

3. OPERABLE UNIT 1-10 REMEDIAL INVESTIGATION

The Operable Unit (OU) 1-10 remedial investigation (RI) involved collecting and analyzing existing data as well as collecting, validating, incorporating, and analyzing new data to provide a database for characterization of Waste Area Group (WAG) 1. The objectives of the RI were to assess the extent of contamination associated with sites identified in WAG 1 and determine site-specific transport properties. The data collected during the RI is being used to support the baseline risk assessment (BRA) for WAG 1 as well as the OU 1-10 feasibility study (FS). In this section, the limited field investigation needed to support the OU 1-10 objectives above is discussed. The planned sampling and analysis objectives and approach utilized are outlined in the Field Sampling Plan (FSP) included as Attachment III to the *Work Plan for WAG 1 OU 1-10 RI/FS* (LMITCO 1996a). The sites included in the field investigation are as follows:

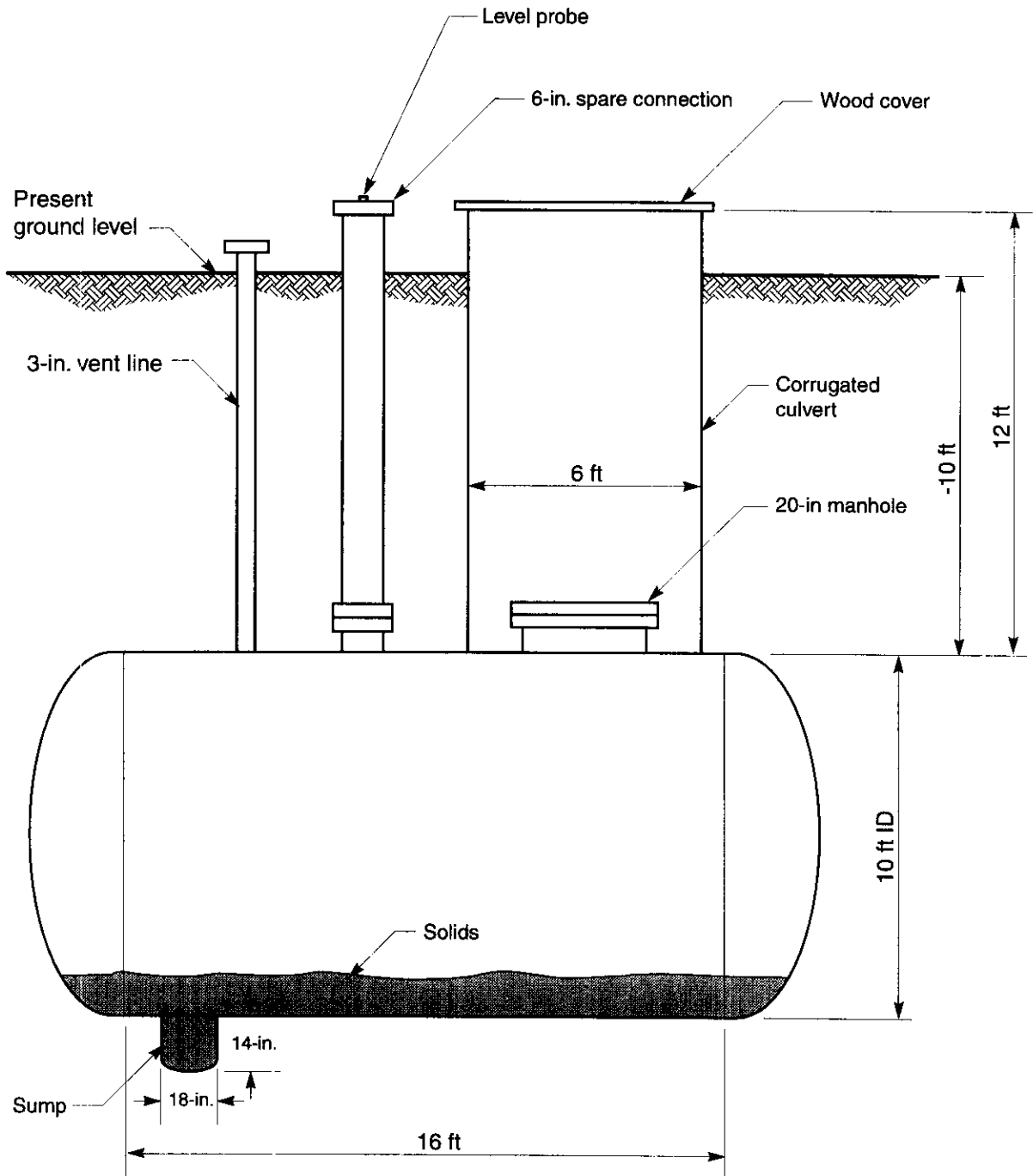
- OU 1-05: Technical Support Facility (TSF) Intermediate-Level (Radioactive) Waste Disposal System (TSF-09)
- OU 1-05: TSF contaminated tank southeast of Tank V-3 (TSF-18)
- OU 1-05: TSF PM-2A Tanks (TSF-26)
- OU 1-08: Water Reactor Research Test Facility (WRRTF) Injection Well (WRRTF-05)
- OU 1-08: WRRTF Fuel Leak (WRRTF-13).

The sampling and analysis performed at each of these sites is discussed below.

3.1 OU 1-05: Technical Support Facility Intermediate-Level (Radioactive) Waste Disposal System

In 1996, OU 1-10 RI sampling at the TSF Intermediate-Level (Radioactive) Waste Disposal System (TSF-09) site was conducted to determine the quantity of sludge and liquids in the V-1, V-2, and V-3 tanks and to characterize the materials in sufficient detail to allow evaluation of remedial alternatives. The sampling performed is briefly summarized below. The quantity of the tank contents in V-1, V-2, and V-3 are shown on Figure 3-1.

