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EXECUTIVE SUMMARY

The roughly 0.5-km² (0.2-mi²) Hanford Waste Vittrification Plant (HWVP) site is located in the Pasco Basin in south-central Washington State at the U.S. Department of Energy's Hanford Site. The HWVP site is planned for use as a waste treatment facility for treating the high-activity fraction of waste currently stored in underground storage tanks on the Hanford Site. In order to determine the pre-construction chemical properties of the proposed construction site soils and to enable the HWVP to segregate these, as necessary, from any impact of HWVP operations, a soil baseline sampling plan was written and implemented.

The main intent of the sampling plan was to establish a pre-construction chemical baseline for the site. In addition, radiological information for site soils was also gathered. The radiological information (presented in Appendixes A1 and A2) showed no apparent radiological anomalies for either the surface soils or the vadose zone.

The ability to differentiate between "baseline" and "background" is an important aspect of understanding the purpose of this plan. Baseline differs from background in that true ("natural") background values may differ from those of baseline. Or, in other words, background is one form of baseline, while all baseline values are not necessarily background. This is important from a regulatory viewpoint. Because the facility is being built on the Hanford Site, it is necessary to be able to establish soil site conditions prior to construction in order to segregate future potential releases as a result of HWVP operations from any site conditions in existence before the advent of HWVP activities.

The sampling plan called for establishing baseline values for three potential impact zones. These three zones were as follows:

- Surface soils
- Shallow vadose zone soils
- Deep vadose zone soils.

The investigation of the surface soils was limited to a depth of 15 cm (6 in.) based on U.S. Environmental Protection Agency guidance. A stratified random sampling approach was used to determine sampling points. The construction site was divided into four separate areas, each area with differing levels and types of use planned, based on preliminary HWVP design layouts. To establish a high level of confidence for the threshold limit values established for the site, 22 sample points were selected. These points were divided among the four areas, with a minimum of five points allocated to each area. The two remaining sample points were allocated to the most southern of the quadrants because it contained exhaust stacks. This was done to assist in looking at the impact from this area on surface soil baseline.

The shallow vadose zone investigation was limited to a depth of 9 m (30 ft). This depth was arrived at based on calculations performed to estimate an overly conservative depth of penetration for a potential large volume chemical spill. Three sites were selected for the shallow vadose zone baseline establishment. Each site was judgmentally located based on either suspected past activities or potential for future release. The first site was

located in the planned location of the HWVP leach field. A second site was located adjacent to an abandoned polyvinyl chloride-cased borehole. The third site was located in the corridor where the HWVP waste transfer lines were planned for operation.

The deep vadose zone investigation extended to groundwater. The location of the deep vadose zone site was the same as the third shallow vadose zone site. This site was selected because the location was the area most likely to potentially experience a release that could extend as far as groundwater.

Baseline values for metals and ions were developed based on the assumption of normal distribution of the data. These baseline values are one-sided non-parametric tolerance intervals. The values calculated, statistically, should encompass 95% of the potential values for that constituent with a 95% level of confidence. This was done by multiplying the standard deviation of the sampled population (s) by a factor (k) which depends upon the number of samples taken, and adding this to the mean value ($\bar{x}$) for that constituent. These values can be used in the future as preliminary standards for determining if HWVP operations have impacted the soil environment.

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1.0 INTRODUCTION

This report describes the pre-construction chemical soil baseline and presents radiological information on the Hanford Waste Vitrification Plant (HWVP) construction site. The proximity of the HWVP site to cribs, cross-site transfer lines, underground storage tanks, as well as the B Plant and its support facilities, necessitates that any impacts from local site operations be evaluated and documented.

The objective of site investigation was to establish the pre-construction conditions by establishing threshold values for any constituents of concern. The possibility of finding existing contamination of the site (although possible) was determined to be unlikely. This report presents chemical and radiological data for the soils specific to the HWVP site, and more specifically, to the surface, shallow vadose, and deep vadose zone soils.

This pre-construction soil baseline report was prepared in support of the HWVP program. The objective of the HWVP program is to implement safe and environmentally sound methods for the treatment through vitrification and interim storage of the high-activity fraction of waste currently stored in underground storage tanks on the Hanford Site. In accordance with U.S. Department of Energy (DOE) Order 5484.1, this document establishes a chemical baseline for the pre-construction condition of the HWVP site soils. These data will be used to establish the degree of any responsibility that the HWVP will incur for contamination to site soils as a result of HWVP operations.

2.0 LOCATION AND SETTING

2.1 LOCATION

The site selected for the HWVP is located in south-central Washington State on the DOE's Hanford Site. The study area for the pre-construction soil baseline characterization encompasses roughly 34 hectares (85 acres) near the western edge of the 200 East Area (Figure 1). The site is situated on a plateau at an average elevation of roughly 216 m (710 ft) above mean sea level (MSL). The Columbia River is 10.5 km (6.5 mi) to the northwest at its closest approach.

Figure 1. HWVP Site Location.

2.2 GEOLOGIC SETTING

The Hanford Site is located in the central part of the Pasco Basin. The Pasco Basin is one of a number of topographic depressions located within the Columbia Plateau Physiographic Province, a broad basin located between the Cascade Range and the Rocky Mountains, formed by structural deformation of thick sequences of tholeiitic flood basalts. These basalts are named the Columbia River Basalt Group.

Three sedimentary formations overlie the basalt: the Ringold Formation, the Plio-Pleistocene Unit, and the Hanford formation. Surface deposits of loess, dune sand, alluvial sand, landslide material, talus, and colluvium of recent age are also present. Within the north-central portion of the Pasco Basin, the youngest and uppermost basalt present is the Elephant Mountain Member of the Columbia River Basalt Group. The Elephant Mountain Member generally overlies the Rattlesnake Ridge interbed, but sometimes is invasive into the underlying sediments.

The Hanford formation, where present on the site, overlies all other formations within the Pasco Basin. It consists of two facies: a flood facies (Pasco Gravels) and a slack water facies (Touchet Beds). Pasco gravels are mostly composed of coarse sand and gravel with minor silt lenses. They were deposited in flood bars and high-energy environments found in the center of the basin. The HWVP site is located over Pasco gravels.

2.3 HYDROLOGIC SETTING

The climate of the Hanford Site is mild, often hot, windy, and dry. The average precipitation is 16 cm/yr (6.3 in./yr) and the 100-yr, 24-h maximum predicted rainfall is 5 cm (2 in.). Potential evapotranspiration rates generally exceed precipitation rates. The annual evaporation can exceed 152 cm (60 in.) (Stone et al. 1983).

The primary natural surface-water bodies within the Hanford Site include the Columbia and Yakima Rivers, and Dry and Cold Creeks. These creeks form an ephemeral stream system whose drainage is tributary to the Yakima River.

An unconfined aquifer lies within the boundaries of the Pasco Basin. In general, the unconfined aquifer consists of Hanford formation glaciofluvial silts, sands, and gravels. The predominantly geologic unit in the unconfined aquifer is the middle Ringold. The middle Ringold is made up of sorted sands and gravels of varying induration.

The bottom of the unconfined aquifer is the top of the basalt surface in most areas. At some locations, structural basalt "highs" actually extend above the water table interrupting the lateral continuity of the aquifer (Gephart et al. 1979, Graham 1981).

Groundwater flows from the areas of recharge to areas of discharge. Sources of natural recharge to the unconfined aquifer on the Hanford Site are rainfall and runoff from the higher, bordering elevations, water infiltrating from the two small ephemeral creeks, and river water along influent reaches of the Yakima and Columbia Rivers. The principal source of this natural recharge occurs along the edges of the Pasco Basin where precipitation and runoff

infiltrate to the water table. Little, if any, natural recharge to the groundwater occurs within the Hanford Site from percolating precipitation due to a high evapotranspiration rate. Estimates of recharge are between 0.3 cm/yr (0.1 in./yr) near the 200 Areas and 5.6 cm/yr (2.2 in./yr) near the 300 Area (Gee and Heller 1985).

The primary source of recharge to the unconfined aquifer has been from waste and disposal operations on the Hanford Site. This artificial recharge occurs principally within the Separations Area (the area including and immediately surrounding the 200 East and 200 West Areas). The major resources of this artificial recharge are the B Pond system, the deactivated Gable Mountain Pond, and the deactivated U Pond. Groundwater discharge is principally to the Columbia River.

2.4 NEARBY WASTE DISPOSAL FACILITIES

Several waste disposal facilities are located near the HWVP construction site. Within a 0.5-mi radius of the center of the HWVP, there are 48 known waste disposal sites of various types under CERCLA regulation. They lie entirely within the 200-BP-9 operable unit, the western half of the 200-BP-6 operable unit, the northwestern corner of the 200-SS-1 operable unit, and the southeastern corner of the 200-BP-10 operable unit. None of these 48 waste disposal sites are contained within the HWVP site boundaries.

