soils from beside/below the VPUs and caissons can be sampled without intrusively entering the structures, so sampling from these locations is possible. However, soil samples from beside/below the trenches cannot be collected without intrusively entering them, and there is insufficient data from the trenches to determine the contamination controls required for sample collection. Therefore, soil samples will not be collected from within the footprint of the trenches during this characterization effort.

Four main phases of work are to be performed under this characterization design. These include the following:

- Delineate burial ground structures using geophysical methods to locate in situ measurement and soil sampling points
- Install cased probe points near or within subsurface burial ground structures
- Collect in situ radiological measurements from within the installed probe points using a MDP assembly
- Collect soil samples from the perimeter of the VPUs and caissons at depths below the bottom of these structures.

GEOPHYSICAL DELINEATION

The first step in performing non-intrusive characterization activities within the 618-10 and 618-11 Burial Grounds will consist of performing geophysical surveys to delineate the VPUs and caissons, and to evaluate existing geophysics data from the trench areas so the probe and soil sampling points can be located. It is important that the VPU and caisson probe points are located as close to the perimeter of these structures as possible to help attain the maximum level of accuracy possible from the MDP. A three-step process will be used for the VPUs and caissons. Geophysical surveys with sufficient detail to locate the probing locations have previously been performed in the trench areas. These data will be evaluated to finalize probing locations at the trenches.

Vertical Pipe Unit and Caisson Geophysical Surveys

The delineation of the VPUs and caissons will be determined using the following three-step geophysical survey approach:

- Reconnaissance-level magnetic field survey (if existing documentation proves incomplete or inconsistent)
- Detailed level magnetic and time domain electromagnetic induction (TDEMI) survey
- Ground-penetrating radar (GPR) survey.

The objective of the reconnaissance-level survey is to identify and stake the general locations of features of interest and to map the area for further evaluation. The reconnaissance-level survey will use a magnetic field mapping instrument (magnetometer) that detects changes in the earth's magnetic field caused by buried objects. The path locations will be established using fiberglass measuring tapes and visual guide markers. Vertical pipe unit/caisson position information will be controlled using an optical encoder.

The detailed magnetic surveys will consist of two parts. The first part uses the above described magnetic survey technique at a reduced grid pattern. The second part is a magnetometric survey that measures the intensity of magnetic eddy currents as a function of time. Computer modeling then creates a horizontal layered resistivity model of the subsurface.

In the final step of the geophysical delineation of the VPUs and caissons, the position and boundary of the subsurface features will be determined using GPR. Ground-penetrating radar profile locations will be determined based on the magnetometer data collected during the first two steps described above.

All the survey data will be downloaded into a computer and electronically overlaid to determine the best fit. When this is completed, the final centerline coordinates of each buried object will be identified. Using these coordinates, field personnel will stake the probe point locations, which will be documented with civil survey and GPS coordinates.

Trench Geophysical Surveys

Extensive geophysical survey data that can be used to locate the probe points in the areas of the 618-10 and 618-11 trenches have been collected during previous mapping activities at these sites. The earlier geophysical work included detailed GPR and magnetometer surveys. The results of these activities were documented onsite maps using global positioning system (GPS) - generated coordinates.

These data can be used to determine the approximate centerlines of the trenches and to identify any areas that may be of special interest. The data will be reviewed prior to determining the final placement of the probe points and the locations will be staked in the field using GPS survey techniques based on mapped coordinates.

Probe Point Installation for Multidetector Probe Logging

Direct-push probe points are to be installed at the perimeter of the VPUs and caissons and lengthwise along the centerline of the trenches. These probe points will be used to access the subsurface of the 618-10 and 618-11 Burial Grounds with a MDP to collect in situ radiological characterization data from the burial ground structures.

The probe points are to be installed using a direct-push method. Unlike conventional drilling methods, direct-push methods allow for the installation of probe rods without having to drill and remove soil to make a path for the rods. Each probe point will consist of a string of threaded rods that will be driven or pushed into the ground using truck-mounted equipment. A conical-shaped steel tip will be threaded onto the down-hole end of the rod string to help facilitate the advancement of and seal the down-hole end of the rods. The probe rods will accommodate the MDP logging tool.

