Characterization and Remediation of the Hanford 618-10 Burial Ground Vertical Pipe Units – 17121

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ABSTRACT

The 618-10 Burial Ground is approximately 148 m by 143 m (485 feet by 470 feet) and consists of 12 trenches and 94 Vertical Pipe Units (VPU's). It is located approximately 8.1 km (5 miles) north of Richland, Washington in the 600 Area of the Hanford Site. The 618-10 Burial Ground received low- to high-activity waste (e.g., fission products and some plutonium-contaminated waste). Most of the waste originated at the 300 Area laboratory facilities. Lower activity radioactive material and shielded drums were disposed in trenches, while laboratory wastes with higher levels of radiation were disposed in Vertical Pipe Units (VPUs).

There are different variants of VPUs. Some VPUs are simply corrugated culverts or standard pipes, 36 cm (14 in.) diameter and 3.1 m to 4.6 m (10- to 15-ft) long, buried vertically. Some VPUs are carbon steel pipes 25 to 61 cm (10 to 24 in.) in diameter and up to 4.6 m (15 ft) in length. The final design of the VPUs is 56 cm (22-in) diameter, 4.4 m (14.4 ft) long waste receptacles constructed by welding five 208 L (55-gallon) bottomless drums together end-to-end and burying them vertically, separated by approximately 3.1 m (10 feet) on center in rows approximately 7.6 m (25 feet) apart. The 618-10 Burial Ground contains approximately 94 VPUs.

Historical documents indicate that shielding materials (e.g., concrete or soil) may have been added to the VPUs to reduce dose rates over the openings, and that each VPU was backfilled with sand and capped with concrete at the end of its service life. Historical documents also indicate that the VPUs were covered with approximately 0.6 m (2-ft) of soil when they were closed, and an additional 0.6 m (2-ft) of topsoil was later added for surface stabilization.

In general, the process for VPU remediation was as follows:

- Installed four cone penetrometers (CPTs) around the exterior of each individual VPU and sent radiation detection probes down the interior of the CPTs to get initial radiation data in order to calculate the overall curie content and create maps showing the dose rate distribution throughout the VPU.
- Removed the CPTs and installed a 122 cm (48-in) diameter, 1.3 cm (0.5-in) thick steel over-casing using a vibrating hammer suspended from a crane that encompassed the VPU with some surrounding soil.
- Using a Bauer BG-30 drill rig with a specifically designed augur bit and a specially designed confinement system the augering process was used to stabilize and size reduce the contents.
- Once the auger reached a depth of 8.5 m (28 feet) the BG-30 drill stem was separated and additional characterization was completed by sending a radiation probe down the center of the drill stem to gather radiological data.
- Once auguring and characterization was completed the waste was removed using a specially designed extended clamshell retrieval bucket and placed into individual 2.7 m x 1.5 m x 1.2 m (9-ft x 5-ft x 4-ft) metal boxes.
- After the waste was placed into the metal waste boxes a low strength grout was added and the grout and waste material was mixed using a large rake device attached to an excavator.

INTRODUCTION

One of the methods used for waste disposal at the 618-10 Burial Ground was the VPU. It was determined during VPU potholing activities that the following three types of VPUs were used at the 618-10 Burial Ground:

- Steel pipe VPUs: carbon steel pipes 25 to 61 cm (10 to 24 in.) in diameter and up to 4.6 m (15 ft) in length
- Corrugated VPUs: corrugated steel pipes 36 cm (14 in.) in diameter and up to 4.6 m (15 ft) in length
- Drum VPUs: 56 cm (22 in.) in diameter and 4.4 m (14.4 ft) in length. These VPUs were constructed by welding five 208-L (55-gal) bottomless drums together end-to-end and burying them vertically. See Fig. 1.

The 618-10 Burial Ground received low- to high-activity waste (e.g., fission products and some plutonium-contaminated waste). Most of the waste originated at the 300 Area laboratory facilities. Shielding materials (i.e., concrete and soil) were added to the VPUs, as necessary, to reduce dose rates over the openings. In addition the VPUs were backfilled with sand and capped with concrete after the VPUs stopped receiving waste, and were covered with approximately 0.6 m (2 ft) of soil when they were closed. Additional topsoil was later added for surface stabilization. Fig. 1 shows the expected configuration of a typical drum VPU.