2.4.1 Cribs

Of the 48 waste disposal sites, 3 cribs located east of the site are closest to the HWVP site. These three cribs (216-B-12, 216-B-55, and 216-B-62) all received low-level or mixed liquid wastes from the 221-B Building (B Plant). Monitoring wells located around the cribs have been used to monitor both the groundwater and the sediments beneath the cribs. Historical data from this monitoring program are found in Fecht et al. (1977). Data from this program indicate that radioactive contaminants from the cribs are essentially fixed to the sediments. Different radionuclides discharged to the ground interact with the sediments to different degrees. Tritium moves essentially with the waste liquid with very little, if any, sorption, except on clays. Ruthenium is slightly sorbed. Cesium and strontium are tightly sorbed to the sediments beneath the cribs. Plutonium is sorbed so tightly that essentially all plutonium is held within 3 m (9.8 ft) of the crib bottom (Fecht et al. 1977). To discern if migration of radionuclides from these cribs to beneath the soils of the HWVP site was a current problem, additional geophysical logging of the sediments beneath the HWVP site was undertaken during this investigation. Results of this activity are presented in Appendix A1 of this report.

2.4.2 Cross-Site Transfer Line

The only other waste disposal or handling activities taking place in a close proximity to the HWVP site boundaries are the Hanford cross-site transfer lines. These lines are used to transfer radioactive liquid materials between the 200 East and 200 West Areas. The ground surface in the area is marked as a surface contamination zone. This zone lies just outside of the HWVP construction site to the southeast.

2.4.3 Other Waste Disposal Activities

Other sites within the 0.8-km (0.5-mi) radius of the center of the HWVP site include reverse wells, waste holding tanks, acid neutralization units, and several unplanned release sites.

3.0 ANALYTICAL PARAMETERS

3.1 CHEMICAL PARAMETERS

As defined, a baseline is "...the ambient concentration levels which exist at the time of first application for a permit..." (Frick and Sullivan 1986). Using this definition, the analytical parameters of interest was established as those which would potentially be present at the time of the baseline investigation, or that could be expected to become site contaminants due to facility operations. The list of constituents considered for the HWVP Soil Baseline investigation included metals, anions, pesticides, herbicides, PCBs, volatile and semivolatile organic compounds (VOCs and semi-VOCs), total halogenated organics (TOX), and soil pH. From this list of constituents, a target list for surface soils and vadose zone soils was developed. Because of the coarse nature of the soils at the construction site, VOCs and semi-VOCs were not considered as target analytes, but all soil samples were field screened for the presence of organics. PCBs were selected only for a single sample site that had a historical potential for PCB presence. Pesticide and herbicide analysis was selected only for surface sample locations that were located within 61 m (200 ft) of existing roadways.

3.2 RADIOLOGICAL INVESTIGATION

Along with an investigation for chemical constituents on the HWVP construction site, an investigation into the presence of radiological constituents in the construction site soils was also carried out. Because radioisotopes are not regulated under RCRA, all radiological information gathered was collected on an informational basis only. For the surface soils, a survey using the Ultra Sonic Ranging and Data System (USRADS) automatic data recording system was used. The HWVP USRADS report can be found in Appendix A2. One advantage of using the USRADS was the ability to pinpoint any sites that would require further sampling for radiological purposes. As a result of the USRADS survey, it was determined that it was unnecessary to collect surface soils for radiological analysis.

For the vadose zone investigation, a Radionuclide Logging System (RLS) was used to determine if anomalies in radionuclide concentrations were present in the soils. Because these data are not available on a real-time basis, field screening for radionuclides was employed along with the collection of samples to support field screening. Field-screening information for radionuclides is contained in the field logbook for each borehole. RLS information can be found in Appendix A1. The analytical values for radiological analysis of the soil samples can be found in *Data Validation Report for the HWVP Soil Baseline* (WHC 1992).

4.0 SOIL SAMPLING ACTIVITIES

Soil sampling at the HWVP construction site began in December 1991. A 61- by 61-m (200- by 200-ft) grid was surveyed onto the site by Kaiser Engineers Hanford in support of HWVP activities. Surface soil sampling points were all tied to these surveyed points. Vadose zone boreholes were sited prior to the survey grid being put in place since the vadose zone boreholes were judgmentally located based on either past site history or future planned site use as related to HWVP activities.

4.1 SURFACE SAMPLING

Surface sample sites were chosen using a stratified random sample selection process. The process is discussed in detail in the sampling plan (WHC 1991). The location and sample numbers assigned to each site are shown in Figure 2. All surface sample sites were screened for volatile organic compounds using an organic vapor monitor. As noted in the HWVP Soil Baseline Sampling Plan, any sample site with an instrument reading ≥ 10 ppm above the ambient background was to be designated for laboratory analysis. None of the 22 sample sites met the criteria. A synopsis of field-screening activities is included in Appendix B. As required by the sampling plan, a minimum of one sample per sample quadrant and a minimum of one sample per sampling day were submitted for laboratory analysis of VOCs to support and verify field-screening activities.

During surface soil sampling activities on December 4, 1991, herbicide application took place along roads on the HWVP construction site and in the immediate area. This application consisted of a mixture containing the active ingredients of Bromacil [5-bromo-3-sec-butyl-6-methyluracil] and Diuron [3-(3,4 dichlorophenyl)-1,1-dimethylurea]; neither of these substances is regulated under RCRA. Only 3 of the 22 scheduled samples on the HWVP site were collected prior to the herbicide application. Surface samples with requests for herbicide analysis were B01FK7, B01FK9, B01FL0, B01FL1, B01FL2, B01FL4, B01FL5, and B01FL7.

Figure 2. Surface Sample Locations and Sample Numbers.

4.2 SHALLOW VADOSE ZONE SAMPLING

Three sites on the HWVP construction site were selected for shallow vadose zone sampling to determine baseline values. These sites were designated HWVP-1, -2, and -3. The depth for shallow vadose zone investigation was set at 9 m (30 ft) based on engineering judgement as set forth in the sampling plan. All three sites were judgmentally selected based on either past history of the site (HWVP-2) or planned future use of the site (HWVP-1, -3). These boreholes were decommissioned in accordance with EII 6.10 as required in the HWVP Soil Baseline Sampling Plan upon completion of sampling activities.

The HWVP-1 site was located in the northeastern section of the construction site. This location was selected based on the proposal for this area to contain the leach field for the HWVP and the potential for this area to be affected by future uncontrolled releases due to this leach field. A schematic of this borehole and its assigned sample numbers are shown in Figure 3.

The HWVP-2 site was located in an area of the site that had been cleared during the 1970's. The reason for this clearing is uncertain, but the most likely explanation was the construction of Hanford Site borehole 299-E29-1, which took place in 1976. In addition to the presence of this borehole, an additional PVC-cased borehole was also located in this area. This PVC-cased borehole had a measured depth of 31 m (103 ft) from the top of the casing and, when investigated, was filled with water to the ground surface [30 m (100 ft) of water]. The hypothesized and undocumented purpose of this borehole was to enable the geophysical logging of the top 30 m (100 ft) of the soil column to fill in for missing borehole log information for the top 30 m (100 ft) of borehole 299-E29-1. This borehole (HWVP-2) was extended to a total depth of 34 m (111.5 ft) with samples collected every 6 m (20 ft) after going beyond the 9-m (30-ft) depth set for the shallow vadose zone. The last sample was collected roughly 3 m (10 ft) below the bottom of the PVC casing. This was done to determine if the water in the PVC casing had impacted the vadose zone in any manner. Additional emphasis was also placed on this site for herbicides. The rationale for this was due to the inability to document the reasoning for the site appearing void of vegetation. A schematic of this borehole and its assigned sample numbers are shown in Figure 4.

The HWVP-3 site was located in the proposed transfer line corridor of the HWVP site. This corridor is where the transfer lines bringing the waste to be treated at the HWVP were routed. In the event of a short-term, undetected leak from these lines, shallow soil contamination would occur. A schematic of this borehole and its assigned sample numbers are shown in Figure 5.

Figure 3. Borehole HWVP-1 and Sample Numbers by Depth.

* Split Sample

Duplicate Sample

MAW\032293-D

Figure 4. Borehole HWVP-2 and Sample Numbers by Depth.

* Split Sample

Duplicate Sample

MAW\032293-C

Figure 5. Borehole HWVP-3 and Sample Numbers by Depth.

* Split Sample
Duplicate Sample

MAW\032293-E

4.3 DEEP VADOSE ZONE SAMPLING

Deep vadose zone sampling was proposed to establish baseline values in the event of contamination extending below the shallow vadose zone investigation depth. The HWVP-3 site was selected to investigate the deep vadose zone. This site was selected because it is located in the transfer line corridor. It was concluded that this site was the area with the greatest potential to be contaminated below the 9-m (30-ft) depth of the shallow vadose zone investigation, and potentially to groundwater. This scenario would result from a long-term, undetected leak, or a large-volume leak, from the transfer lines. Samples for the deep vadose zone investigation were collected roughly every 6 m (20 ft) for the total length of the borehole [below 9 m (30 ft) of depth] until the borehole was estimated to be 12 m (40 ft) above the water table. At this point sample collection was performed every 3 m (10 ft). The final sample was collected just below the water table [from 91 m to 92.5 m (301 ft to 303.5 ft)]. A schematic of this borehole and its assigned sample numbers are shown in Figure 5.