In June and July 1996 liquid and sludge samples were collected from the V-1, V-2, and V-3 tanks using a specialized sampling system designed for use in the tanks. The sampling was performed in accordance with Environmental Restoration Technical Procedure (TPR)-138 "TSF-09 Tanks V-1, V-2, and V-3 Remote Sampling System." Samples were collected from five locations in Tanks V-1 and V-3 and four locations in Tank V-2. The tanks were sampled in the following order; V-1, V-3, and V-2. The tanks were accessed for sampling through a 6-in. pipe that is located in the center of each tank and extends to approximately 6 in. above the ground surface. Once inserted in a tank the sampler could be lowered, rotated, and angled via hand-operated controls at ground surface to almost any position within the tank. A light and camera inserted through the open manholes on the tanks were used to guide and verify correct placement of the sampler at the locations specified in the FSP (LMITCO 1996b). By creating a vacuum with a small portable pump, sample material from the selected locations was drawn up through a stainless steel nozzle and reinforced Teflon tubing into sample jars positioned below an outlet nozzle inside a vacuum chamber at the ground surface. Samples of the liquid phase (defined as Strata 4 in the FSP) in



Tank	Solids Level	Liquids Level	Liquids Contents
V1	12"	21.5"	655 gal.
V2	11"	28"	1,316 gal.
V3	14"	73.5"	5,818 gal.

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Figure 3-1. Quantity of tank contents in tanks V-1, V-2, and V-3.

each tank were collected first, prior to excessive disturbance through movement and operation of the sampler. Solid phase samples in each tank were collected from Strata 1 (the tank sump), Strata 2, and last, Strata 3. If the tanks were equally divided at the midpoint, the solids on the northern side of the tank are defined as Strata 2 (excluding the solids in the sump), and those on the southern side as Strata 3. During collection of samples from within the solid phases, frequent mixing of the material using forced air was necessary to draw the material up through the approximately 20 ft of 1/2-in. hosing into sample containers. This resulted in collection of solids entrained in tank liquids from these locations. The percentages of solids in containers of sample material collected from locations within the solid phase in the tanks ranged from less than 5 to 60%.

Prior to beginning the sampling, the system was steam-cleaned. Between sample locations in a tank and between sampling of each tank, the Teflon tubing and nozzles through which the sample material traveled were flushed using deionized water and forced air provided from a pressurized stainless steel tank. Following completion of the sampling, the sample boom, which was the primary portion of the sampler inserted into the tank contents, was disconnected from the sampler and placed in waste storage. The rest of the sampling system was placed in a wooden storage box for possible reuse. The contact beta/gamma radiation readings on the collected liquid sample containers from the tanks measured with a portable device were generally low, 0.2 to 50 mrem/h. One exception to this was the first container of sample from location 4-1 in Tank V-2, which had a reported beta/gamma radiation reading of 375 mrem/h. Following collection of this material, the sampler was raised approximately 7 in. because the elevated radiation reading indicated that in addition to liquid, tank solids were also being collected. This sample container was later discarded since it was not representative of the phase being sampled. Contact beta/gamma radiation levels on the sample containers collected from solid phase locations ranged from 6 to 1,800 mrem/h. Higher radiation readings were associated with containers having a high percentage of solids.

Samples of the entire sludge and liquid column in each tank were collected using a composite liquid waste sampler (COLIWASA), following completion of the sampling described above. In Tank V-3 this full profile sample was collected by slowly and carefully inserting a glass COLIWASA (in the open position) into the tank through the open manhole. Once the bottom of the tank was reached, the COLIWASA was closed via the T-handle on top and lifted out of the tank. The sludge and liquid levels were measured, using inch and foot increment markers on the glass COLIWASA and the sample material transferred into a 1,000-mL sample container. The dual profile sampling in Tanks V-1 and V-2 was performed in the same manner with one exception. Following collection of the first COLIWASA full of material, the sampler was reinserted in the tanks two more times and sample material transferred into the 1,000-mL sample jars. This was necessary to provide adequate sample material to perform the intended analyses, though it may have resulted in samples that were not representative of the entire undisturbed tank profiles. The sample technician reported that the material collected the second and third times from Tanks V-1 and V-2 did not form distinct aqueous and solid phases in the COLIWASA as they had the first time the COLIWASA was inserted in the tanks. The total height of the liquid and solid phase for each tank as measured in the COLIWASA was 27 in., 26 in., and 74 in. in Tanks V-1, V-2, and V-3, respectively. The solid phases were reported as 12 in., 11 in., and 14 in., respectively, for Tanks V-1, V-2, and V-3. The collected samples from the V-1, V-2, and V-3 tanks were stored in a refrigerated environment until they were shipped to a commercial laboratory in October 1996 for analysis.

The approximately 3 to 4 month delay between sample collect and analysis is due to a delay in finding a laboratory that could perform the requested analyses on the highly radioactive samples. The delay is not expected to compromise use of the sample results to evaluate treatment options or plan necessary treatability studies. This is true for a number of reasons. First the material is waste which has

been present in the tanks for 10 to 15 years. Collection and storage of this waste in sample containers for 3 to 4 months should not produce any changes that the waste had not already undergone while stored in the tanks. Additionally, based on the results of the 1993 sampling and analysis, most of the contaminants of potential concern (COPCs) in the tank are present at such high concentrations, that the variability introduced by storing the samples temporarily will not significantly effect use of the data for evaluation against regulatory levels and treatment options. The data is not intended for use in evaluating current or future risks in the BRA.

An evaluation of the 1996 results of the radiological analysis of Tanks V-1 [Idaho National Engineering and Environmental Laboratory (INEEL) Engineering Design File (EDF) INEL/INT-97-00150/1000-43 "V Tank Radiological Data Evaluation, V-1 Evaluation"], indicate that the tank contains 18.3 nCi/g transuranic (TRU) isotopes and 219.5 g of fissionable materials [as defined in the *INEL Reusable Property, Recyclable Materials and Waste Acceptance Criteria (RRWAC)*]. Total tank activity from activation and fission product radionuclides is 51.04 Ci. The most activity is contributed by Cs-137 and Sr-90. An evaluation of the 1996 results of the radiological analysis of Tanks V-2 (INEEL EDF INEL/INT-97-00270/1000-44 "V Tank Radiological Data Evaluation, V-2 Evaluation"), indicate that the tank contains 5.12 nCi/g TRU isotopes and 84.6 g of fissionable materials (as defined in the RRWAC). Total tank activity from activation and fission product radionuclides is 39.14 Ci. The most activity is contributed by Cs-137 and Sr-90. An evaluation of the 1996 results of the radiological analysis of Tanks V-3 (INEEL EDF INEL/INT-97-00271/1000-45 "V Tank Radiological Data Evaluation, V-3 Evaluation"), indicate that the tank contains 3.09 nCi/g TRU isotopes and 128.1 g of fissionable materials (as defined in the RRWAC). Total tank activity from activation and fission product radionuclides is 88.78 Ci. The most activity is contributed by Cs-137 and Sr-90. For all three tanks the high fissionable material quantities indicate a potential criticality concern that requires further evaluation before planning any remedial action. In addition, the relatively high concentrations of TRU isotopes need to be considered when evaluating remedial options since reducing wastes volumes may result in a TRU waste (i.e., TRU isotope concentrations greater than or equal to 100 nCi/g). For all of the tanks, the concentrations of radionuclides are three to four orders of magnitude higher in the solids than the liquids.

