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Annual Environmental Monitoring Report
CALENDAR YEAR
2017

REV 0 (3-20-2018)

US ECOLOGY WASHINGTON
LOW LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY

Radioactive Material License
WN-I019-2
Air Emissions License number
RAEL-009

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 EXECUTIVE SUMMARY

The purpose of the environmental monitoring program is to ensure the limits and constraints of the applicable regulations are met, to ensure the site is being operated in a safe manner and to detect any changes to environmental radiation levels that could be caused by site operations. Figure 2.1 shows the site and the location of the environmental monitoring activities. This report summarizes the results of our program.

US Ecology Washington (USEW) submits this environmental monitoring report each year in accordance with the Washington Administrative Code (WAC 246-250-600 (7)). WAC 246-250-340 also requires environmental monitoring. These regulations require:

> "…measurements and observations be made and recorded to evaluate the potential health and environmental impact during construction and operation of the facility and to enable the evaluation of long-term effects and need for mitigation measures. The monitoring system must be capable of providing early warning of a radiological release before it reaches the site boundary."

The USEW radioactive materials license through the state of Washington (WN-I019-2) requires implementation of an environmental monitoring program through the USEW Facility Standards Manual (FSM) and Richland Operational Procedures. The environmental monitoring program complies with the requirements in the Washington Administrative Code and the USEW radioactive materials license.

The Washington State Department of Health (DOH) license condition 72 directs that US Ecology must provide an annual report that contains the following information:

> "A comprehensive annual report of all sample analyses, with statistical trend analyses and discussion of all anomalous results and actions taken, specification of the quantity of each of the principle contaminants released to the unrestricted areas in liquid and in airborne effluents during the preceding year, wind rose for the facility, depth to water and depth to bottom, pH, as well as non-radiological contaminants specified in the Facility Standard Manual for all groundwater wells, ventilation exhaust samples taken from the inspection facility, and comparisons of onsite groundwater wells and the U.S. DOE groundwater wells in the vicinity of the facility."

License condition 72 also requires that this report shall be submitted in general accordance with the department's document entitled "Recommended Content and Format for Annual Environmental Reports". The latest version is dated October 21, 2013 (see appendix F).

US Ecology Washington is a shallow land burial facility for low level radioactive waste. There is no water above ground, and the ground water is about 300 feet below ground surface. All water used on site is from the Columbia River via the Hanford site water system. Water is used for domestic purposes and for dust control. The disturbed area is approximately 100 acres, which includes the filled and partially filled waste trenches. See site specific drawing Figure 2-1, and in the surrounding community Figure 2.2.

Trends and abnormal sample results are discussed later in this report. In 2017, there were several noteworthy analyses:

- Uranium in MW-8 and Carbon 14 in MW-5 are being watched
- An elevated plutonium was found in fence line vegetation
- Cesium 137 was detected in trench cap vegetation
- Uranium was detected in fence line soil

There are numerous results that are above investigation levels or elevated, but none are believed to be the result of operations at USEW, and none are outside of the levels normally seen.

The annual calculated dose from all sources is 34 mrem compared to the annual limit of 100 mrem. The annual calculated dose from all effluent sources is negligible (<0.25 mrem per year) compared to our limit of 25 mrem from effluents. The annual dose from air emissions calculated with the CAP88 code (Environmental Protection Agency, 2016) is 1.1E-4 mrem per year compared to our limit of 1 mrem per year. There is no assigned MEI for this facility, therefore compliance with dose regulations is met by ensuring the fence line dose in the predominant wind direction is less than the applicable standard.

The radionuclides of concern are those listed in the Environmental Impact Statement (EIS) (Washington State Department of Health, 2004), which include longer lived power plant activated material such as cobalt-60, fuel derived isotopes such as strontium-90 and cesium-137, and naturally occurring and source material such as uranium and radium. This facility is licensed to accept any isotope.

Compliance with the dose limits is ensured if the maximum dose in an uncontrolled area is less than the applicable limit.