5.0 RESULTS

Tables 1 through 4 give the statistical summary of the sampling data for metals and ions for the HWVP Soil Baseline sampling effort. As can be seen in *Data Validation Report for the HWVP Soil Baseline* (WHC 1992) data for VOCs, semi-volatiles, pesticides, PCBs, and herbicides, these constituent's baseline values are virtually at the non-detect level. The validation report qualifies these data with U (for non-detect), J (for judgmental value), or R (for rejected), and B (for blank contamination). These qualifiers and their specific application to each sample are discussed in detail in the validation report. Overall completeness of the chemical data was affected by the rejection of all herbicide data due to missed holding times, the rejection of and flagging as judgmental some ion data, and the rejection of a small amount of metals data due to laboratory analytical problems. A more detailed explanation of data acceptance is given in *Data Validation Report for the HWVP Soil Baseline* (WHC 1992).

Table 5 gives the calculated upper threshold limit values for HWVP vadose zone and surface soils based on the analytical data. These upper threshold limit values will act as a future reference in determining whether HWVP operations have an impact on the surrounding soil environment.

Table 1. Summary Statistics for Selected Constituents for the Vadose Zone Soil Samples of the HWVP--Borehole 1. (sheet 1 of 2)

Constituent	Sample size (n)	Greater than (GT)	Less than (LT)	Average ($\bar{x}$)	Std dev (s)	Minimum	Maximum
Aluminum	11	11	0	5,938	964.02	4,520	7,420
Antimony ^a	11	1	10	1.6	0.069	1.4	1.6
Arsenic	11	11	0	3.4	2.571	1.6	9.3
Barium	11	11	2	0.33	0.075	0.2	124
Beryllium ^a	11	9	2	0.33	0.075	0.2	0.39
Cadmium ^a	11	8	3	0.31	0.175	0.18	0.66
Calcium	11	11	0	10,238	6,042.78	5,085	26,800
Chromium	11	11	0	9.7	1.949	7.1	14.2
Cobalt	11	11	0	9.0	2.033	5.7	11.7
Copper	11	11	0	15.7	14.397	6.5	58.2
Iron	11	11	0	18,059	3,110.37	13,000	21,800
Lead	11	11	0	6.9	7.095	3.2	27.7
Magnesium	11	11	0	4,323	887.77	3,540	6,350
Manganese	11	11	0	275	51.66	199	358
Mercury ^a	11	3	8	0.14	0.110	0.08	0.43
Nickel	11	11	0	8.0	1.452	6.3	10
Potassium	11	11	0	1,131	299.04	825	1,855
Selenium ^a	11	1	10	1.63	1.471	0.74	4.15
Silver ^a	11	1	10	0.39	0.013	0.36	0.4
Sodium	11	11	0	333	302.41	124	1,150

Table 1. Summary Statistics for Selected Constituents for the Vadose Zone Soil Samples of the HWV--Borehole 1. (sheet 2 of 2)

Constituent	Sample size (n)	Greater than (GT)	Less than (LT)	Average ($\bar{x}$)	Std dev (s)	Minimum	Maximum
Sodium ^b	10	10	0	251	141.31	124	588
Thallium ^a	11	1	10	0.39	0.013	0.37	0.415
Vanadium	11	11	0	40.8	9.651	24.1	50.8
Zinc	11	11	0	38.4	8.043	26.5	51.5
Cyanide ^a	11	1	10	5.0	0.144	4.8	5.25
Fluoride	11	3	8	1.4 ^c	1.629 ^c	<1.0	5
Chloride	11	11	0	34.3	43.210	11.85	161.1
Chloride ^b	10	10	0	21.66	10.524	11.85	46
Nitrite	11	0	11	<1.0	NC	<1.0	<1.0
Nitrate	11	11	0	4.8	0.414	4.2	5.85
Sulfate	11	11	0	196	362.51	30	1,240
Sulfate ^b	10	10	0	92	113.45	30	366
Phosphate	11	0	11	<4.0	NC	<4.0	<4.0
Ammonia	11	0	11	<0.5	NC	<0.5	<0.5

NOTE: Units reported in mg/kg (parts per million) unless otherwise noted.

^aReported less-than-detection-limit values in the database were used in the calculations.^bPotential outlier observation was removed.^cCalculated by substituting non-detects with one-half of detection limit.

< = Compound was analyzed for but not detected. Reported value after the "<" sign is the detection limit.

GT = Greater than detection limit.

LT = Less than detection limit.

NC = Not calculated.

Table 2. Summary Statistics for Selected Constituents for the Vadose Zone Soil Samples of the HWVP--Borehole 2. (sheet 1 of 2)

Constituent	Sample size (n)	Greater than (GT)	Less than (LT)	Average ($\bar{x}$)	Std dev (s)	Minimum	Maximum
Aluminum	17	17	0	5,570	731.09	4,540	6,720
Antimony ^a	17	4	13	5.2	2.181	1.5	7.8
Arsenic	15	15	0	3.0	1.784	1.3	8
Barium	17	17	0	64.7	16.022	43.3	90.1
Beryllium ^a	17	9	8	0.28	0.077	0.19	0.43
Cadmium ^a	17	9	8	0.45	0.336	0.19	1.5
Calcium	17	17	0	8,394	4,273.59	3,410	19,600
Chromium	17	17	0	8.7	1.660	5.9	12
Cobalt	17	17	0	6.8	1.849	4.8	9.8
Copper	17	17	0	12.3	3.324	8.8	19.1
Iron	17	17	0	14,326	2,694.21	10,500	18,800
Lead	17	17	0	4.5	1.649	3.1	8.9
Magnesium	17	17	0	4,316	872.41	3,230	7,090
Manganese	15	15	0	255	53.09	188	353
Mercury ^a	17	1	16	0.09	0.006	0.08	0.1
Nickel	17	17	0	9.9	2.681	6.2	15.6
Potassium	17	17	0	1,061	196.35	853	1,630
Selenium ^a	15	0	15	1.18	1.082	0.73	3.9
Silver ^a	17	0	17	0.84	0.258	0.38	1
Sodium	17	17	0	189	77.22	112	406.5

Table 2. Summary Statistics for Selected Constituents for the Vadose Zone Soil Samples of the HWVP--Borehole 2. (sheet 2 of 2)

Constituent	Sample size (n)	Greater than (GT)	Less than (LT)	Average ($\bar{x}$)	Std dev (s)	Minimum	Maximum
Thallium ^a	17	0	17	0.41	0.076	0.37	0.62
Vanadium	17	17	0	28.0	7.002	17.7	39.7
Zinc	17	17	0	33.2	5.984	25.5	47.4
Cyanide ^a	17	1	16	5.0	0.150	4.8	5.4
Fluoride	17	3	14	<1.0	NC	<1.0	2.9
Chloride	17	17	0	24.9	33.176	10.7	148.75
Chloride ^b	16	16	0	17.2	9.386	10.7	50.9
Nitrite	17	0	17	<1.0	NC	<1.0	<1.0
Nitrate	17	17	0	5.6	0.626	4.7	6.8
Sulfate	17	17	0	60	30.55	29	166
Sulfate ^b	16	16	0	53	14.1	29	86
Phosphate	17	0	17	<4.0	NC	<4.0	<4.0
pH	13	13	0	9.4	0.329	8.6	9.9
Ammonia	17	11	6	4.2 ^c	7.505 ^c	<0.5	26

NOTE: Units reported in mg/kg (parts per million) unless otherwise noted.

^aReported less-than-detection-limit values in the database were used in the calculations.^bPotential outlier observation was removed.^cCalculated by substituting non-detects with one-half of detection limit.

< = Compound was analyzed for but not detected. Reported value after the "<" sign is the detection limit.

GT = Greater than detection limit.

LT = Less than detection limit.

NC = Not calculated.