During the 1996 sample analysis, total carbon results were reported for the solid phases in the tanks, and total organic carbon for the liquid phases. Assuming all of the reported carbon in the solid phase is organic carbon, the weighted percentages^a of total organic carbon in the tanks are 2.6%, 4.1% and 3.0% respectively for Tanks V-1, V-2, and V-3. Total carbon results reported for the solid phase are approximately four orders of magnitude higher than the total organic carbon results reported for the liquid phases in the tanks. Average bromide, and phosphate concentrations in the tank solids are relatively low, ranging from nondetectable to 4.36 ppm and nondetectable to 16.15 ppm, respectively. Average bromide and phosphate concentrations in the liquids range from 1.22 to 5.39 ppm and 1.49 to 22.2 ppm, respectively. Average chloride concentrations range from 58.7 to 229.12 ppm and 1.8 to 5.39 ppm, respectively for the tank solids and liquids. The average sulfate concentrations in the sludge are low in Tanks V-2 and V-3 (79.44 and 125.85 ppm) but much higher in Tank V-1 (814.68 ppm) due to one detection of 2,540 ppm in one of the solid phase samples from the tank sump. Nitrate, nitrite, and fluoride were not detected in the tanks in 1996. Total suspended solids range from 2 ppm in V-2 liquids to 65.3 ppm in Tank V-1, pH of the liquids and solids are between 7 and 8.

a. Weighted percentages and concentrations for each tank were determined by calculating average concentrations for each phase (liquid and solid) for each analyte using the combined 1993 and 1996 data, then multiplying the calculated averages by a weighting factor, based on the ratio of liquid or solid in the tanks to the total quantity of tank contents.

Average concentrations of metals in the tank solids range from nondetectable for thallium and selenium to 33,275 ppm calcium. Selenium, thallium arsenic, vanadium, antimony, beryllium, and tin concentrations were the lowest (<100 ppm), followed by cadmium, barium, boron, copper, mercury, nickel and silver (<1,000 ppm). Concentrations of chromium, sodium, silica, lead, aluminum, magnesium and potassium ranged from 753.5 to 6,257.5 ppm. The highest average concentrations in the tank solids are for calcium, manganese, zinc and iron (>10,000 ppm). Average concentrations of metals in the tank liquids ranged from nondetectable (barium, beryllium, selenium, thallium, and vanadium) to 580 ppm sodium in Tank V-1. Concentrations of zinc in Tank V-1, are an order of magnitude higher than the concentrations detected in the both the liquid and solid phases of the other tanks. In general, of the three tanks, V-1 appears to have the highest concentrations of metals.

The results of the 1993 and 1996 sampling show few organic compounds in the tank wastes. However a number of these, Aroclor-1260, trichloroethene and tetrachloroethene were detected at relatively high concentrations. In 1996, Aroclor-1260, a polychlorinated biphenyl compound (PCB) was detected in the tank sludges at concentrations ranging from 150 to 660 ppm in Tank V-1, 160 to 260 ppm in Tank V-3, and 210 to 370 ppm in Tank V-3. None of the PCB compounds tested for in 1996 were detected in the liquid phases (detection limits ranged from 0.1 to 0.2 ppm). Average weighted concentrations of Aroclor-1260 in the three tanks are 122, 63.08, and 28.58 ppm respectively for V-1, V-2 and V-3 respectively. During the 1996 sampling and analysis, semivolatile organic compounds (SVOCs) detected in the liquid or sludge phases of the three tanks, were bis(2-ethylhexyl)phthate, 2-methylnaphthalene, 1,2-dichlorobenzene, pyrene, and naphthalene. Bis(2-ethylhexyl)phthate was detected at the highest concentrations ranging from 1,500 to 12,000 ppm in the tank sludges and 0.073 to 0.2 ppm in the liquids. Volatile organic compounds (VOCs) detected during the two sampling events are trichloroethene, methylene chloride, vinyl chloride, 1,2-dichloroethene, 1,1-dichloroethane, tetrachloroethene, and cis-1,2-dichloroethene. During the 1993 sampling and analysis the concentrations of trichloroethene in the tank sludges ranged from nondetectable (at 0.6 ppm) in Tanks V-2 and V-3 to 23 ppm in Tank V-1. The concentrations of tetrachloroethene ranged from 430 ppm in Tank V-3 to 1,800 ppm in Tank V-1. Weighted average concentrations calculated for tetrachloroethene and trichloroethene are 7.24, 4.28, and 3.49 ppm in Tanks V-1, V-2, and V-3 respectively.

3.2 OU 1-05: Technical Support Facility Contaminated Tank Southeast of Tank V-3

In 1996 OU 1-10 RI sampling at the TSF contaminated tank southeast of Tank V-3 (TSF-18 or also called V-9) site was conducted to determine the quantity of sludge and liquids in the V-9 tank and to characterize the materials in sufficient detail to allow evaluation of remedial alternatives. The sampling performed is briefly summarized below.

In March 1996 the liquid in Tank V-9 was sampled. The amount of liquid collected was 4 L from a location in the tank 10 ft belowground surface (bgs) and an estimated 3.5 ft above the conical tank bottom. The samples were collected using a peristaltic pump, fitted with Teflon tubing and inserted into the tank through a 6-in. pipe extending from the ground surface into the top of the tank at the center. Contact beta/gamma radiation readings on the 19 sample containers ranged from 12 to 130 mrem/h. The collected liquid, dark brown in color and containing a lot of fine particulate matter was shipped to an on-Site laboratory for analysis. The requested analyses for the sample were anions (chlorine, NO₃, NO₂, PO₄, SO₄, fluorine, bromine), total halogens, total organic carbon, total suspended solids, pH, Contract Laboratory Program (CLP) metals (with also tin, boron, and silica added to the target analyte list), PCBs, VOCs and

SVOCs, gamma spectroscopy, uranium and plutonium isotopes, Cm-242, Cm-244, Am-241, Sr-90, Np-237, Ra-226 and tritium.