The probing rods are advanced by fitting a conical tip to the down-hole end of the initial rod(s) and a drive cap to the upper end of the rod string. The initial rod is positioned beneath the drive head of the probe equipment, checked to verify that it is plumb, and pushed into the ground using the drive head until another section of rod must be added to advance the string further.

The upper end of the rods will be temporarily sealed. The probe points will remain in place until further characterization or remediation activities take place.

Vertical Pipe Unit Probe Point Installation

Documentation available for the 618-10 and 618-11 Burial Grounds indicates that there are 94 VPUs at the 618-10 Burial Ground and 50 VPUs at the 618-11 Burial Ground. The VPUs typically consist of five open-ended, 209 L (55-gal) drums that have been welded together end-to-end. Historical information indicates that each drum measured approximately 55.9 cm (22 in.) in diameter and 0.9 m (3 ft) long. There is also historical documentation indicating that up to 10 of the VPUs at the 618-10 site were constructed using 3.1 m (10-ft-) long sections of approximately 0.3 m (12-in.-) diameter corrugated metal pipe. The VPUs were installed vertically, and historical documentation indicates that they likely were positioned on a concrete footing. The upper portion of the VPUs was likely capped with a concrete plug . Approximately 0.6 to 1.8 m (2 to 6 ft) of cover material has been placed over the VPUs for access and contamination control.

Up to four probe points are to be installed at each VPU for the purposes of collecting MDP data. The probe points will be installed at approximately equally spaced positions outside the perimeter of each VPU. The probe points are to be installed as close as possible to the VPUs to obtain the highest resolution possible from the MDP logging tool. If refusal is encountered at shallow depths, the probe point will be stepped out until the rods can be advanced to the desired depth. Each of the MDP probe points will be installed to an approximate target depth of 0.9 m (3 ft) below the bottom of the VPU structures.

Caisson Probe Point Installation

Based on limited available documentation, three to five caissons are present only at the 618-11 Burial Ground. According to historical information, each caisson was constructed of a 3 m (10-ft-) long section of 2.4 m (8-ft-) diameter corrugated metal pipe that was oriented vertically and positioned on a concrete footing. The top of the caisson was positioned ~4.6 m (15 ft) below the ground surface at the time the burial ground was in operation. The top of the caisson is likely covered with a ~3 m (10-ft-) square, 20.3 cm (8-in.-) thick concrete top. The caisson was connected to the ground surface through an offset 91.4 cm (36-in.) metal chute. The top of the chute was capped with a domed metal lid.

Up to six (a minimum of three) equally spaced probe points are to be installed at each caisson for the purpose of collecting MDP data. If the chute position can be determined by the geophysical surveys, one of the probe points will be located near and along the side of the chute. The other probe point locations will be determined based on the position of this probe point. As with the VPUs, the probe points will be positioned as close as possible to the caissons outside the perimeter of the structures.

If refusal is encountered at shallow depths, the probe point will be stepped out until the rods can be advanced to the desired depth.

An attempt will be made to drive each probe point to a depth of 0.9 m (3 ft) below the bottom of the caissons. Up to 0.9 m (3 ft) of cover material has been placed over the caisson locations. This cover depth will be identified using the geophysics data described previously. It is possible that the caisson footing will be encountered prior to reaching this depth and the probe point will reach refusal.

Trench Probe Point Installations

Based on the geophysical delineation of the trenches, probe points will be positioned along the entire length of each trench at the approximate centerline. These probe points will be spaced at approximately 7.6 m (25-ft) intervals unless areas of interest or objects of concern indicate that adjustments to this spacing are necessary. If areas of concern or interest are identified in the trenches it may be necessary to either increase or decrease the spacing of the MDP probe points. The project engineer will determine if spacing adjustments are required.

Each of the probe points will be driven to a total depth of approximately 9.2 m (30 ft) below the existing ground surface.

MULTIDETECTOR PROBE MEASUREMENTS

Each of the planned direct-push locations will be logged using an MDP instrument that is configured with two gamma-ray detectors that are used as spectrometers, two neutron detectors, and a gross gamma detector. The MDP system was designed for use in characterizing VPUs at the 618-10 and 618-11 Burial Grounds. The detectors are configured to measure a broad range of radiation sources and activities through the wall of a steel direct push rod. These detectors are incorporated into a single assembly with integral shielding to restrict the field of view of some of the detectors, improve efficiency, and locate the vertical position of radiation sources within the material being logged.