2.0 INTRODUCTION

USEW Low Level Radioactive Waste (LLRW) Disposal Facility is located in north-central Benton County about 20 miles northwest of the city of Richland, Washington. The facility address is ¼ mile west of 200 East, Hanford reservation, Richland, Washington. The facility is situated within the US Department of Energy (DOE) Hanford Site on 100 acres of land (see Figure 2.1). DOE leases the site to the state of Washington and the State subleases to USEW. The facility is entirely within the Hanford separations area, which covers approximately 82 square miles in the center of the Hanford Site. The facility is located just southwest of 200 East and about 2.5 miles east of 200 West. The Hanford 200 Areas contain irradiated uranium fuel processing facilities, plutonium separation facilities, and the major radioactive waste storage and disposal facilities (see Figure 2.2).

The USEW facility began operating in 1965. Approximately 14 million cubic feet of low-level waste has been received through December 31, 2017. This waste contains solid or solidified materials, contaminated equipment, cleaning wastes, tools, protective clothing, gloves, laboratory wastes, and naturally occurring or accelerator produced radioactive material (NARM). The waste is from any source other than nuclear fuel, and contains limited amounts of Special Nuclear Material. The manifested activity of the buried waste is approximately 4 million curies

(Ci). The total radioactivity actually contained on site is considerably less than the manifested activity due to radioactive decay and conservatism of manifested quantities.

All waste is contained in trenches that are excavated into the surficial sediments. When completely filled, each trench is covered with at least eight feet of soil and capped with a layer of gravel. Older trenches were covered with three feet of soil before gravel placement. At present, there are two open trenches and 19 closed trenches, one closed tank farm, and one closed chemical trench that does not contain LLRW. The trenches are located on about 32 acres in the southeast and east-central part of the facilities. Trench size is variable but the larger trenches are up to 150 feet wide, 1,000 feet long and 50 feet deep.

During operation, material is handled in closed containers inside of the restricted area and in open containers in the inspection facility in the lab building. Most waste handling operations are in and around the two open waste disposal trenches, Trenches 18 and 19.

The facility officers are:

CEO:	Jeff Feeler
Manager:	Mike Ault
RSO/RPM:	Sean Murphy
Regulatory Compliance:	Parrish Jones

This site has 21 full time employees.