Table 3. Summary Statistics for Selected Constituents for the Vadose Zone Soil Samples of the HWVP--Borehole 3. (sheet 1 of 2)

Constituent	Sample size (n)	Greater than (GT)	Less than (LT)	Average ($\bar{x}$)	Std dev (s)	Minimum	Maximum
Aluminum	28	28	0	5,827	1,011.05	4,400	8,290
Antimony ^a	28	0	28	2.7	1.959	1.5	6.3
Arsenic	25	25	0	2.8	1.800	0.43	7.7
Barium	28	28	0	69.1	20.206	37.1	109
Beryllium ^a	28	18	10	0.34	0.149	0.19	0.65
Cadmium ^a	28	15	13	0.29	0.135	0.19	0.59
Calcium	28	28	0	7,359	3,100.58	3,300	18,400
Chromium	28	28	0	10.1	2.391	6.5	17.9
Cobalt	28	28	0	7.5	2.649	4.9	15
Copper	28	28	0	13.4	3.724	7.3	20.9
Iron	28	28	0	15,739	4,644.5	11,300	29,900
Lead	28	28	0	4.1	1.385	2.7	8.7
Magnesium	28	28	0	4,456	1,132.32	3,080	7,640
Manganese	25	25	0	264	65.90	191	431
Mercury ^a	28	6	22	0.10	0.045	0.08	0.32
Nickel	28	28	0	10.8	3.176	6.8	18.9
Potassium	28	28	0	1,064	232.76	737	1,680
Selenium ^a	6	0	6	1.79	1.596	0.74	3.9
Silver ^a	28	0	28	0.54	0.251	0.37	1
Sodium	28	28	0	281	237.30	93.6	971

Table 3. Summary Statistics for Selected Constituents for the Vadose Zone Soil Samples of the HWVP--Borehole 3. (sheet 2 of 2)

Constituent	Sample size (n)	Greater than (GT)	Less than (LT)	Average ($\bar{x}$)	Std dev (s)	Minimum	Maximum
Thallium ^a	28	2	26	0.53	0.105	0.37	0.64
Vanadium	28	28	0	33.5	13.260	18	72.4
Zinc	28	28	0	34.3	8.256	24.8	56.3
Cyanide ^a	28	2	26	5.1	0.241	4.7	5.6
Fluoride	28	3	25	<1.0	NC	<1.0	8.2
Chloride	28	28	0	55.1	98.553	8	458
Chloride ^b	27	27	0	40.2	60.099	8	297.6
Nitrite	18	0	18	<1.0	NC	<1.0	<1.0
Nitrate ^a	18	17	1	4.6	0.802	2	5.6
Sulfate	28	28	0	163	473.95	32	2,571
Sulfate ^b	27	27	0	74	44.75	32	241
Phosphate	18	0	18	<4.0	NC	<4.0	<4.0
pH	18	18	0	9.3	0.203	9	9.8
Ammonia	28	3	25	<0.5	NC	<0.5	5.3

NOTE: Units reported in mg/kg (parts per million) unless otherwise noted.

^aReported less-than-detection-limit values in the database were used in the calculations.^bPotential outlier observation was removed.

< = Compound was analyzed for but not detected. Reported value after the "<" sign is the detection limit.

GT = Greater than detection limit.

LT = Less than detection limit.

NC = Not calculated.

Table 4. Summary Statistics for Selected Constituents for the Surface Soil Samples of the HWVP. (sheet 1 of 2)

Constituent	Sample size (n)	Greater than (GT)	Less than (LT)	Average ($\bar{x}$)	Std dev (s)	Minimum	Maximum
Aluminum	22	22	0	6,516	618.84	5,160	7,490
Antimony ^a	22	16	6	6.2	2.615	1.6	8.7
Arsenic	22	22	0	2.5	0.433	1.6	3.2
Barium	22	22	0	84.5	5.500	75	95.5
Beryllium ^a	22	7	15	0.23	0.063	0.19	0.4
Cadmium ^a	22	15	7	0.31	0.096	0.2	0.46
Calcium	22	22	0	3,491	516.38	3,010	5,620
Chromium	22	22	0	7.8	0.753	6.1	9
Cobalt	22	22	0	9.1	0.666	7.5	10
Copper	22	22	0	11.2	1.185	8.8	14.2
Iron	22	22	0	18,032	1,150.73	15,900	20,300
Lead	22	22	0	6.7	1.079	4.6	9
Magnesium	22	22	0	3,953	274.31	3,320	4,550
Manganese	22	22	0	329	22.71	294	394
Mercury ^a	22	11	11	0.21	0.162	0.09	0.48
Nickel	22	22	0	8.4	0.563	7.2	9.4
Potassium	22	22	0	1,743	203.48	1,270	2,040
Selenium ^a	22	6	16	1.36	1.206	0.79	4.3
Silver ^a	22	3	19	0.90	0.272	0.4	1.1
Sodium	22	22	0	138	15.81	109	172

Table 4. Summary Statistics for Selected Constituents for the Surface Soil Samples of the HWVP. (sheet 2 of 2)

Constituent	Sample size (n)	Greater than (GT)	Less than (LT)	Average ($\bar{x}$)	Std dev (s)	Minimum	Maximum
Thallium ^a	22	3	19	0.41	0.012	0.39	0.43
Vanadium	22	22	0	37.2	3.218	31.7	42.6
Zinc	22	22	0	41.5	4.392	32.4	51.9
Fluoride	22	11	11	2.0 ^c	1.743 ^c	<1.0	6.9
Chloride	22	22	0	12.8	2.454	8.3	17.6
Sulfate	22	21	1	30.8 ^c	9.921 ^c	<1.0	59
Ammonia	22	22	0	13.6	19.699	0.8	66
TOX ^a	4	0	4	88	18.00	62	100

NOTE: Units reported in mg/kg (parts per million) unless otherwise noted.

^aReported less-than-detection-limit values in the database were used in the calculations.

^bPotential outlier observation was removed.

^cCalculated by substituting non-detects with one-half of detection limit.

< = Compound was analyzed for but not detected. Reported value after the "<" sign is the detection limit.

GT = Greater than detection limit.

LT = Less than detection limit.

NC = Not calculated.

Table 5. Threshold Limit Values for Selected Constituents for Soil Samples of the HWVP.

Analyte	Borehole 1	Borehole 2	Borehole 3	Surface
Aluminum	8651.72	7387	8101	7970
Antimony	1.6 ^a	10.6	6.3 ^a	12.3
Arsenic	10.64	7.6	6.8	3.5
Barium	148.32	104.5	114.5	97.4
Beryllium	0.54	0.47	0.66	0.4 ^a
Cadmium	0.803	1.3	0.59	0.54
Calcium	27248.4	19018	14332	4704
Chromium	15.2	12.8	15.5	9.6
Cobalt	13.8	11.4	13.5	10.7
Copper	56.2	20.6	21.8	14.0
Iron	26814.7	21024	26184	20736
Lead	26.9	8.6	7.2	9.2
Magnesium	6822	6485	7002	4597
Manganese	420.4	391	412	382.4
Mercury	0.43	0.1	0.32 ^a	0.6
Nickel	12.09	16.6	17.9	9.7
Potassium	1972.8	1549	1587	2221
Selenium	4.15 ^a	3.9 ^a	3.9 ^a	4.2
Silver	0.4 ^a	1 ^a	1 ^a	1.1 ^a
Sodium	1184.3	381	814	175.2
Sodium	662.4 ^b			
Thallium	0.415 ^a	0.62 ^a	0.64 ^a	0.43 ^a
Vanadium	68	45.4	63.3	44.8
Zinc	61	48.1	52.9	51.8
Cyanide	5.25 ^a	5.4 ^a	5.6 ^a	
Fluoride	5.6	2.9 ^a	8.2 ^a	6.1
Chloride	155.9	107.4	276.7	c
Chloride	52.3 ^b	40.5 ^b	176.2 ^b	18.6
Nitrate	6.0	7.2	6.6	c
Nitrite	d	d	d	c
Sulfate	1216.5	136	1229	54.1
Sulfate	422.3 ^b	88.6 ^b	175	
Phosphate	d	d	d	c
Ammonia	d	22.9	5.3 ^a	59.9

NOTE: Units in mg/kg (parts per million) unless otherwise noted.

^aLess than 50% of the samples collected contained this constituent above the detection level. The value given is the maximum value of those samples collected that had the constituent present at greater than the detection limit.

^bThe value given is the threshold limit value calculated after a potential outlier was removed from the data.

^cThe analytical results for these constituents were flagged as rejected when validated.

^dThe constituent is reported at below detection levels for all samples.