The components of the MDP are primarily standard radiation measurement modules with associated software elements to provide an integrated approach for data acquisition, analysis, and archiving. Additional elements include daily performance checks using radioactive sources to verify system operability. The five detectors in the MDP system perform the following functions.

- *Gross Gamma Activity* – An energy-compensated Geiger-Mueller (GM) detector, with a nominal 0.8 in. diameter, has a sensitivity range from a few mR/hr to about 500 R/hr. Detecting gross gamma activity assists in defining the depths where the MDP NaI(Tl) and cadmium zinc telluride (CZT) detectors will be most effective for isotopic characterization of the waste.

- *Low-Level Gamma Isotopic Activity* – A thallium-doped sodium iodide NaI(Tl) detector (1 in. diameter by 1 in. long) is used as one of the gamma spectrometers for analyses for the primary isotopes expected in the Hanford Site wastes. The primary detectable radionuclides that are associated with irradiated fuels or activated materials include cesium-137, europium-154, europium-152, and cobalt-60.

- *High-Level Gamma Isotopic Activity* – The second gamma detector for spectrometry, used for high-level (>2 R/hr) isotopic measurements, uses a CZT detector (0.5 in. by 3.5 in.). This detector provides reasonable resolution and is more sensitive at the lower gamma-ray energies (<1.0 MeV). This probe provides good resolution for many long-lived radionuclides and has been used previously to detect and quantify irradiated fuel materials and activation products in a number of environments.

- *Neutron Detection* – Spontaneous neutron production occurs from plutonium-239 and uranium-235. Helium (^3He) and boron triflouride (BF_3) detectors are used to assess the presence of quantities of neutron-generating fissile radioactive materials that may not be directly detectable using gamma spectrometry methods. Although the high-pressure ^3He detector is more sensitive to neutron detection than BF_3, the BF_3 detector is less sensitive to gamma radiation interference and is more suitable for neutron detection within higher gamma radiation fields.

- *Gamma Probe* - Although not an integral part of the MDP system, a second gross gamma detector (GM probe) is used to log the holes prior to inserting the MDP into the casings for system data collection. This hand-held GM probe provides preliminary estimates of exposure rates and hot-spot locations prior to data collection using the MDP.

Field Measurements

In situ characterization using the MDP system to perform field measurements consists of the following activities:

- Deploy GM Probe

  The MDP operator lowers the GM probe to the bottom of the direct-push rod casing and raises the GM probe at 0.3 m (1-ft) increments to record detector measurements at various elevations.

- Perform Source Check

  Prior to field operation, the MDP system undergoes a field check process using radioactive sources traceable to the NIST. At the beginning and end of each field measurement day, the MDP operator performs source checks to ensure system operability. A gamma-emitting radioactive source traceable to NIST will be used for the source checks. A cesium-137, barium-133, or other similar source with an activity of approximately 10 µCi will be used as a check standard.

- Perform Radiological Assay

  Measurements are performed starting at the bottom of the probe point casing and taken in 0.3 m (1-ft) increments until the instrument has reached the ground surface. The MDP operator lowers the MDP to the bottom of the direct-push rod casing and ensures that the MDP is properly configured to perform measurements. The operator then initiates the integrated software program and begins radiological assay. The computer program will perform system countdown during measurements indicating the time remaining to complete the measurement at that interval.

SOIL SAMPLING AND ANALYSIS

The primary purpose for collecting and analyzing soil samples will be to assess the vertical distribution of contaminants in the soils directly beneath the VPUs and caissons. This information may be useful in determining if liquid contaminants have migrated into the soil column. One soil sample will be collected from beneath up to 10% of the VPUs at each site, and two soil samples will be collected from beneath each of the caissons at the 618-11 Burial Ground. These data will be used to support the planning for subsequent characterization and remediation activities.

Vertical Pipe Unit Soil Sampling

The intent of the sampling philosophy will be to obtain the most diverse potential information from a limited sampling activity. The VPU soil sampling locations will be selected based on the physical position of the VPUs in the burial grounds, structural characteristics as determined using the geophysics survey data, and their radiological signatures as indicated from the MDP logging data.