Figure 2.1 Site Layout and Environmental Sampling Locations

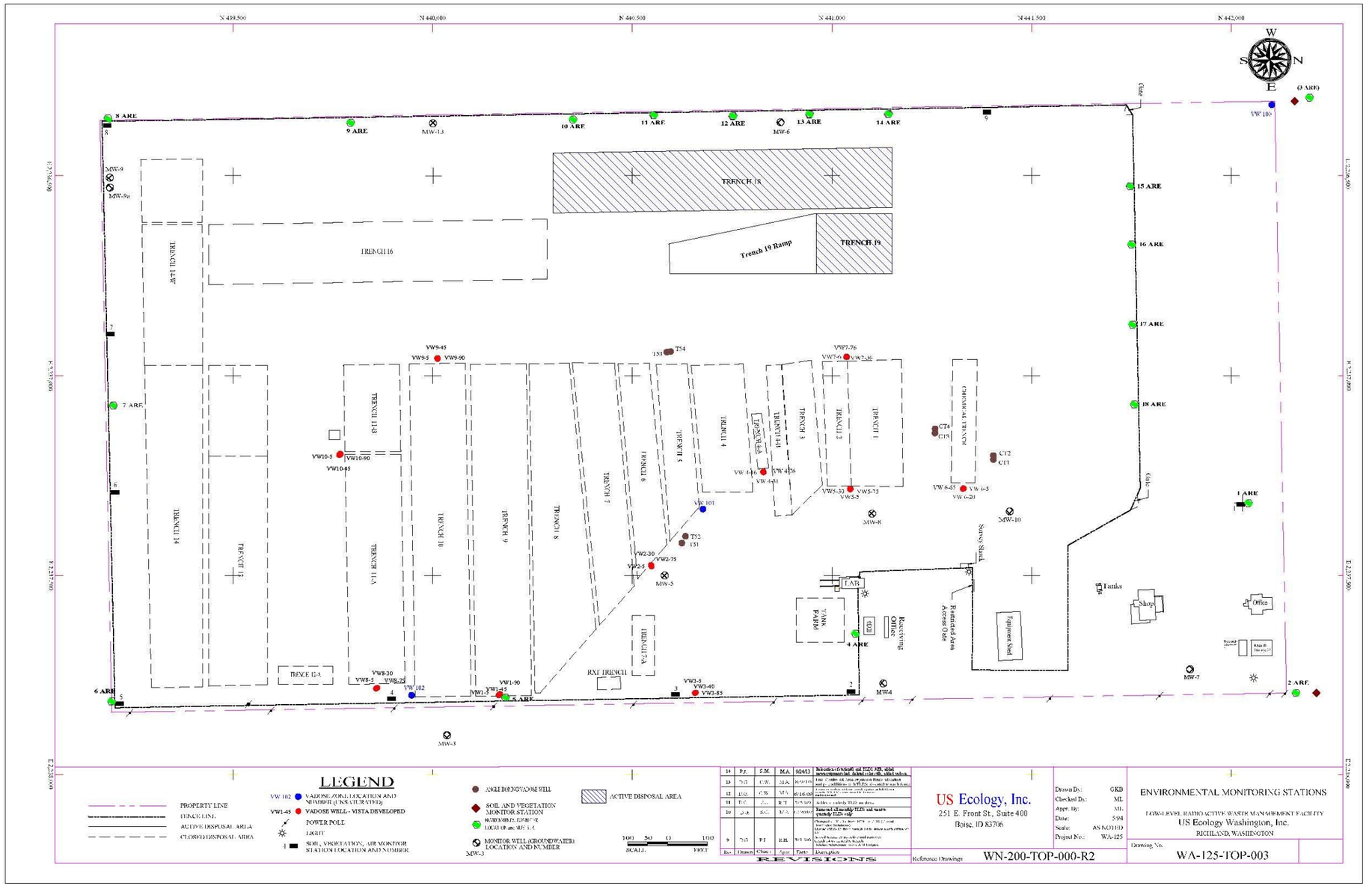
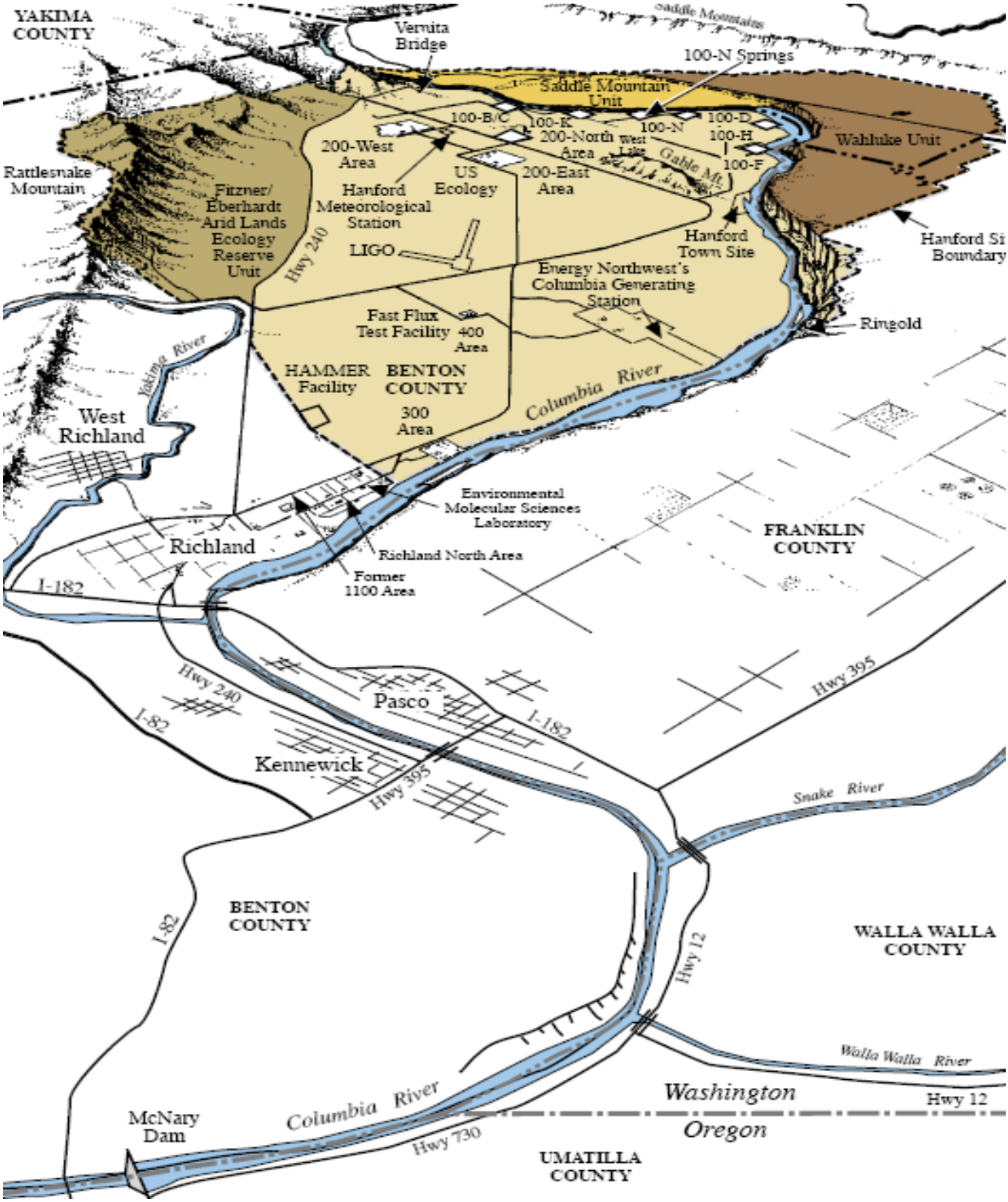