In April and June 1996, the solids in Tank V-9 were sampled. The samples were collected using a very long-handled device with a detachable sample bomb. When inserted in the tank solids, the material was collected by sliding a 4-in. length of aluminum housing over the material via a T-handle rising to the top of the handle. Outside of the tank, the collected material was transferred from the bomb into a stainless steel pan and then into sample jars, using a stainless steel spoon. The tank solids, which had the consistency of mud and contained a lot of organic debris such as twigs and straw, were collected from a location 13 ft 6 in. bgs and an estimated 6 in.–1 ft above the tank bottom. The contact beta/gamma radiation readings on both of the two 250-mL sample containers collected during the first sampling event were 800 mrem/h. During the second sampling event, performed in the same manner as described above, 1,000 mL of tank solids were collected. Beta/gamma radiation readings ranged from 350 to 700 mrem/h on contact with the four sample containers. Most of the collected material was submitted to an on-Site laboratory for the following analyses (in duplicate): anions (chlorine, NO₃, NO₂, PO₄, SO₄, fluorine, and bromine), total halogens, total organic carbon (TOC), percent moisture, pH, particle-size distribution, density, CLP metals (with tin, boron, and silica added to the target analyte list). VOCs, gamma spectroscopy, uranium and plutonium isotopes, Cm-242, Cm-244, Am-241, total Sr, Np-237, and Ra-226. Additional sample material was stored under refrigeration until it was shipped to a commercial laboratory in October 1996, for analysis for CLP target compound list (TCL) SVOCs and PCBs using SW-846 methods.

During the 1996 analysis of liquid and sludge samples from the V-9 tanks, various radiological isotopes were detected at high concentrations. These include strontium, cesium, uranium, americium, plutonium, and tritium. Total strontium and Cs-137 concentrations ranged from $2.5\text{E}+3 \pm 2.5\text{E}+1$ pCi/mL and $4.2\text{E}+3 \pm 1.62\text{E}+1$ pCi/mL, respectively in the liquid to $7.07\text{E}+6 \pm 3.0\text{E}+6$ pCi/g and $6.37\text{E}+6 \pm 3.2\text{E}+5$ pCi/g, respectively in the sludge. Uranium isotopes detected include U-233, U-234, U-235, U-236, and U-238. The concentrations of these in the liquids ranged from $2.1\text{E}+2$ pCi/mL U-234 to an estimated U-238 concentrations of 0.9 pCi/mL. U-238 was also the uranium isotope detected at the highest concentration in the sludges ($1.31\text{E}+4$ pCi/g). Concentrations of Am-241, Pu-238 and Pu-239/240 in the liquid are $4.02\text{E}+1 \pm 2.5$ pCi/mL, $1.7\text{E}+2 \pm 1.29\text{E}+1$ pCi/mL, and $4.5\text{E}+1 \pm 3.69$ pCi/mL, respectively. Concentrations of these TRU isotopes in the sludges are approximately two orders of magnitude higher than in the liquid. In addition to Cs-137, other gamma-emitting isotopes detected in the liquids and sludges include Eu-152, Eu-154, and Co-60. The reported tritium concentration in the liquid is $3.53\text{E}+2 \pm 0.18$ pCi/mL.

A TOC of 3.06 ppm was detected in the V-9 liquids. In the sludges the reported TOC results are greater than 1% by weight (10,023 and 12,925 ppm). Chloride was the anion detected at the highest concentrations in the tank liquid and solids; 10.9 ppm in the liquid sample and 483 to 503 ppm in the solid samples. Bromide, fluoride, nitrate, nitrite, phosphate and sulfate concentrations range from nondetectable to 0.29 ppm and nondetectable to 45.3 ppm, respectively in the tank liquid and solids. The reported pH of the liquids and solids are both between 7 and 8. The liquids contain less than 1% total suspended solids (3.06 ppm) and the solids have a water content between 66.5 and 67.5%.

Concentrations of metals in the tank solids range from nondetectable for arsenic and selenium to 10,300 ppm potassium in the sludges. Cobalt, thallium and vanadium were detected in the lowest concentrations (<10 ppm) in the sludges followed by antimony, beryllium, boron, cadmium and tin (<100 ppm). Concentrations of barium, copper, lead, manganese, nickel, silicon, and silver ranged from 232 to 825 ppm. Chromium and mercury concentrations were 975 and 1,100 ppm and 2,050 and

2,110 ppm, respectively in the two sludge samples. Aluminum, calcium, iron, magnesium, potassium, and zinc concentrations ranged from 1,280 to 10,300 ppm. In the liquid sample aluminum, antimony, arsenic, selenium, silver, thallium, tin and vanadium were not detected. Concentrations of beryllium, cobalt, lead, and mercury were the lowest, ranging from 0.065 ppm beryllium to 0.942 ppm lead. Concentrations of barium, cadmium, chromium, and copper were reported as 1.02, 1.9, 1.46, and 2.98 ppm. Concentrations of potassium, magnesium, and sodium were highest, ranging from 208 ppm magnesium to 8,340 ppm potassium, followed by boron, calcium, iron, manganese, nickel, silicon, and zinc which were detected at concentrations between 13.8 and 90.6 ppm.

A number of organic compounds were detected in the V-9 liquids and sludges, most notably trichloroethene which is present in the solid phase at greater than 1% by weight (14,000 to 26,000 ppm) and in the liquid at 410 ppm. Other VOCs detected include methylene chloride (liquid only; 59 ppm), 1,1,1-trichloroethane, chloromethane (sludge only), bromomethane (sludge only), and tetrachloroethene. The concentrations of these compounds detected in the sludge ranged from 59 to 2,600 ppm. The concentration of 1,1,1-trichloroethane in the liquid is 58 ppm. SVOCs detected in V-9 samples are 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 2,4-dimethylphenol, 2-methylnaphthalene, 2-methylphenol (o-cresol), 4-methylphenol (p-cresol), di-n-butylphthalate, phenol, naphthalene, phenanthrene, tributylphosphate (liquid only) and bis(2-ethyl)phthalate. Concentrations ranged from 0.006 to 0.83 ppm in the liquid, and 13 to 1,100 ppm in the sludge. Aroclor-1260 was the only PCB detected in the V-9 samples. The reported concentration in the liquid is 0.036 ppm and 260 and 310 ppm in the two sludge samples.

3.3 OU 1-05: Technical Support Facility PM-2A Tanks

In 1996 OU 1-10 RI sampling at the TSF PM-2A Tank (TSF-26) site was conducted to determine the quantity of sludge and other materials in the tanks and to characterize the materials in sufficient detail to allow evaluation of remedial alternatives. The sampling performed is briefly summarized below.