6.0 REFERENCES

- Fecht, K. R., G. V. Last, and K. R. Price, 1977, *Evaluation of Scintillation Probe Profiles From 200 Area Crib Monitoring Wells*, ARH-ST-156, Atlantic Richfield Hanford Company, Richland, Washington.
- Frick, G. W. and T. F. P. Sullivan, 1986, *Environmental Glossary*, 4th Ed., Government Institutes, Inc., Rockville, Maryland, p. 33.
- Gee, G. W. and P. R. Heller, 1985, *Unsaturated Water Flow at the Hanford Site: A Review of Literature and Annotated Bibliography*, PNL-5428, Pacific Northwest Laboratory, Richland, Washington.
- Gephart, R. E., R. C. Arnett, R. G. Baca, L. S. Leonhart, and F. A. Spane, Jr., 1979, *Hydrologic Studies Within the Columbia Plateau, Washington: An Integration of Current Knowledge*, RHO-BW-ST-5, Rockwell Hanford Operations, Richland, Washington.
- Graham, M. J., 1981, *Hydrology of the Separations Area*, RHO-ST-42, Rockwell Hanford Operations, Richland, Washington.
- Stone, W. A., J. M. Thorp, O. P. Clifford, and D. J. Hoitink, 1983, *Climatological Summary for the Hanford Area*, PNL-4622, Pacific Northwest Laboratory, Richland, Washington.
- WHC, 1991, *Hanford Waste Vitrification Plant Soil Baseline Sampling and Analysis Plan*, WHC-SD-HWV-AP-003, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1992, *Data Validation Report for the HWVP Soil Baseline*, WHC-SD-HWV-TI-034, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A1

SPECTRAL GAMMA-RAY LOGS OF HWVP BOREHOLES

**RADIONUCLIDE LOGGING SYSTEM PASSIVE SPECTRAL GAMMA-RAY
BOREHOLE SURVEY REPORT**

APPENDIX A1

RADIONUCLIDE LOGGING SYSTEM PASSIVE SPECTRAL GAMMA-RAY BOREHOLE SURVEY REPORT

BACKGROUND

Three boreholes were drilled near the Hanford Waste Vitrification Plant (HWVP) in the 200 East Area for the acquisition of vadose zone soil samples. Following completion of sampling and logging, the holes were backfilled. All of the logs were run to establish background baselines.

Borehole 299-E28-94 (HWVP-1) was drilled by driving a single steel casing, 6.0 in. in inner diameter (ID) and 0.52 in. thick, to the completion depth of 29.5 ft. The section from 0 to 26.0 ft was logged with the Radionuclide Logging System (RLS) high purity germanium (HPGe) system on January 9, 1992.

Borehole 299-E29-52 (HWVP-2) was drilled by driving a single steel casing, 6.0 in. in ID and 0.52 in. thick, to the completion depth of 111.5 ft. The section from 0 to 107.5 ft was logged with the RLS HPGe system on January 10, 1992.

In the first drilling phase for Borehole 299-E28-95 (HWVP-3), a steel casing of 10.0-inch ID and thickness 0.5 in. was driven from the ground surface to a depth of 126 ft, then the January 9, 1992 log was run from 0 to 126 ft. Subsequently, the drilling proceeded by driving a steel casing of 8.0-in. ID and thickness 0.33 in. within the 10.0-in. casing. This 8-in. casing extended from the ground surface to the completion depth of 301 ft. Logs were run in the 8-in.-cased section (between 123 ft and 297.5 ft) on February 3, 1992, February 4, 1992, February 11, 1992, and February 13, 1992.

LOG RESULTS

All of the log data were collected in the move-stop-acquire (MSA) mode, in which the tool was stationary during data collection. The data acquisition points were spaced 0.5 foot apart and the counting time was 180 seconds (live time) at each point. Energy-dependent casing corrections have been determined for four thicknesses of steel: 0.09 in., 0.33 in., 0.375 in., and 0.4 in.. Corrections for casings of other materials or different thicknesses have not been established. Decay activities are reported in picocuries per gram (pCi/g) of sample. These activities were calculated by methods described in the papers cited at the end of this report, November 1991 calibration.

Borehole 299-E28-94 (HWVP-1)

The casing correction for 0.4-in.-thick steel was used because the correction for the true casing thickness (0.52 in.) has not been determined. This means that the log responses have been under-corrected and the actual

radioelement concentrations are slightly higher than the calculated concentrations.

The RLS HPGe gross count log for borehole 299-E28-94 shows no apparent anomalies. The calculated activities for potassium, thorium, and uranium show that the calculated potassium activities vary between about 10 and 15 pCi/g over the logged interval, and the thorium and uranium activities are much smaller than 5 pCi/g over the logged interval. The activity variations are within the statistical uncertainties of the measurements. The potassium, uranium, and thorium activities are typical of natural background due to naturally occurring radioelement in the sediments in the HWVP area.

Analyses of the individual gamma-ray spectra indicated that man-made gamma-ray emitters are either not present, or exist in concentrations too low to produce analyzable peaks in the spectra.

Borehole 299-E29-52 (HWVP-2)

The casing correction for 0.4-in.-thick steel was applied to the data because the correction for the true casing thickness (0.52 in.) has not been determined. This means that the log responses have been under-corrected and the actual radioelement concentrations are slightly higher than the calculated concentrations.

The RLS HPGe gross count log for borehole 299-E29-52 shows no apparent anomalies. The calculated activities for potassium, thorium, and uranium show that the calculated potassium activities vary between about 10 and 20 pCi/g over the logged interval, and the thorium and uranium activities are much less than 5 pCi/g over the logged interval. The activity variations are within the statistical uncertainties of the measurements. These activities are typical of natural background due to naturally occurring radioelements in the sediments in the HWVP area.

Analyses of the individual gamma-ray spectra indicated that man-made gamma-ray emitters either are not present or exist in concentrations too low to produce analyzable peaks in the spectra.

Borehole 299-E28-95 (HWVP-3)

The maximum correction (i.e., the correction for 0.4 in. of steel) was applied to log data recorded over the depth interval of 0 to 125 ft. For that interval, the actual casing thickness was 0.5 in. and the data were under-corrected, i.e., the actual activities are slightly higher than those calculated. For the depth interval 126 ft to 297 ft, the casing thickness was 0.33 in. A correction for this casing thickness is available and was applied to these data.

The RLS HPGe gross count log for borehole 299-E29-52 shows no apparent anomalies. The calculated potassium activities vary between 10 and 20 pCi/g over most of the logged interval, and the thorium and uranium activities are less than 5 pCi/g over the logged interval. The activity variations are within the statistical uncertainties of the measurements. These activities

are typical of natural background due to naturally occurring radioelements in the sediments in the HWVP area.

Analyses of the individual gamma-ray spectra indicated that man-made gamma-ray emitters either were not present or existed in concentrations too low to produce analyzable peaks in the spectra.

Because the hole was logged in six sections, there are five depth intervals where two activity traces from two different logging runs overlap. Typically, as in the depth increment 271 ft to 272.5 ft, the activity traces show good continuity from one log run to another. Within the depth interval from 125 ft to 130 ft, there was a discontinuity between potassium traces. This is explained as follows. The depth interval 123 ft to 179.5 ft was logged on February 13, 1992, after both casings were emplaced. The log was therefore run through a short double-cased section in which the total casing thickness was 0.83 in. The casing correction for 0.4-in.-thick casing under-corrected the potassium responses, leading to a sequence of apparent potassium concentrations that are lower than the actual concentrations.

More difficult to explain is the offset in the uranium trace encountered at about 126 ft. This offset is opposite to that observed for potassium, and therefore suggests that the uranium signal has not been attenuated by the double thickness of casing. It is also apparent that the calculated concentration of uranium is relatively high over the entire interval extending from 123 ft to 179.5 ft. The only explanation offered by the Geophysics is the following hypothesis.

As explained in the Data Analysis Summary, the uranium activities were calculated from the intensities of gamma-ray peaks associated with the decay of bismuth-214 or lead-214. Lead-214 and bismuth-214 are, respectively, the eighth and ninth decay products of uranium-238. Both occur below radon-222 in the decay chain. If a mechanism, such as a drop in atmospheric pressure, drew radon from the formation into the borehole, then the decay of radon-222 in the borehole would deposit lead-214 and bismuth-214 there, producing a spuriously high uranium signal unaffected by the casing. A similar anomaly in the apparent thorium concentration, owing to accumulation of radon-220 (fifth decay product of thorium-232) is less likely because of half life differences. The half life of the uranium daughter, radon-222, is 3.8 days, whereas the half life of the thorium daughter, radon-220, is only 55 seconds. Uranium studies (e.g., Fleischer et al. 1978) have shown that atmospheric pressure fluctuations induce variations in radon concentrations in soils.

The above hypothesis is also considered applicable to the interval from 271 ft to 297.5 ft from borehole 299-E28-95. The hypothesis is strengthened by data from the Hanford Meteorology Station that indicate that both logs (123 ft to 179.5 ft and 271 ft to 297.5 ft) were run at times that followed decreases in barometric pressure.

DATA ANALYSIS SUMMARY

Potassium-40, uranium-238, and thorium-232 decay activities were derived from the intensities of gamma rays that accompany decays of certain nuclides. Relevant properties of these nuclides are as follows:

- Potassium-40 is a naturally occurring isotope of potassium that comprises 0.012% of natural potassium.
- Lead-214 is the eighth decay product of uranium-238, and its decay activity is identical to the decay activity of uranium-238 if the decay chain is in secular equilibrium.
- Bismuth-214 is the ninth decay product of uranium-238, and its decay activity is identical to that of uranium-238 if the decay chain is in secular equilibrium.
- Actinium-228 is the second decay product of thorium-232, and its decay activity is identical to the decay activity of thorium-232 if the decay chain is in secular equilibrium.
- Bismuth-212 is the eighth decay product of thorium-232, and its decay activity is identical to the decay activity of thorium-232 if the decay chain is in secular equilibrium.
- Thallium-208 is the ninth decay product of thorium-232, and its decay activity is 34% of the decay activity of thorium-232 if the decay chain is in secular equilibrium. The factor of 34% arises from a branching ratio in the decay chain.