Figure 2.2 DOE's Hanford Site and Surrounding Community



3.0 COMPLIANCE SUMMARY

Each section that follows will contain statistical trend analysis and a discussion of anomalous results. Section 8 of this report will contain a list of any contaminant released in air or water. The wind rose will be included in Appendix B. Section 7 of this report will contain the groundwater protection program information. Ventilation exhaust sample information will be included in the air emissions Appendix A.

USEW license allows the possession of 60,000 Curies of dry packaged radioactive waste, 36,000 Kg of Source Material, and Special Nuclear Material in quantities not sufficient to form a critical mass.

The dose calculated for the environment and members of the public are less than the applicable limits.

See Table 8.1 for a list of all samples that exceeded action levels.

3.1 Summary of Releases

Date of Release	Type of release	Agency notified
No releases in 2017		

4.0 ENVIRONMENTAL PROGRAM INFORMATION

4.1 Description of the Environmental Program

USEW is required to perform environmental monitoring to show compliance with the Washington Administrative Code WAC 246-250-170. These regulations require that the annual doses due to effluents do not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of any member of the public. USEW assumes that the methods described in ICRP-26 (Recommendations of the ICRP, ICRP Publication 26, 1977), and adopted by the NRC in 1991 are equal to the above limits. USEW assumes that achieving levels less than 25 mrem CEDE also meet the above limit. In addition, effluents release must be maintained "As Low As is Reasonably Achievable" (ALARA). The constraint on air emissions from WAC 246-221-005(4), 10 mrem per year criterion for airborne emissions must also be verified.

The environmental monitoring program monitors all pathways which could result in offsite dose. These include environmental air, soil, vegetation, groundwater and direct radiation. Since the facility is located within the Hanford Reservation, the probability of any effluent reaching the general population is very low. Monitoring of food pathways is not possible since there are no farms or ranches near the facility. Wildlife is not monitored as hunting or trapping are prohibited on the Hanford Reservation. Vegetation samples provide some indication of radionuclides that could be found in the diet of wildlife, but provide no information for use in a dose assessment to humans. Groundwater is monitored for continuous trending and detection of potential impacts by the site, but is not used in human dose assessment. There are no wells that use the underlying aquifer for domestic or agricultural purposes. Soil is monitored as an indication of wind-blown particles that would not be detected in air samples and provides an indication of potential releases from the site. Soil results are not used in a human dose assessment as there is no pathway into humans other than the respirable portion.

Ensuring that effluents from the facility are less than regulatory limits is sound business practice.

Table 4.1 Contract Laboratories:

Lab Name	*Type of Analysis*	*Certifications*
Test America Laboratories Richland (TALR)	Ground water, soil, vegetation; radiological and chemical	WA State Dept. of Ecology, NELAP, NRC, DoD ELAP
Mirion Technologies, Irving, CA	Thermo-luminescent dosimetry (TLD)	NVLAP

The potential exposure pathways for radiation or radioactive materials released from the site are direct exposure, airborne radionuclides, and radionuclide releases into the groundwater. The environmental monitoring program includes nine fixed environmental air stations, routine monitoring of soil and live vegetation, environmental TLDs and ten groundwater wells.