Sampling of the PM-2A tanks was performed in two stages. In April 1996 samples were collected from a location directly below the manholes in the tanks using a hand corer fitted with Teflon liners precleaned according to Environmental Protection Agency (EPA) protocol. The sand or diatomaceous earth phases in the tanks were mounded directly below the manholes and were approximately 23 ft below the top of the culverts surrounding the tanks. The total depth that the hand corer could be inserted in the tank contents was 18 in. The material collected from the tanks was primarily a fine-grained sand or diatomaceous earth. Little evidence of the reported sludge layer in the tanks was detected.

The results of the sampling and analysis for Tanks V-13, indicate that many of the contaminants found in Tanks V-1, V-2, and V-3 are also present in the PM-2A tanks although generally at lower concentrations. An evaluation of the radiological analysis of Tank V-13, indicates that the tank contains 2.01 nCi/g TRU isotopes and 127 g of fissionable materials (as defined in the RRWAC). Total tank activity from activation and fission product radionuclides is 27 Ci. As is true for the V-1, V-2, and V-3 tanks, the high fissionable material quantity indicates a potential criticality concern for the V-13 tank that requires further evaluation before planning any remedial action.

No VOCs or SVOCs, with the exception of bis(2-ethylhexyl)phthalate were detected in the V-13 samples. Estimated concentrations of bis(2-ethylhexyl)phthalate in the two samples were 12 and 75 ppm. Concentrations of metals and anions in the collected samples appear to be fairly low with the exception of antimony, arsenic, mercury, cadmium, chromium, copper, lead, manganese, thallium, and sodium. The pH

of the samples were reported as 9.36 and 8.68 and the density as 1.18 and 0.749. Sulfate at 481 and 371 ppm, was the anion detected at the highest concentrations. Two PCBs, Aroclor-1254 and Aroclor-1260 were detected in the samples at concentrations ranging from 5 to 13 ppm.

The lack of sludge material in the samples collected from directly below the manhole indicates that (1) the sludge layers (reportedly 12 in. in V-13 and 4 in. in V-14) are not as deep as previously believed or (2) they were substantially disturbed during a deposition in 1982 of diatomaceous earth in the tanks through the manholes using an air-driven sand blaster. It is probable that the process mixed the sludge immediately below the manhole with the diatomaceous earth, and deposited it deeper in the 55-ft-long tanks. In a second phase of sampling, samples were collected from four locations within Tank V-13. The samples were collected using a corer mounted on a plate fitted with remotely controlled tracks, which allowed the sampler to be "driven" to various locations in the tank. The samples were collected by inserting and rotating, via remote controls, lined corers in the tank material. A camera and light also mounted on the plate allowed visual selection of sample locations within the tanks. The locations selected were in areas where the diatomaceous earth layers appeared most shallow, darker, or both.

From the Phase I sampling event, three cores from Tank V-13 were submitted to an on-Site analytical laboratory for analysis. Five separate aliquots from the three cores were analyzed for gamma-emitting radionuclides, total strontium, uranium, thorium and plutonium isotopes, Am-241, and CLP metals (with tin, boron, and silica added to the target analyte list). From the Phase II sampling event, four cores from three locations within Tank V-13 were submitted to an analytical laboratory. The collected material will be subject to the following analyses (in duplicate): anions, total halogens, TOC, percent moisture, pH, density, CLP throwaway limit metals (including also tin, boron, and silica), CLP, TCL VOCs, SVOCs, PCBs, (by SW-846 methods) gamma spectroscopy, uranium and plutonium isotopes, Cm-242, Cm-244, total Sr, Np-237, Am-241, and Ra-226. No samples were collected from Tank V-14 during the second sampling event. The large amount of diatomaceous earth mounded in the tank below the manhole prevented movement of the remote sampling device in the tank. Beta/gamma radiation readings on contact with the liners collected during the Phase I and II sampling were measured using a portable field instrument. Radiation reading on the cores collected from Tank V-14 during the first sampling event were all less than 5 mrem/h (4 and 0.6 mrem/h). Radiation readings on the samples from Tank V-13 ranged from 5 to 120 mrem/h.

3.4 OU 1-08: WRRTF Injection Well

In 1996, during the OU 1-10 RI, groundwater sampling at the WRRTF-05 injection well site was conducted. The objective of the sampling and analysis performed was to provide data for use in evaluating the groundwater pathway in the BRA for WAG 1 and determine whether changes in water quality caused by reported fuel oil contamination had occurred since the previous sampling and analysis event. The sampling was performed in accordance with the FSP (LMITCO 1996b) and Environmental Restoration Standard Operating Procedure (ER-SOP)-11.8, "Groundwater Sampling." The water level in the well was measured as 214.46 ft. Prior to purging the well, samples for VOC and CLP SVOC analysis were collected from 216.5 and 243 ft bgs using a Teflon bailer. Following purging of 1,216 gal of groundwater and the stabilization of groundwater parameters, samples for VOC and SVOC analysis were collected from 243 ft bgs using the dedicated stainless steel sampling manifold. Samples were also collected from 216.5 ft using a Teflon bailer following purging. During sampling no physical indication of fuel oil contamination such as a petroleum odor or an oil sheen was reported by the sampling technicians. The collected samples were shipped to an off-Site laboratory for analysis. The results of the sampling are discussed in Section 4 of this report.

3.5 OU 1-08: WRRTF Fuel Leak

In 1996 OU 1-10 RI sampling at the WRRTF Fuel Leak (WRRTF-13) site was performed. The primary objective of this sampling was to provide sufficient data to define the lateral extent of contamination in the subsurface above the basalt layer at the site. Borings were placed outside the assumed edge of the contamination plume as determined by the Track 2 soil vapor survey (LMITCO 1995a). Borehole No. 1 was advanced to a depth of 4 ft before sampling began. The boring and sampling were performed as specified in the FSP (LMITCO 1996b) by drilling down to the desired sampling depth using a hollow-stem auger drill rig, then driving a 2.5-ft-long, 4-in.-diameter split-spoon sampler into the soil ahead of the auger flights. Sample material for each analysis was collected from discrete intervals in the split spoon retrieved from the boring and placed in pre-labeled sample containers. Field screening for organic vapors was performed on one of the samples from each sample interval in accordance with the procedure in Appendix B of the FSP. Samples were collected from nine intervals until the interface between alluvium and basalt interface was reached at 28.5 ft bgs. No indication of petroleum contamination was detected during the drilling (e.g., strong petroleum odors or discolored soil) or during the headspace screening analysis for organic vapors of the samples from Borehole No. 1. The samples from the 4- to 6.5-ft interval and the 26.5- to 28.5-ft interval were sent to an off-Site laboratory for VOC, CLP SVOC, total recoverable petroleum hydrocarbon (TRPH), and polynuclear aromatic hydrocarbon (PAH) analysis.