The energies of the gamma rays used for analyses are shown in the following table.

Element analyzed	Nuclide	Gamma-ray energy (keV)
Potassium	K-40	1461
Uranium	Pb-214	241, 295
	Bi-214	609, 1120, 1764
Thorium	Ac-228	911, 969
	Bi-212	727
	Tl-208	583, 2614

Data processing programs written by Geophysics personnel were used to calculate the intensities of the spectral peaks associated with the named gamma rays and correct these peak intensities for steel casing.

The radionuclide activities were derived from the corrected peak intensities by one of the following methods.

1. Potassium, uranium, and thorium concentrations corresponding to the 1461-keV, 609-keV, and 2614-keV gamma-ray peak intensities were calculated with linear functions that relate corrected peak intensity to nuclide concentration. These linear relations were derived from the November 1991 RLS HPGe calibration data and are reported in Koizumi et al. (1992).
2. Radioelement concentrations corresponding to the corrected intensities of the other gamma-ray peaks were calculated with the method that was derived by Geophysics personnel to assess the concentrations of artificial nuclides. This method is described in Brodeur et al. (1991) and Koizumi et al. (1992, 1993).

Calculation of calibration factors used in the analyses depended on the calibration data recorded in November 1991 and on nuclear data (half lives, branching ratios, number of gammas per decay) for the particular nuclides. All of the nuclear data were taken from Erdtmann and Soyka (1979).

LIMITATIONS TO THE RADIOELEMENT ANALYSES

Energy-dependent casing corrections have been established for steel casing with thicknesses of 0.09 in., 0.33 in., 0.375 in., and 0.4 in. Corrections for casings of different materials and/or different thicknesses have not been calculated and therefore cannot be used in data analysis.

Uranium activities were calculated from the intensities of peaks that correspond to gamma rays associated with the decay of lead-214 and bismuth-214. These nuclides have decay activities identical to the decay activity of uranium-238 if the uranium-238 decay chain is in secular equilibrium. Departures from secular equilibrium are usually traceable to either (1) a geochemical process that separates uranium from radium-226 (the fifth decay product of uranium-238) or (2) a mechanism that allows radon-222 (the sixth decay product of uranium-238) to escape from the sample.

The individual gamma-ray spectra from the three boreholes contain no indications of disequilibrium between uranium-238 and radium-226. Effects due to the other source of disequilibrium, i.e., diffusion of radon-222, may have appeared in the uranium results for the 123-ft-to-179.5-ft and the 271-ft-to-297.5-ft sections of Borehole 299-E28-95.

The calibration data were recorded with the RLS HPGe detector centered in calibration zones that are uniform in density, water content, and gamma-ray source material. The dimensions of each zone are large enough that the detector always responded as though surrounded by a medium of infinite extent. Therefore, the use of the calibration results to calculate nuclide concentrations carries the assumption that the nuclides in the logged formation are also distributed in thick uniform layers.

Gamma-ray sources are not normally distributed in the earth in thick uniform layers. Source inhomogeneities are reflected to some degree by the fluctuations in the amplitudes of the log traces. A factor called the vertical spatial resolution quantifies the correlation between (1) the intensity of a log fluctuation and the depth interval over which it extends and (2) the intensity of the corresponding gamma-ray source and the thickness of the zone in which the source is embedded. The vertical spatial resolution of the RLS HPGe logging system has not been investigated.

Gamma-ray logging specialists (Conaway and Killeen 1979, Conway et al. 1980) have developed methods to improve the spatial resolution through data processing. These have not been implemented in the RLS data processing.

REFERENCES

- Brodeur, J. R., C. J. Koizumi, W. H. Ulbricht, and R. K. Price, 1991, *Calibration of a High-Resolution Passive Gamma-Ray Logging System for Nuclear Waste Assessment*, WHC-SA-1175-FP, Westinghouse Hanford Company, Richland, Washington.
- Conaway, J. G. and P. G. Killeen, 1979, *The Effects of Borehole Diameter, Borehole Fluid, and Casing Thickness on Gamma Ray Logs in Large Diameter Boreholes*, Current Research, Part C, Geological Survey of Canada, Paper 79-1C, pp. 37-40.
- Conaway, J. G., Q. Bristow, and P. G. Killeen, 1980, *Optimization of Gamma-Ray Logging Techniques for Uranium*, Geophysics, Vol. 45, No. 2, February 1980.
- Erdtmann and Soyka, 1979, *Die Gamma-Linien der Radionuklide (The Gamma Rays of the Radionuclides)*, Verlag Chemie GMBh, Weinheim, Deutschland.
- Koizumi, C. J., J. R. Brodeur, W. H. Ulbricht, and R. K. Price, 1991, *Calibration of the RLS HPGe Spectral Gamma-Ray Logging System*, WHC-EP-0464, Westinghouse Hanford Company, Richland, Washington.
- Koizumi, C. J., R. K. Price, and R. D. Wilson, 1992, *Calibration of the RLS HPGe System for 200 Aggregate Area Management Study Screening Measurements*, WC-SD-EN-TRP-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Fleischer, R. L., M. D. Fiske, H. R. Hart, R. S. Likes, and A. Mongro-Camero, 1978, *Radon Measurements Using the Nuclear Track Technique*, Transactions of the 1978 Annual Meeting of the American Nuclear Society, June 1978, San Diego).

APPENDIX A2
HWVP SAMPLING PLAN SITE USRADS SURVEYS

APPENDIX A2

HWVP SAMPLING PLAN SITE USRADS SURVEYS

SCOPE

This report summarizes the results of the radiological surveys conducted over the entire surface of the HWVP sampling plan site, 200 Area, Hanford Site, Washington. In addition, this report explains the survey methodology using the Ultrasonic Ranging and Data System (USRADS) automatic data recording equipment.

The radiological surveys of the HWVP Site, along with the background study, were conducted by Site Investigative Surveys, Occupational Health and Safety organization of the Westinghouse Hanford Company. The survey methodology was based on utilization of the Ultrasonic Ranging and Data System (USRADS) for automated recording of the gross gamma radiation levels of the surface soil.

INSTRUMENTATION

The surveys were conducted in December 1991 and January 1992, using a Ludlum Model 2221 count rate meter with a 1-in. by 1-in. NaI Ludlum Model 44-2 radiation detector and a Ludlum Model 19 uR meter. Both were calibrated by Pacific Northwest Laboratory (PNL). These instruments were interfaced with a CHEMRAD Tennessee Corp. Series 2000 USRADS. The count rate meter was set for gross counting, i.e., window "out." The window setting allows detection of low-, intermediate-, and high-energy photons. The USRADS equipment is used to record the detector readings versus the location of the readings, generate a map of the survey area, and save the data on computer storage mediums.

Before the survey of the HWVP site is performed, a USRADS survey of an 80,000-ft² area located to the west of the 200 East Area security fence (bounded on the north by Hanford Site coordinate N42400, on the south by N42200, on the east by W57200, and on the west by 57600) was conducted to determine the ambient radiation level near the HWVP site. This background area had been previously surveyed with GM meters by B Plant Health Physics and found contamination free. The average NaI background was determined to be 1999.03 cpm with a standard deviation of 359.94 cpm. The average background dose rate was 8.76 uR/h with a standard deviation of 1.66 uR/h.

One feature of the USRADS is the ability to enter a "threshold" setting upon initiating a survey. The threshold setting is a value that, when exceeded, will highlight the data point plotted on the CPU monitor. This feature alerts the CPU operator that the counts-per-minute data have exceeded the threshold, or preset value. To conduct the HWVP surveys, it was desired to establish a value for the threshold where readings above the setting could be considered surface contamination. The threshold value established for the entire HWVP survey was approximately twice the background count rate determined at the 200 East Area background test site, or 3,900 cpm. This value is valid based on the premise that too low of a setting would highlight normal fluctuations above the calculated mean, and too high of a setting would cut off the low end of surface contamination that might be present.

METHODOLOGY

Prior to performing the surveys, a grid block system was used at the site to establish horizontal control and tie the individual surveys together. Each survey of the area entailed setting up the USRADS equipment in a grid block, connecting the radiation survey meters to the USRADS data pack, calibrating the USRADS equipment, and performing the survey. Calibration of the USRADS is performed prior to starting a survey. The purpose to the calibration sequence is to reestablish the positioning of instrumentation after the equipment is moved to a new location.