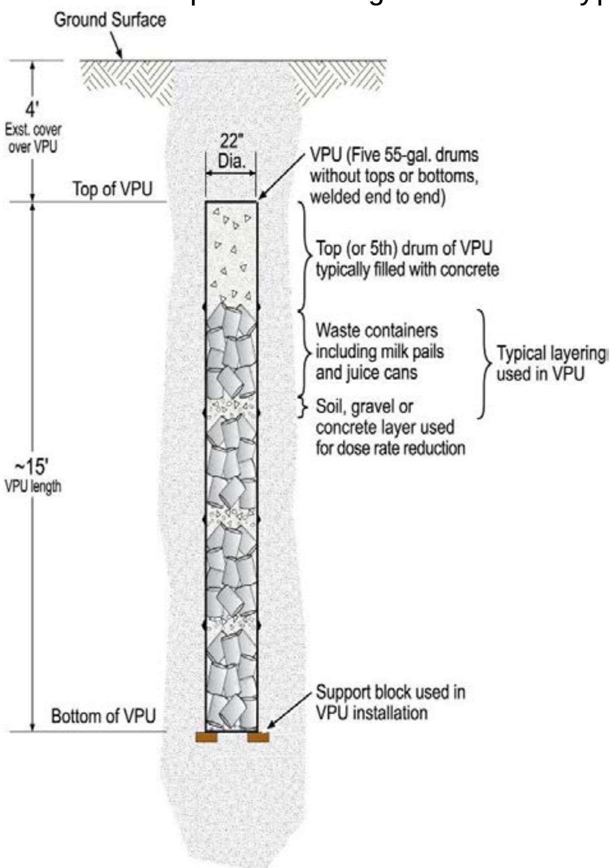

Fig. 1. Standard 618-10 VPU contents.

DISCUSSION

Initial Characterization:

Using ground penetrating radar to determine the approximate location of the VPUs the project installed four cone penetrometers (CPTs) around the exterior of each individual VPU and then sent radiation detection probes down the interior of the CPTs to get initial radiation data in order to calculate the overall curie content and create maps (Fig. 2) showing the dose rate distribution throughout the VPU. This information was further refined once potholing around the VPUs was completed (Fig. 3) and the actual distance between the CPTs and VPUs could be validated. Potholing activities were also used to determine the construction (steel pipe, metal culvert or 208-L (55-gal) drums) used for each VPU.

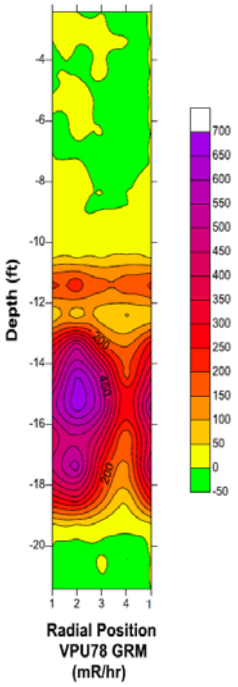

Fig. 2. VPU Dose Map.

Fig. 3. VPU Potholing.

Mock-Up Testing:
In order to ensure the success of the auguring process a full scale mock-up area was constructed (Fig. 4) and typical items that would be present in the actual VPUs was placed inside of the VPUs. As can be seen in Fig. 5, these included 113.6-L (30-gal) drums filled with smaller canes, 18.9-L (5-gal) buckets filled with various items such as metal washers, nails, PPE, scrap metal, tygon tubing. Concrete plugs were poured at various levels as the items were placed into the VPUs and a final concrete plug was placed and filled the VPU to the top.

Fig. 4. Mock-up Area.

Fig. 5. Loaded Mock-up VPUs.

Over-casing Installation and Augering:

With the completion of characterization and the confirmed location of each VPU the CPTs were removed and a 122 cm (48-inch) diameter, 8.63 m (28-foot) long steel over-casing was driven around each VPU using a vibratory hammer hanging from a crane (Fig. 6). The over-casing was installed to control materials located in the VPU during the next stages of the process.

A carbon steel pipe with a 122 cm (48-in.) outer-diameter and a 1.3 cm (0.5-in.) wall thickness was selected for the over-casing. This over-casing is long enough to pass through the overburden, surround the entire length of the VPU, and extend beyond the bottom of the VPU.

The depth (below grade) required for driving the over-casings was determined to be the sum of the maximum overburden, VPU height, and required clearance below the VPU. The below-grade length of 7.6 m (24.8 ft) results from the following values:

- Maximum overburden: 2.07 m (6.8 ft)
- Typical VPU height: 4.6 m (15.0 ft)
- Minimum bottom clearance: 0.9 m (3.0 ft)

The over-casing height above grade must be high enough to contain material swell from the augering operations. An estimate of this height was calculated by considering augering swell, addition of water for in situ moisture control, and freeboard.

Fig. 6. Installation of Over-Casing.