Direct radiation exposure rate measurements at all site fence line monitoring locations were within allowed limits and below investigation levels. Since access to the areas near the site is controlled, potential exposure to non-occupational personnel was minimal. Exposures from the direct radiation pathway would be immeasurably low at other Hanford facilities or at the nearest residence which is outside the Hanford Reservation.

In addition, effluent release data from the package inspection facility is used to calculate doses from site airborne releases to the general public. These calculations show that doses from site airborne releases are extremely low and indistinguishable from normal environmental background levels.

The facility completed quality assurance surveillances on the groundwater sampling, soil sampling, vegetation sampling, air sampling and environmental TLD placement.

US Ecology Richland Operation Procedures for environmental monitoring are included in Appendix E.

Table 4.2 Required MDC

Radionuclide	**Water (pCi/l)**	**Airborne Activity (pCi/m3)**	**Soil (pCi/g – dry)**	**Vegetation (pCi/g - dry)**
Ba/La-140	24	0.02	0.05	0.21
Curium-141	10	0.01	0.02	0.09
Ce/Pr-144	92	0.09	0.18	0.30
Cobalt-58	10	0.01	0.02	0.09
Cobalt-60	6	0.01	0.02	0.09
Cesium-134	11	0.01	0.02	0.09
Cesium-137	7	0.01	0.02	0.09
Europium-152	56	0.06	0.11	0.51
Europium-154	27	0.03	0.05	0.24
Europium-155	24	0.02	0.05	0.21
Iron-59	17	0.02	0.03	0.15
Manganese-54	10	0.01	0.02	0.09
Sodium-22	10	0.01	0.02	0.09
Ruthenium-103	10	0.01	0.02	0.09
Ruthenium-106	85	0.09	0.17	0.78
Antimony-124	10	0.01	0.02	0.09
Antimony-125	24	0.02	0.05	0.21
Zinc-65	21	0.02	0.04	0.18
Zr/Nb-95	17	0.02	0.03	0.15
Gross Alpha (Lab)	2	0.002	-	-
Gross Beta (Lab)	3	0.02	0.1	1.0
Gross Alpha (USEW)	-	0.003	-	-
Gross Beta (USEW)	-	0.003	-	-
Iodine-125	-	30	-	-
Plutonium-238	0.01	-	0.01	0.01
Plutonium-239/240	0.01	-	0.01	0.01
Uranium	0.1	-	0.2	0.1

The Minimum Detectable Concentration (MDC) is defined as the concentration at which a 5% risk of false detection and false non-detection exists.

4.2 Environmental Monitoring Program Changes

The well pumps in well 10 were replaced with a variable speed pump in May of 2017. The bladder type sample pump failed during the 1st quarter a sampling evolution on March 15, 2017.

Table 4.3 Environmental Monitoring Requirements

				ACTION LEVELS		
MEDIUM	LOCATION	TYPE, FREQUENCY	ANALYSIS	INVESTIGATION LEVEL	REPORTING LEVEL	ACTION CATEGORY[1]
ENVIRONMENTAL AIR	Environmental. Monitoring Stations 1-9	Continuous, changed weekly	Gross Alpha	1 E-14μCi/cc	1.7 E-14 μCi/cc	3, 4
			Gross Beta	1 E-13 μCi/cc	2.6 E-11 μCi/cc	3, 4
	Environmental. Monitoring Stations 1-9	Continuous, Quarterly Composite of Weekly Samples	Cobalt-60	5 E-14 μCi/cc	2.6 E-11 μCi/cc	3, 4
			Cesium-137	5 E-14 μCi/cc	1.9 E-10 μCi/cc	3, 4
			Gamma Spec	5 X MDC	5 X MDC	3, 4
	Environmental. Monitoring Stations 1,2,5	Continuous, for at least 30 days/qtr	Tritium	2 E-11 μCi/cc	6.1 E-8 μCi/cc	3, 4
OCCUPATIONAL AIR	One downwind plus one at each location of potential exposure	Continuous during operations, 1 hour minimum NA if no waste handling operations	Gross Alpha	NA[4]	3 E-13 μCi/cc[11]	1
			Gross Beta[2]	NA[4]	1 E-12 μCi/cc[11]	1
			Iodine-125 When required)	NA[4]	5 E-10 μCi/cc[11]	1