With the exception of four grid blocks, each grid block was traversed in a north-south direction on approximately 25-ft centers. Grid blocks 94, 95, and 101 were surveyed in a cross-hatched pattern on 25-ft centers; grid block 102 was a high-density survey with a cross-hatched pattern on approximately 5-ft centers. The gamma detector was maintained 6 in. from the soil surface by suspending the NaI detector from a boom attached to the surveyor's backpack. The uR meter was mounted approximately 3 ft above the soil surface. Detector geometry remained relatively constant throughout the entire survey. Survey speed was approximately 1 m/s.

As the surveyor traverses the survey area, the USRADS records the output data from the radiation detector versus the location of where in the survey area the data was detected--each second. Therefore, while the survey is in progress, a real-time map of the survey area is generated. When the survey is completed, the survey data set is saved on a computer disk.

Radiation survey instruments were checked for the proper instrument response at the beginning of each day. This was accomplished by placing a uranium check source next to the detector and observing the instrument's response to the source. Local background radiation checks were also performed. This involved taking three 1-min counts and calculating the average of the three counts.

RESULTS

The entire HWVP site sampling plan area was surveyed, with the exception of the known surface contaminated areas and a controlled area just north of Seventh St. where well drilling operations were ongoing. The area surveyed was approximately 4,400,000 ft², or 100.8 acres.

A problem was encountered during 18 individual USRADS surveys. A loose interface jack/plug combination on the uR meter caused the USRADS to interpret several events as a single event giving a false elevated dose rate reading. These elevated readings were determined to be false because they were seen as a rapid rise and fall of dose rate rather than a gradual rise and that the maximum count rate recorded in these surveys was not coincident with these dose rate "spiked" areas.

The survey consisted of 110 individual USRADS surveys collecting a total of 99,486 data points. The statistics for each survey follow.

HNWP USRADS SURVEY STATISTICS

GRID	SURVEY	DATE	DATA PTS.	MAX CPM	MEAN CPM	SD CPM	MAX UR	MEAN UR	SD UR
1	VP1A	12/27/91	823	2860	2092.86	298.27	13.12	9.21	1.14
2	VP2A	12/27/91	814	2860	2029.09	348.74	13.12	9.2	1.11
3	VP3A	12/27/91	868	2820	2055.41	389.01	12.82	9.07	1.2
4	VP4A	01/03/92	686	2560	1878.57	256	11.62	8.18	1.28
5	VP5A	01/03/92	851	2540	1900.54	287.16	11.62	8.27	1.06
6	VP6A	01/10/92	650	2640	1831.2	392.9	11.52	8.52	1.09
7	VP7A	01/10/92	900	2700	1896.87	289.27	12.02	8.46	1.07
8	VP8A	01/14/92	858	2660	1802.73	249.27	*24.82	8.1	1.43
9	VP9A	01/14/92	672	2500	1825.98	218.49	11.32	7.97	1.12
10	VP10A	01/17/92	788	2260	1570.36	282.37	*82.22	7.96	4.34
11	VP11A	01/17/92	607	2520	1775.49	255.11	11.92	8.08	1.15
12	VP12A	01/22/92	654	2000	1331.28	247.44	*35.12	8.19	2.05
13	VP13A	01/22/92	603	2260	1626.04	201.24	11.32	8.61	1.03
14	VP14A	01/22/92	803	2080	1454.12	217.84	11.82	8.84	0.96
15	VP15A	01/17/92	921	2600	1890.12	212.3	11.72	8.68	0.99
16	VP16A	01/17/92	805	2380	1696.92	226.46	11.12	7.9	1.21
17	VP17A	01/14/92	810	2440	1914.67	197.98	11.72	8.34	1
18	VP18A	01/14/92	698	2520	1893.09	242.2	11.42	8.46	0.93
19	VP19A	01/10/92	981	2720	2064.3	315.31	12.42	9.46	0.98
20	VP20A	01/10/92	888	2680	2034.93	203.76	12.42	9.03	0.97
21	VP21A	01/03/92	938	2680	2013.65	255.75	*34.92	8.8	1.85

* False elevated reading

HWP USRAOS SURVEYS STATISTICS

GRID	SURVEY	DATE	DATA PTS.	MAX CPM	MEAN CPM	SD CPM	MAX LR	MEAN LR	SD LR
22	VP22A	01/03/92	832	2620	2074.25	196.79	12.02	8.97	0.92
23	VP23A	12/27/91	854	3060	2255.97	252.81	13.52	9.71	1.05
24	VP24A	12/27/91	822	2820	2224.6	258.37	12.92	9.39	2.22
25	VP25A	12/30/91	823	2960	2252.52	212.05	13.42	10.05	1.05
26	VP26A	12/30/91	741	3080	2290.28	216.47	13.02	10.07	1.19
27	VP27A	12/30/91	772	3000	2215.26	375.01	13.52	9.67	1.73
28	VP28A	12/30/91	784	2940	2268.37	207.51	12.82	9.9	1.01
29	VP29A	01/03/92	907	2840	2014.33	341.88	12.72	8.99	1.34
30	VP30A	01/03/92	746	2980	2018.77	270.62	12.32	8.87	1.2
31	VP31A	01/13/92	892	2780	1961.26	360.02	*24.02	9.28	1.27
32	VP32A	01/10/92	784	2840	2036.15	357.69	12.22	9.09	1.61
33	VP33A	01/14/92	834	2640	1866.95	268.99	*67.92	11.37	9.59
34	VP34A	01/14/92	939	2560	1897.38	257.04	*45.82	8.98	2.83
35	VP35A	01/17/92	969	2480	1798.14	268.08	*44.92	8.34	2.71
36	VP36A	01/17/92	737	2480	1913.08	219.9	13.62	8.68	1.12
37	VP37A	01/22/92	691	2440	1713.69	213.65	12.02	8.99	1.08
38	VP38A	01/22/92	907	2280	1651.16	220.31	12.42	8.78	1.13
39	VP39A	01/24/92	641	1700	1151.33	178.5	10.62	7.96	1.07
40	VP40A	01/24/92	627	1580	1099.52	147.63	11.62	8.58	0.95
41	VP41A	01/24/92	850	1640	11.32	167.98	11.02	8.14	0.95
42	VP42A	01/23/92	733	1920	1382.05	190.65	11.32	8.54	1.06

*false elevated reading

HWV USRAVS SURVEYS STATISTICS

GRID	SURVEY	DATE	DATA PTS.	MAX CPM	MEAN CPM	SD CPM	MAX LR	MEAN LR	SD LR
43	VP43A	01/23/92	652	1880	1277.45	257.8	11.82	8.7	1.41
44	VP44A	01/20/92	925	2840	1915.72	215.66	11.62	8.65	1.06
45	VP45A	01/20/92	768	2340	1782.73	215.17	11.32	8.19	1.13
46	VP46A	01/15/92	750	2620	1952.96	239.89	*47.82	8.82	2.7
47	VP47A	01/15/92	1024	2640	1950.9	215.62	11.82	8.3	2.14
48	VP48A	01/13/92	919	2700	2012.73	212.9	12.22	8.41	2.2
49	VP49A	01/13/92	688	2680	2025.55	276.28	12.42	9.2	0.98
50	VP50A	01/08/92	700	2640	1928.8	388.4	11.42	8.93	0.97
51	VP51A	01/08/92	701	2780	1977.52	344.09	12.12	9.04	1
52	VP52A	12/30/91	756	3000	2242.91	263.32	13.52	9.31	1.54
53	VP53A	12/30/91	734	3020	2250.49	221	13.02	9.89	0.92
54	VP54A	12/31/91	804	3000	2267.54	216.8	12.82	9.92	1.03
55	VP55A	12/31/91	644	2840	2255.12	229.5	13.22	9.97	1.04
56	VP56A	12/31/91	784	2960	2271.2	250.11	13.42	9.89	0.99
57	VP57C	12/31/91	828	2900	2221.38	329.66	12.52	9.77	0.99
58	VP58A	01/08/92	891	2700	2048.01	257.85	12.72	9.16	1.02
59	VP59A	01/08/92	882	2520	1989.77	215.88	12.02	8.81	0.98
60	VP60A	01/13/92	701	2640	1995.24	218.39	*40.02	9.08	2.15
61	VP61A	01/13/92	941	2580	1994.43	259.95	*118.12	10.33	8.69
62	VP62A	01/15/92	900	980	749.38	85.61	*45.22	8.76	2.27
63	VP63A	01/15/92	885	2520	1955.19	201.3	13.32	8.72	1.05