Size reduction and stabilization was performed using a Bauer BG-30 drilling machine and a specially designed auger in order to neutralize hazards contained in the VPUs in situ, thereby minimizing any potential for exposure of personnel or release to the environment. The process was designed to breach all containers in order to ensure that no free liquids and no voids are present, and to size reduce all material within the over-casing to facilitate removal. Fig. 8 shows the typical size of the retrieved materials after augering was completed. For reference the larger screening material is 7.6 cm x 7.6 cm (3-inch x 3-inch) and the smaller screening material used was 1.3 cm x 1.3 cm (½-inch x ½-inch) in size. As can be seen in Fig. 7 the augured material was greatly size reduced and no unopened containers or free liquids were present.

Fig. 7. Typical conditions of item after being augured.

Size reduction and stabilization required the installation of an Augering Test Enclosure (ATE) on the overcasing as shown in Fig. 8. The ATE a specifically designed to house a size-reduction and stabilization auger with the stem protruding out the top of the enclosure to allow for attachment to the drill rig. The ATE was be connected to an active ventilation system and a water system pump skid. The auger would be run at a slow rotational speed and slowly advanced down through the VPU material. After size reduction and stabilization, the auger would be retracted from the VPU, washed using embedded spray rings located within the ATE and radiological sampling of the auger and airspace would occur through specially designed ports.

Fig. 8. ATE installed on Over-Casing.

The main function of the ATE was to control dust and contamination during augering operations. Features of the ATE included the following:
Lifting lugs
Connection for active ventilation
Access ports for swipe sampling
Air sampling port
High-pressure, low-volume water nozzles for rinsing
High-pressure and low-volume water nozzles were located near the top, middle, and bottom of the ATE to provide a high-pressure rinse of the auger and stem as it is retracted from the standpipes.
A specially designed auger, attached to a Bauer BG-30 drill rig, similar to Fig. 9, for size reduction and mixing the contents of the standpipe was used. The size-reduction portion of the auger is composed of a triple cutting plate with a series of tungsten carbon teeth on each cutting surface. The teeth are snapped into a carbon steel block with a retaining ring for easy replacement if damaged. Centered at the tip is a pilot bit with teeth to keep the auger centered as it descends through the contents of the over-casing. The stem extends through the top of the auger enclosure for connection to the drill rig stem.

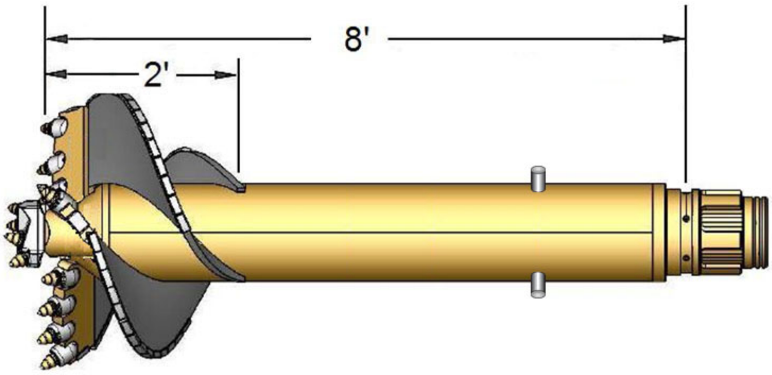

Fig. 9. Size-Reduction and Stabilization Auger.

The overall augering process was so successful that the 618-10 VPU project was able to complete the auguring of all 80 VPUs in the timeframe allotted for the completion of 28 VPUs.

Waste Retrieval and Grouting:

Once the auger reached the full depth of the VPU the drill stem was separated and a radiation probe was sent down the hollow drill stem to further validate the radiation readings that were taken during initial characterization via the CPTs. This further characterization was used to determine that all of the augered material located in the VPU was low level waste (LLW) and met the Environmental Restoration Disposal Facility (ERDF) Waste Acceptance Criteria (WAC).

After the auguring was completed a modified excavator with an extension tube and specially designed clamshell was used to retrieve the material from the overcasing (Fig. 10). As the waste material was removed it was loaded into metal waste boxes that were filled to the appropriate level to allow for the addition of a stabilizing grout. A low strength grout was added to encapsulate any possible lead and to stabilize the waste in general. The waste material and grout were mixed using a specially designed mix rake attached to an excavator (Fig. 11). Once the waste/grout mixture solidified, the waste boxes were loaded into an additional waste container and shipped offsite for disposal.

Fig. 10. VPU Waste Retrieval Clamshell.

Fig. 11. Grout/Waste Mixing.

CONCLUSION

The 618-10 Burial Ground VPU remediation was long considered one of the highest risk and most complex project within the DOE complex. After several years of planning and determining all of the “what ifs” that could happen. The project team showed that even the toughest jobs can be completed when approached with proper planning and a questioning attitude. Throughout the project the team was constantly looking for better ways to perform the work while maintaining worker and environmental safety at the forefront of everything. The final equipment designs, fabrication process and operational testing were key to the success of the project and prevented what could have very easily become a multi-year science project that never actually completed any field work.