MEDIUM	LOCATION	TYPE, FREQUENCY	ANALYSIS	ACTION LEVELS: INVESTIGATION LEVEL	ACTION LEVELS: REPORTING LEVEL	ACTION CATEGORY[1]
SOIL[5]	Env. Monitoring Stations 1-9 and NE, NW Corners	Grab, Once Every Three Quarters	Gross Beta	35 ρCi/g (dry)	35 ρCi/g (dry)	3, 4
			Total Uranium[6]	1 ρCi/g (dry)	1 ρCi/g (dry)	3, 4
			Plutonium-238	0.03 ρCi/g (dry)	0.03 ρCi/g (dry)	3, 4
			Plutonium-239/240	0.03 ρCi/g (dry)	0.03 ρCi/g (dry)	3, 4
			Cobalt-60	0.3 ρCi/g (dry)	0.3 ρCi/g (dry)	3, 4
			Cesium-137	0.25 ρCi/g (dry)	0.25 ρCi/g (dry)	3, 4
			Gamma Spec	5 X MDC	5 X MDC	3, 4
VEGETATION[5]	Env. Monitoring Stations 1-9 and NE, NW Corners	Grab, Annually	Gross Beta	100 ρCi/g (dry)	100 ρCi/g (dry)	3, 4
			Total Uranium[6]	0.25 ρCi/g (dry)	0.25 ρCi/g (dry)	3, 4
			Pu-238	0.02 ρCi/g (dry)	0.02 ρCi/g (dry)	3, 4
			Pu-239/240	0.02 ρCi/g (dry)	0.02 ρCi/g (dry)	3, 4
			Cobalt-60	0.1 ρCi/g (dry)	0.1 ρCi/g (dry)	3, 4
			Cesium-137	0.2 ρCi/g (dry)	0.2 ρCi/g (dry)	3, 4
			Gamma Spec	5 X MDC	5 X MDC	3, 4
	Filled and capped trenches	Grab Annually	Gross Beta	100 ρCi/g (dry)	100 ρCi/g (dry)	3, 4
			Total Uranium[6]	0.25 ρCi/g (dry)	0.25 ρCi/g (dry)	3, 4
			Plutonium-238	0.02 ρCi/g (dry)	0.02 ρCi/g (dry)	3, 4
			Plutonium-239/240	0.02 ρCi/g (dry)	0.02 ρCi/g (dry)	3, 4
			Cobalt-60	0.1 ρCi/g (dry)	0.1 ρCi/g (dry)	3, 4
			Cesium-137	0.2 ρCi/g (dry)	0.2 ρCi/g (dry)	3, 4
			Gamma Spec	5 X MDC	5 X MDC	3, 4
			Tritium	NA[4, 8]	NA[4, 8]	

				ACTION LEVELS		
MEDIUM	LOCATION	TYPE, FREQUENCY	ANALYSIS	INVESTIGATION LEVEL	REPORTING LEVEL	ACTION CATEGORY[1]
GROUNDWATER	Wells	Grab, Once	Gross Alpha	12 ρCi/l	15 ρCi/l	3, 4
	#013[14]	Every	Gross Beta	12 ρCi/l	50 ρCi/l	3, 4
	#010	Quarter	Tritium	3,600 ρCi/l[12]	20,000 ρCi/l	3, 4
	#008		Carbon-14	250 ρCi/l	2,000 ρCi/l	3, 4
	#005		Total Uranium[6]	4.5 ρCi/l	30 ρCi/l	3, 4
	#003		Plutonium-238	0.03 ρCi/l	See Pu-239/240	3, 4
	#009[14]		Plutonium-239/240	0.03 ρCi/l	40 ρCi/l (total Pu)	3, 4
	#009A[14]		Cobalt-60	6 ρCi/l	100 ρCi/l	3, 4
	(Tritium		Cesium-137	7 ρCi/l	200 ρCi/l	3, 4
	only)		Gamma Spec	5 X MDC[3]	5 X MDC[3]	NA[4]
	#004		Phenols	NA[4, 8]	NA[4, 8]	NA[4]
	#006[14]		Specific			
	#007		Conductance	NA[4, 8]	NA[4, 8]	NA[4]
			Metals	NA[4, 8]	NA[4, 8]	NA[4]
			TDS	NA[4, 8]	NA[4, 8]	NA[4]
			TOC	NA[4, 8]	NA[4, 8]	NA[4]
			VOC	NA[4, 8]	NA[4, 8]	NA[4]
			Nitrates	NA[4, 8]	NA[4, 8]	NA[4]
			Temperature	NA[4, 8]	NA[4, 8]	NA[4]
FIELD BLANK DEIONIZED WATER		1 blank per set of samples	Note 9	NA[4, 10]	NA[4, 10]	NA[4]
DOH Split Samples	As determined by the Department	As determined by the Department	As determined by the Department	As appropriate for analysis	As appropriate for analysis	3, 4