Samples in Borehole No. 2 were collected from 12 intervals until the alluvium/basalt interface was reached at 34 ft bgs. As in Borehole No. 1, no evidence of petroleum contamination was detected during the drilling or the headspace screening analysis for organic vapors of the samples from Borehole No. 2. The samples from the 4- to 6.5-ft and 31.5- to 34-ft intervals were sent to an off-Site laboratory for CLP VOC, and SVOC, TRPH, and PAH analysis. Samples in Borehole No. 3 were collected from eight intervals until the alluvium/basalt interface was reached, at 24 ft bgs. From 18.5 to 27 ft bgs, where the alluvium/basalt interface was reached the soil in the split spoons was discolored and had a strong petroleum odor. The results of headspace screening for volatile organic vapors from the samples collected from these intervals ranged from 5 ppmv to greater than 20 ppmv (recorded as greater than 20 ppmv only because of saturation of the instrument during screening). Samples from the 4- to 6.5-ft, 21.5- to 24-ft and 26.5- to 27-ft intervals were sent to an off-Site laboratory for CLP VOC, SVOC, TRPH, and PAH analysis. The intervals sampled for laboratory analysis in each borehole are summarized in Table 3-1. The results of the sampling and analysis are discussed in Section 4 of this report.

Two additional boreholes were drilled and headspace screening performed following completion of the planned sampling to further characterize the lateral extent of contamination. The Track 2 passive soil gas survey indicated that most of the contamination at the site was located in the area between the buildings near the excavated transfer pipeline that leaked. However the 1990, 1991, and Track 2 Phase II sampling and analysis results indicated that contamination was also present below where two 10,000-gal diesel fuel tanks were removed. To characterize the lateral extent of this contamination, Borehole No. 4 and Borehole No. 5 were placed approximately 20 ft south and 40 ft north, respectively, of the former locations of tanks TAN-787 and TAN-739. Samples were collected from 10 intervals in Borehole No. 4 until the alluvium/basalt interface was reached at 29 ft bgs. Samples were collected from 10 intervals in Borehole No. 5 until the alluvium/basalt interface was reached at 28.2 ft bgs. No indication of petroleum contamination was detected during the drilling or the headspace screening analysis for organic vapors of the samples from Borehole No. 4 or Borehole No. 5.

Table 3-1. Borehole intervals sampled for laboratory analysis.

Borehole ID	Sample Interval (ft)	Sample ID	Notes
1	4 to 6.5	1TB60101/02	First interval below depth of excavated pipeline.
	26.5 to 28.5	1TB61201	Last interval before basalt interface.
2	4 to 6.5	1TB61801	First interval below depth of excavated pipeline.
	31.5 to 34	1TB62801	Last interval before basalt interface.
3	4 to 6.5	1TB63501	First interval below depth of excavated pipeline.
	21.5 to 24	1TB64301	Contaminated interval
	26.5 to 27	1TB64601	Last interval before basalt interface.

3.6 OU 1-10 Quality Assurance and Quality Control Sampling

The purpose of collecting and analyzing quality assurance and quality control (QA/QC) samples is to confirm the achievement of project objectives and data quality objectives (DQOs). The overall objectives associated with the OU 1-10 sampling activities are discussed in Section 5.4 of the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (LMITCO 1996a). Specific DQOs are discussed in the FSP (LMITCO 1996b). The planned data uses, sampling design, types of analyses, required detection limits, precision, accuracy, completeness, and comparability needs for each sampling and analysis event are identified in the following sections. How these DQOs were evaluated and the extent to which they were achieved in the OU 1-10 investigation are also discussed. All data collected in this investigation were validated to method validation Level C or A in accordance with the Quality Assurance Project Plan (QAPjP) for WAGs 1, 2, 3, 4, 5, 6, 7, and 10 (LMITCO 1995b). The 1996 sampling data are contained in Appendix A.

During the WRRTF-05 groundwater sampling, a rinsate sample, a trip blank, and a field blank were collected and analyzed for VOCs. The rinsate was also analyzed for CLP SVOCs. During the WRRTF-13 investigation, a rinsate sample was collected from sampling equipment between drilling of Borehole No. 2 and Borehole No. 3. One duplicate soil sample was collected during the WRRTF-13 sampling. The results of the analysis of these samples are shown in Table 3-2.

Table 3-2. OU 1-10 remedial investigation field investigation quality assurance and quality control sampling results.^a

Site	Sample ID	Sample Type	Sample Matrix	Analysis	Analytical Results
WRRTF-05	1TPA0501DV	Field blank	Water	VOC	Chloroform—36 ug/L ^{b,c} Bromodichloromethane—3 ug/L Dibromochloromethane—0.5 ug/L
	1TPA0601DV	Rinsate	Water	VOC	Cis-1,2-dichloroethene—0.1 ug/L J Chloroform—45 ug/L J ^{b,c} Bromodichloromethane—3 ug/L Toluene—0.2 ug/L J Dibromochloromethane—0.6 ug/L 1,3- and 1,4-xylene—0.3 ug/L J 1,2-xylene—0.1 ug/L J 1,2,4-trimethylbenzene—0.2 ug/L J Naphthalene—0.2 ug/L J
WRRTF-13	1TPA0701DV	Trip blank	Water	VOC	Chloroform—48 ug/L J Bromodichloromethane—4 ug/L Dibromochloromethane—0.6 ug/L
	1TPA06010S	Rinsate	Water	SVOC	Bis(2-ethylhexyl)phthalate—1 ug/L J
	1TB601010S	Regular	Soil	SVOC	Bis(2-ethylhexyl)phthalate—28 ug/kg J
	1TB601020S	Duplicate	Soil	SVOC	Bis(2-ethylhexyl)phthalate—28 ug/kg J
	1TB60101TP	Regular	Soil	TRPH	Petroleum hydrocarbons—6.4 mg/kg
	1TB60102TP	Duplicate	Soil	TRPH	Petroleum hydrocarbons—7.1 mg/kg
	1TB65201CV	Rinsate	Water	VOC	All nondetectable results except acetone flagged “R” because of exceeding holding time. Acetone flagged “U” because of blank contamination.

a. Only positively detected results are shown.

b. Result from dilution analysis.

c. Flagged “J,” the result may be biased high because of potential carryover.