* False elevated reading

HWP USRADS SURVEYS STATISTICS

GRID	SURVEY	DATE	DATA PTS.	MAX CPM	MEAN CPM	SD CPM	MAX LR	MEAN LR	SD LR
64	VP64A	01/15/92	1141	2520	1840.28	277.23	*43.72	7.49	4.79
65	VP65A	01/20/92	928	2580	1871.9	214.1	12.12	8.72	1.24
66	VP66A	01/23/92	678	840	400.8	140.34	14.92	8.4	1.27
67	VP67A	01/23/92	674	1980	1350	192.97	11.92	8.54	1
68	VP68A	01/25/92	897	2180	1530.81	263.34	*50.22	8.76	2.4
69	VP69A	01/24/92	802	1540	1074.54	154.41	11.62	8.58	1.03
70	VP70A	01/30/92	592	2460	1606.32	292.97	13.82	8.83	1.67
71	VP71A	01/25/92	1118	2120	1360.64	196.01	12.32	8.65	1.01
72	VP72A	01/25/92	752	2340	1638.43	206.01	11.62	8.41	1.02
73	VP73A	01/20/92	700	2400	1809.69	200.61	12.12	8.68	1.06
74	VP74A	01/20/92	966	2520	1769.57	212.49	12.42	8.92	1.12
75	VP75A	01/20/92	709	2420	1729.17	210.25	11.82	8.07	1.22
76	VP76A	01/16/92	741	2520	1955.47	203.91	12.52	8.75	0.93
77	VP77A	01/16/92	637	2440	1900.6	213.39	11.72	8.52	1.09
78	VP78A	01/16/92	945	2720	1924.17	215.61	11.52	8.71	1.01
79	VP79A	01/13/92	821	2600	1983.56	198.52	12.52	8.87	0.99
80	VP80A	01/08/92	699	2680	1940.31	304.48	11.92	8.76	1.03
81	VP81A	01/21/92	627	2340	1604.21	289.09	12.02	8.72	1.8
82	VP82A	12/31/91	742	2780	2149.49	386.92	13.42	9.66	1.91
83	VP83A	12/31/91	781	2900	2207.4	225.72	13.22	9.83	1.05
84	VP84A	01/02/92	932	3400	2036.27	268.66	12.92	8.92	1.2

* False elevated reading

HWP USDAO'S SURVEYS STATISTICS

GRID	SURVEY	DATE	DATA PTS.	MAX CPM	MEAN CPM	SD CPM	MAX LR	MEAN LR	SD LR
85	VP058	01/02/92	786	2740	1972.24	334.64	12.52	8.52	1.72
86	VP06A	01/07/92	852	2820	1993.1	274.48	12.82	8.71	1.21
87	VP07A	01/07/92	796	2700	1898.77	371.69	12.32	8.51	1.33
88	VP08A	01/07/92	920	2580	1862.67	285.29	13.62	8.28	1.16
89	VP09A	01/07/92	946	2600	1846.69	293.05	11.52	8.15	1.06
90	VP00A	01/09/92	905	2620	1873.26	283.99	11.72	8.41	1.13
91	VP01A	01/09/92	978	2720	1844.13	432.26	13.32	8.62	1.07
92	VP02A	01/21/92	988	2360	1698.36	260.27	11.42	8.22	1.11
93	VP03A	01/26/92	1032	2460	1684.88	297.25	14.32	7.87	1.35
94	VP04A	01/29/92	1586	2040	1342.79	106.17	14.12	8.18	1.78
95	VP05A	01/30/92	1713	2760	1587.95	412.31	14.72	8.56	2.23
96	VP06A	01/27/92	606	2760	1835.94	338.13	14.42	9.21	2.1
97	VP07A	01/25/92	1054	2700	1707.38	374.05	13.22	8.41	1.67
98	VP08A	01/28/92	639	2520	1339.15	316.04	14.12	8.26	1.71
99	VP09B	01/27/92	919	2580	1696.97	443.66	*22.52	8.58	2.62
100	VP100A	01/27/92	1023	2700	1593.43	369.76	13.82	8.49	1.92
101	VP101A	01/30/92	1699	3120	1708.64	439.7	13.52	8.23	1.86
102	VP102A	01/26/92	7509	2500	1728.5	256.9	*21.22	8.55	1.31
103	VP103A	01/26/92	757	2540	1772.97	276.08	11.82	8.02	1.3
104	VP104A	01/21/92	970	2420	1493.88	411.09	*31.52	8.06	2.75
105	VP105A	01/21/92	951	2340	1626.44	312.8	*42.02	8.63	2.64

* false elevated reading

MWP USRAOS SURVEYS STATISTICS

GRID	SURVEY	DATE	DATA PTS.	MAX CPM	MEAN CPM	SD CPM	MAX LB	MEAN LB	SD LB
106	VP106A	01/09/92	845	2620	1941.23	220.39	11.82	8.78	0.98
107	VP107A	01/07/92	814	2660	1925.75	260.16	11.92	8.71	0.94
108	VP108A	01/07/92	814	2680	1985.53	222.36	12.72	8.66	1.05
109	VP109A	01/07/92	908	2740	1971.76	406.03	12.02	8.85	1.04
110	VP110A	01/02/92	1214	2680	1854.22	412.6	12.02	8.36	1.79

APPENDIX B
SURFACE FIELD SCREENING

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SURFACE FIELD SCREENING

12-4-91

Duane Jacques

Field notes for HWVP soil samples collected and screened for total volatile organic compounds (VOC).

Field Conditions: The skies were partly cloudy with light, variable winds. The temperature was about 45 to 50 degrees F. Light rain had fallen earlier that morning.

- 0920 Calibrated OVM 580B (UL) (a trademark of Thermo Environmental Instruments, Inc.) total organic vapor analyzer at the 200-E HWVP site. The instrument was using an 11.8 eV lamp, serial number 003877. The instrument was calibrated to 101 ppm isobutylene.
- 0927 Challenged instrument calibration with five readings of 9.51 ppm isobutylene. The readings were 8.8, 8.8, 8.7, 8.7, and 8.7.
- 0951 Checked plastic zip-lock bag and aluminum foil from sampling equipment for total VOC. No VOC detected. Background instrument readings were 0.3 to 0.6 ppm.
- 1000 Changed filter and recalibrated instrument to 101 ppm isobutylene. Background instrument readings were still somewhat high.

Sampling Method

Approximately 3 tablespoons of well mixed soil was put into a medium sized plastic zip-lock bag. The soil was obtained from a depth of 0 to 6 inches and was damp from early morning rain. The bag was flattened from the sample upwards to remove air. The bag was then sealed and shaken for 10 to 15 seconds. Prior to sampling, the ambient VOC level detected by the OVM 580B (UL) was recorded. Then the headspace immediately above the soil sample was analyzed for total VOC. The highest VOC reading was recorded on the field data sheet and also logged into the instrument memory. All instrument readings are reported in ppm, isobutylene equivalent.

- 1110 Challenged instrument calibration with five readings of 9.51 ppm isobutylene. The readings were 9.9, 9.9, 9.5, 9.5, and 9.1. Zero air reading (through a charcoal filter) was 0.0. The 101 ppm isobutylene standard was reading 108 ppm.
- 1250 Recalibrated with 101 ppm isobutylene. Challenged instrument calibration with five readings of 9.51 ppm isobutylene. The readings were 8.1, 8.1, 8.1, 7.7, and 7.7.
- 1355 Challenged instrument calibration with five readings of 9.51 ppm isobutylene. The readings were 8.5, 8.1, 8.1, 8.1, and 7.7.
- 1505 Completed field screening for VOC. Challenged instrument calibration with five readings of 9.51 ppm isobutylene. The readings were 7.7, 7.7, 7.3, 7.3, and 7.3.

1630 Finished soil sampling and packed up equipment. Left site.

Total VOC Measured in Soil Samples Collected at the HWVP Site

Instrument: 580B OVM with 11.8 eV lamp
 Calibration Standard: 101 ppm Isobutylene
 Date: 12-4-91

Sample #	Time	Ambient VOC	Total VOC	Soil VOC
B01FJ8	14:00	0.1	3.9	3.8
B01FJ7	14:06	0.9	2.4	1.5
B01FK4	14:10	0.5	3.9	3.4
B01FJ9	14:22	0.9	3.9	3.0
B01FK0	14:15	0.5	3.5	3.0
B01FK7	13:46	0.9	4.3	3.4
B01FK8	13:36	0.9	3.9	3.0
B01FK2	13:41	0.9	3.9	3.0
B01FK5	14:28	0.9	3.9	3.0
B01FK6	14:35	0.9	3.5	2.6
B01FJ5	13:29	0.9	3.5	2.6
B01FJ6	13:23	0.9	3.9	3.0
B01FK9	13:15	0.9	4.3	3.4
B01FL0	14:53	1.3	3.5	2.2
B01FL3	14:40	0.9	3.5	2.6
B01FJ3	14:46	0.9	3.9	3.0
B01FJ2	11:38	2.4	3.9	1.5
B01FJ1	11:20	2.8	3.5	0.7
B01FH7	10:08	1.3	5.8	4.5
B01FJ0	11:02	3.1	5.8	2.7
B01FH9	10:40	2.4	6.1	3.7
B01FH8	10:16	2.4	6.1	3.7

NOTE: All concentrations are reported in ppm, isobutylene equivalent.

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END