				ACTION LEVELS		
MEDIUM	LOCATION	TYPE, FREQUENCY	ANALYSIS	INVESTIGATION LEVEL	REPORTING LEVEL	ACTION CATEGORY[1]
DIRECT GAMMA DOSE (TLD)	NW, NE, SW, SE Corners and N, S, E, W Fence lines Fence line position(s) nearest each active disposal trench	Continuous, Quarterly	Tissue dose using TLDs	90 mrem/quarter	400 mrem/year	3, 4

NOTES Table 4.3

1) Table 4.4 presents the action required based upon action categories.
2) If Actinium-227 is listed on manifest or known to be present at concentrations required to be manifested, the reporting level is 2.0 E-13 μCi/cc.
3) The required minimum detection concentrations (MDCs) are listed in Table 4.2.
4) NA = Not applicable or none established.
5) Dry to wet ratio will be obtained.
6) Total uranium analysis is defined as the sum of the concentrations of uranium isotopes reported.
7) These are interim reporting levels.
8) Concentrations will be evaluated and reported annually in the environmental report.
9) Field blank analysis is the same as well sample analysis. Used for sample QA.
11) If a respirator is worn, the appropriate protection factor (e.g., PF = 50) can be used in determining whether or not the reporting level was exceeded.
12) Investigation level for MW 13 tritium is 5000 ρCi/l.
13) Iodine air sampling is only required when offloading or handling packages containing at least 1 mCi of iodine.
14) Background (station 1) or upgradient (MW-9, 9A, 6 and 13).

Table 4.4 Action Categories

Actions Required When Action Level Met or Exceeded

1. Type 1 Event
   Follow Reporting Level requirements
   Potential for bioassay examined by RPM.

2. Type 2 Event
   Immediate notification of on-site inspector
   Take corrective action

3. Investigation Level
   Notify the RPM
   Take corrective actions described in FSM 6.1.5

4. Reporting Level
   Notify the RPM and the Department.
   Take corrective actions described in FSM 6.1.5
   Make reports in accordance with FSM 6.1.4.C

5.0 ENVIRONMENTAL RADIATION PROTECTION PROGRAM AND DOSE ASSESSMENT

5.1 Air

Nine low-volume air samplers operating at 1.5 cfm are located around the perimeter of the facility. Particulate air filters were collected weekly such that a minimum of five days and a maximum of nine days collection time have accumulated. USEW uses in-house analysis for gross alpha and gross beta concentration determination. Historically, the amount of radioactive material collected on a filter during a week long period has been too small to accurately analyze for individual radionuclides of concern. Therefore, samples are combined into composite samples to increase the sensitivity and accuracy of the analysis. Particulate filters are composited quarterly and sent to the contract laboratory for gamma spectroscopy.

Three air monitoring stations also collect air moisture in desiccant cartridges operating at 150 cc/min. The desiccant cartridges operate continuously for at least 30 days per quarter and are sent to the contract laboratory for tritium analysis.

Station 1 is the control station for the facility located approximately 1,000 feet north of the receiving area. NUREG 1388 (Environmental Monitoring of Low-Level Radioactive Waste Disposal Facility) states:

> "Air monitoring should include fence line and offsite sampling. The locations of the sampling stations should be based on meteorological data (wind directions) and critical-group locations."

Station 1 is the only non-fence line sample in a wind neutral direction from waste operations, and is representative of air in our vicinity (200 Area of the Hanford Nuclear Reservation). The remaining 8 stations are in the predominantly downwind direction.

There are no defined critical groups for environmental dose assessment.

Iodine contained in waste shipments to the site have been infrequent and very low for the last decade, and iodine sampling has not detected iodine above the minimum detectable concentration. Iodine sampling is conducted in close proximity and downwind whenever waste packages containing at least 1 mCi of iodine are being handled. Iodine is sampled by collection on charcoal canisters and in-house analysis for iodine using low energy gamma detectors.