3.6.1 Precision and Accuracy

Spatial variations are present in concentrations of contaminants at a site, creating sampling variability. Additional variability, called measurement error, occurs during sampling collection, handling, processing, analysis, quality evaluation, and reporting. Concentrations of contaminants reported represent the true concentrations in the media sampled plus the measurement error, which can be minimized but not eliminated. Although it may not be significant in many cases, it is important to assess the contribution of measurement error to the total error in individual investigations. This is done by using the results of quality control (QC) samples to estimate accuracy and precision, quantitative estimators of measurement error and bias.

3.6.1.1 Overall Precision. Precision is a measure of the reproducibility of measurements under a given set of conditions. In the field, precision is affected by sample collection procedures and the natural heterogeneity in the soil. Overall precision (field and laboratory) can be evaluated by the use of duplicate samples collected in the field. Greater precision is typically required for chemicals with very low action levels that are close to background concentrations (EPA 1989). At the WRRTF-13 site investigation only one duplicate sample was collected, making a quantitative evaluation of precision impossible. However a qualitative evaluation based on the relative percent differences between the reported concentrations of contaminants in the regular and duplicate sample, can be performed. The only positively detected analytes in both the regular and duplicate sample were bis(2-ethylhexyl)phthalate (at an estimated concentration of 28 µg/kg in both samples) and petroleum hydrocarbons (at 6.4 and 7.1 mg/kg). The calculated relative percent difference for the petroleum hydrocarbon results is 10%, indicating low variability between the two results. In the WRRTF-05 investigation, no duplicate samples were collected during the March 1996 sampling event.

3.6.1.2 Overall Accuracy. Accuracy is a measure of bias in a measurement system. Accuracy is affected by sample preservation and handling, field contamination, and the sample matrix in the field. The effects of the first three can be assessed by evaluation of the results of field and equipment blanks. Before the WRRTF-05 sampling, a rinsate sample was collected from the sampling equipment and analyzed for VOCs and SVOCs. As shown in Table 3-2, very low concentrations of a number of compounds were detected in the rinsate sample. Chloroform, bromodichloromethane, dibromochloromethane were also detected in the field and trip blanks prepared during the sampling event. These are common contaminants found in high-performance liquid chromatography grade water. Also detected in the rinsate blank were cis-1,2-dichloroethene, toluene, xylene, naphthalene, 1,2,4-trimethylbenzene at concentrations below the contract-required quantification limits (CRQL); however, none of these were detected in the groundwater samples collected. The results of the QC sample analysis indicate that sample handling and field contamination have not created a bias that would impact the intended use of the sample data.

3.6.1.3 Laboratory Precision and Accuracy. The laboratory precision and accuracy requirements are part of the validation criteria against which laboratory data are evaluated. More information on the validation of the OU 1-10 sampling and analysis results can be found in limitations and validation (L&V) reports (BEO-153-96, BEO-154-96, BEO-152-96, BEO-137-96, BEO-147-96, BEO-143-96, and BEO-144-96). Laboratory precision is estimated through the use of spiked samples (i.e., matrix and/or surrogate spikes) and/or laboratory control samples. Laboratory accuracy is assessed through the use of matrix spikes (MSs). The number of laboratory QC samples are specified in the analytical methods used and in the LMITCO Sample Management Office (SMO) statement of work (SOW) (or task order statements of work). Evaluation criteria for the QC samples are specified in LMITCO SMO data validation TPRs. For samples analyzed in accordance with CLP protocol, the validation is also in accordance with this protocol.

A review of the L&V reports for WRRTF-05 and WRRTF-13 sampling indicates that all laboratory precision and accuracy indicators were in control. The L&V report on the analysis of the WRRTF-13 sample results indicates that no QC flags were assigned to the TRPH results. In the validation of the PAH results, the positive results for indeno(1,2,3-cd)pyrene in four samples were flagged "U" as false positives because of blank contamination. In the validation of the VOC results, all of the positive acetone results and most of the methylene chloride results were flagged "U" because of method blank contamination. Positive results for diethylphthalate and di-n-butylphthalate reported in the SVOC analysis of the soil and rinsate samples were flagged "U" as false positives because of blank contamination.

The L&V report for the VOC analysis of the WRRTF-05 samples indicates that all of the positively detected methylene chloride results were flagged "U" as false positives because of method blank contamination. All positive results for chloroform were flagged "J" as estimated values because of the potential for cross contamination. In the SVOC analysis, the positive results for di-n-butylphthalate and diethylphthalate were flagged "U" as false positives because of method blank contamination.

3.6.2 Completeness

Completeness is a measure of the quantity of usable data collected during an investigation. The QAPjP (LMITCO 1995b) requires that an overall completeness goal of 90% be achieved during an RI/FS. If critical parameters or samples are identified, a 100% completeness goal is specified in the QAPjP. In the WRRTF-05 sampling, all of the four planned samples were designated as critical. The nondetected results for bromomethane, 1,2,3-trichloropropane, and 1,2-dibromo-3-chloropropane were flagged "R" as rejected because of calibration problems during the VOC analysis of the WRRTF-05 samples. This resulted in a 95% completeness for the VOC results and a 98% overall completeness for the sampling event. Although a 100% completeness goal was specified, the impact of the "R" flags on the bromomethane, 1,2,3-trichloropropane, and 1,2-dibromo-3-chloropropane results are negligible because these are not COPCs for the site (see Section 4.1.14.3). The TRPH, VOC, and SVOC analyses were designated critical analyses for the samples from the boring interval with the highest detected field screening results in the WRRTF-13 investigation. For the WRRTF-13 sampling, 100% completeness for both the critical parameters and samples, and overall completeness was achieved. The calculated completeness results, based on the planned and actual number of samples and data points by sampling event, are shown in Table 3-3. As shown for both the WRRTF-05 and WRRTF-13 sites, more analyses than originally planned were performed because samples were submitted to a laboratory for PAH analyses in addition to the planned analysis. Although the QA/QC samples were not included in the completeness calculations, it should be noted that all of the WRRTF-13 VOC results (except acetone, which was already flagged as "U") from the analysis of the WRRTF-13 rinsate sample were rejected because of holding time noncompliance. This does not impact interpretation of the sampling and analysis results for WRRTF-13 because the results do not indicate any potential cross-contamination which the rinsate is designed to detect. The VOC results for the borehole are consistent with the SVOC and TPH results for the boreholes (i.e., all results indicate detectable contamination is limited to two intervals in Borehole #3).