The VPUs that were constructed using 0.5 m (22-in.) diameter drums may represent wastes disposed during a different time period that the waste in the VPUs that were constructed using the approximately 0.3 m (12-in.) diameter corrugated metal pipe. At least one soil sample will be collected from below each type of VPU if the different construction types can be determined using geophysics data.

The VPUs were constructed in distinct rows at each of the burial grounds. Since it is possible that the rows were constructed at different times and may represent different time periods when waste was disposed at the burial ground, at least one VPU from each row will be selected for soil sampling. Unless the other location selection criteria indicate otherwise, the positions for sampling within each row will be varied for each row.

The MDP radiological surveys will be used to develop dose rate ranges and estimated radionuclide compositions that can be used to group the VPUs. Soil sample locations at the VPUs will be selected based on these groupings to evaluate different dose rates or differing radionuclides and to target locations where mobile radiological contaminants may exist.

Locations that exhibit low or no activity during the MDP surveys may indicate VPUs that are empty and did not receive waste. These locations will be given the lowest priority for soil sampling.

Direct-push soil samples at the VPUs will be collected from a depth interval that starts at approximately 0.6 m (2 ft) below the bottom of the VPUs and that extends to approximately 1.8 m (6 ft) below the bottom of the VPUs. Sample recovery rates will determine the actual depth intervals. Target depths for the samples will be determined based on geophysics and MDP data. Soil samples will be collected during separate probe pushes (i.e., not from the MDP probe pushes). Soil sampling is proposed beside/below the VPUs; angled pushes to try to collect soil samples directly beneath the VPUs are not technically feasible.

Caisson Soil Sampling

Two locations near the perimeter of each caisson will be selected for direct-push soil sampling based on information collected while driving the MDP probe points and the data from the MDP logging data. The data will be evaluated to determine the positions around the perimeter of the caissons where contamination is most likely to be encountered and to identify locations where the direct-push soil sampling tools are likely to reach the desired sampling depths. If there appears to be no variation in the MDP data for a caisson or if based on the MDP data it appears that a caisson had not received waste, two locations on opposite sides of the caisson will be selected based on the likelihood that the soils beneath the caisson can be reached with the direct-push soil sampling tools. It will be preferable that opposite sides of the caisson are sampled if there is no variation in the MDP data; however, the accessibility of soils beneath the caissons may prevent this.

Direct-push soil samples at the caissons will be collected from a depth interval that starts at approximately 0.6 m (2 ft) below the bottom of the caissons and that extends to approximately 1.8 m (6 ft) below the bottom of the caissons. Sample recovery rates will determine the actual depth intervals. Target depths for the samples will be determined based on geophysics and MDP data. Soil samples will be collected during separate probe pushes (i.e., not from the MDP probe pushes). Soil sampling is proposed beside/below the caissons; angled pushes to try to collect soil samples directly beneath the caissons are not technically feasible.

Direct-Push Sampling Methods

Samples will be collected using direct-push sampling tools. The direct-push sampling tool consists primarily of a sample barrel that is lined with a removable plastic liner. The down-hole end of the barrel is fitted with a removable tip and cutting shoe and the upper end of the tool is attached to the direct-push rods. The tool will be pushed to the top of the desired sampling interval, the tip will be pulled to open the cutting shoe, the sample barrel installed, and the sampling tool advanced to fill the sampling barrel. The direct-push equipment operator will use care not to overdrive the device. The sample material recovered in the barrel is then removed from the cased hole and cut open to containerize the sample media.

CONCLUSION

As of this writing, data from non-intrusive characterization are still being gathered, so a detailed evaluation cannot be given. The data and information collected through this activity will be used to develop decision logic to evaluate grouping strategies for intrusive sampling and remediation tasks. For example, VPU groupings developed using the data and information collected through this activity could be used to determine the appropriate number of intrusive samples that may be included in future characterization work.

Based on the characterization results, the remediation approach can be refined to provide a detailed design that includes environment, safety, and health controls; radiological controls; confinement strategy; and development of any new instrumentation that will be required.

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