3.6.3 Detection Limits

The analytical results obtained in this investigation are being used to complete a BRA and characterize the type and preliminary extent of contamination at the WRRTF-05 and WRRTF-13 sites. For the risk assessment, acceptable detection limits for organic compounds are regulatory [e.g., based on maximum contaminant levels (MCLs)] or risk-based. In the WRRTF-05 groundwater investigation, analysis for volatile compounds was performed by EPA Drinking Water Method 524.2, which specifies

Table 3-3. OU 1-10 Field Investigation Completeness Results.

Sampling Event	Number of Samples and % Completeness by Analysis				
	SVOC	VOC	PAH	TRPH	Total
WRRTF-05					
Planned	4 (256) ^a	4 (236)	0 (0)	0 (0)	4 (492)
Actual	4 (256)	4 (224)	4 (64)	0 (0)	4 (480)
% completeness	100	95	NA	NA	98
WRRTF-13					
Planned	7 (448)	7 (231)	7 (112)	7 (7)	7 (798)
Actual	7 (448)	7 (231)	7 (112)	7 (7)	7 (798)
% completeness	100	100	100	100	100

a. Number of data points given in parenthesis.

lower detection limits than the CLP specified method for the compounds of interest. The samples were also analyzed for PAHs by EPA Method 8310, which specifies lower detection limits than the CLP specified method for compounds associated with petroleum products such as diesel fuel. The soil samples collected from the WRRTF-13 site were also analyzed by EPA method 8310 because the COPCs at the site are primarily PAHs.

The analytical laboratory reports all positive results for analyzed compounds even if they are less than the CRQL. Unless the results are rejected as unusable during data validation, all results are used to characterize the nature and extent of contamination at a site as well as the associated risk. However, those compounds that are detected below the CLP CRQL, are generally flagged “J” as estimated values. CRQLs are chemical and sample matrix-specific concentrations that a laboratory must be able to routinely and reliably detect and quantify when using the analytical method specified in the CLP SOWs. During the WRRTF-13 data validation process for the two samples collected from the 21.5- to 24-ft and 26.5- to 27-ft intervals in Borehole No. 3, the positive results for methylene chloride, xylene, and ethylbenzene were flagged “J” as estimated because the reported results were below the CRQL. The positive results for anthracene and pyrene in the two samples collected from the 21.5- to 24-ft and 26.5- to 27-ft intervals in Borehole No. 3 were flagged “J” as estimated for the same reason. The L&V report for the VOC analysis of the WRRTF-05 samples indicates that many of the positive results for dichlorodifluoromethane, tetrachloroethylene, sec-butylbenzene, toluene, 1,2-xylene, 1,3-xylene, 1,4-xylene, 1,2,4-trimethylbenzene, isopropylbenzene, tert-butylbenzene, 1,3,5-trimethylbenzene, ethylbenzene, and cis-1,2-dichloroethene were flagged “J” as estimated because the reported concentrations were below the CRQL. In the SVOC analysis, the positive results for acenaphthalene, 2-methylnaphthalene, and di-n-butylphthalate were flagged “J” as estimated values because the reported concentrations were below the CRQL.

3.6.4 Comparability and Representativeness

Comparability is a qualitative characteristic that refers to the confidence with which one data set can be compared to another. At a minimum, comparable data must be obtained using unbiased sample designs. If sampling designs are not unbiased, the reasons for selecting another design should be well documented. Representativeness is a qualitative parameter that expresses the degree to which the sampling and analysis data reflect the characteristics being measured. Representativeness is best evaluated by comparing the number of samples collected with the number necessary to be representative and by confirming that the sample locations were properly located.

3.6.4.1 WRRTF-05. The objective of the WRRTF-05 RI sampling was to supplement the existing sampling and analysis data to determine whether changes in water quality because of the reported fuel oil contamination had occurred since the last sampling and analysis event and for use in evaluating the groundwater pathway in the BRA for WAG 1. To meet the first objective it would be necessary to collect data that are comparable to the data collected in previous groundwater sampling events for the WRRTF-05 injection well. Four samples were collected from the well during the RI, before and after purging, from the water table, and at depth in the aquifer. These were collected in essentially the same manner as previous samples using either a bailer or the stainless steel sampling manifold. During the RI sampling, EPA Method 524.2 was used for the analysis for VOCs rather than the CLP method to achieve a lower detection level for the COPCs. SW846 Method 8310 was used to analyze for PAHs in addition to the CLP SVOC analysis. This should have little effect on the comparability of the data, because no PAHs and few VOCs were detected during the last sampling event.

In the WRRTF-05 investigation, the sampling has been biased toward detecting contamination if present. Because fuel oil was detected in the water-level monitoring tube within the gravel pack of the WRRTF-05 well, the sampling has been focused on the groundwater in the vicinity of the well and where it would most likely be detected, floating on the water table. Little evidence of fuel oil contamination has been detected in the six sampling events at the well and a more comprehensive, unbiased investigation of water quality in the area has not been necessary.

3.6.4.2 WRRTF-13. During both the 1994 Track 2 and the 1996 RI sampling events, the intent of the investigation at WRRTF-13 was to obtain information on the nature and extent of contamination at the site rather than to define mean concentrations of COPCs. The borings and sample locations were biased toward those areas where contamination was most likely, or where the edge of the contamination plume was postulated to be. In 1996, the drilling, field screening, and sampling and analysis were performed using the same methods, techniques, and procedures with few changes from the 1994 Track 2 investigation. During the RI, each borehole was characterized in 2.5-ft-long intervals rather than 2.0-ft-long intervals as in the 1994 sampling. In addition to the same analyses as those performed in 1993, PAH analysis by SW846 method 8310 was performed on soil samples submitted to the laboratory. These two changes are not expected to have an effect on the comparability of the two data sets.

The number of samples collected during the RI are adequate to determine the presence or absence of contamination at the site. The total number of boreholes placed at the site during the Track 2 and RI may not be adequate to define the extent of contamination at the site more precisely than it was previously defined during the shallow soil gas survey. However, the number of boreholes drilled during the RI are adequate to confirm that contamination does not extend beyond the boundaries defined during the soil gas survey (Section 4.1.18).

3.7 References

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