All air sample results were at background levels. There is no discernable increasing or decreasing trend in air sample results. See Appendix A for details on air emissions.

Cobalt-60 and cesium-137 are not detected in air sample gamma spec analysis on a consistent basis, no trend analysis is possible. Graphs are not provided.

Air sample station were not operating during the following intervals:

Date	*Station(s)*
7-5-2017	all
7-24-2017	1 and 9

The WAC 246-221-290 Table II column 1 levels are the air concentration that if a person breathed that concentration for an entire year, they would receive a dose of 50 mrem CEDE. To calculate a dose from an air sample, the average for the year is compared to the Table II value, and a dose assigned.

Dose (mrem) = $\frac{\text{Average corrected concentration}}{WAC\ 246-221-290\ table\ II\ col.1}$*50 mrem

Table 5.1 Air Average Concentrations and Estimated Dose

	Station 2-9, Average Concentration, (µCi/ml)	*Station 1 Average Concentration (µCi/ml)*	*All Station Corrected Average (µCi/ml)*	*Table II column 1*	*Dose in mrem/year*
Alpha	1.29E-15	1.45E-15	0	9E-14	0.0
Beta	2.59E-14	2.77E-14	0	6E-12	0.0
Tritium	6.45E-12	3.78E-12	2.67E-12	1E-7	0.0

5.2 Water

There are no water samples collected at this facility other than ground water.

5.3 Vegetation

Vegetation samples are collected annually at site perimeter sampling locations (nine environmental air-monitoring stations and the northeast and northwest site corners) provided there is at least one quarter with sufficient vegetation. Trench cap vegetation is monitored annually. The vegetation sampling procedure requires at least 300 grams of live deep-rooted vegetation to obtain a minimum sample.

All vegetation samples are analyzed for gross beta, gamma isotopic, uranium, and plutonium. In addition, trench cap vegetation is analyzed for tritium. Tritium monitoring of vegetation is experimental and there is no consensus opinion on interpretation of results. Vegetation samples are not analyzed for non-radiological constituents.

Two samples were reported as above the Reporting Level RL: Station 6 plutonium and Trench 16 cesium-137. Investigation of these results were inconclusive and suggested that the radioactive material detected was statistically consistent with radioactivity from other sources in our environment.

The following should be noted when reviewing vegetation sample results:

- Vegetation samples from Trench 11 include samples from both the 11A and 11B areas of the trench,
- Vegetation samples from Trench 13 includes samples from both sections of Trench 13 (stable and unstable portions),
- Vegetation samples from Trench 14 include samples from Trench 14, Trench 14W and the sample portion of Trench 14W.

Table 5.2 2017 Sites Not Sampled Due to Insufficient Vegetation

Sample location	*Reason for no sample*
Tank Farm	No vegetation present
Trench 3	Insufficient vegetation present
Trench 4A	Insufficient vegetation present
Trench 4B	Insufficient vegetation present

Vegetation Gross Beta Activity

All sample results from the stations and trench cap were equivalent to previous year's results. No vegetation samples exceeded the action level for gross beta activity of 100 pCi/g. Annual trench cap deep-rooted vegetation samples were taken in the second quarter of 2017.

The Department of Energy does not report gross beta concentrations in vegetation at the Hanford Reservation.

According to the National Council on Radiation Protection and Measurements in Environmental Radiation Measurements, gross beta activity is due mainly to potassium-40, lead-210, bismuth-210 and the uranium and thorium series (National Council on Radiation Protection and Measurement, 1976). NCRP 76 suggests background beta in vegetation is between 7.8 and 123 pCi/g.

Gross beta activity from both trench cap vegetation and environmental monitoring station vegetation samples are consistent with historical results for the facility and expected values throughout the world. None of these results indicate increasing trends.

Vegetation Total Uranium Concentration

Total uranium concentration in vegetation is measured using alpha spectroscopy, mathematically combining the concentration of U-234, U-235 and U-238.

No trend was observed in site perimeter vegetation samples.

Vegetation Plutonium Concentration

In 2017, vegetation samples from environmental monitoring stations and trench caps were analyzed for plutonium-238 and plutonium-239/240. One sample from Station 6 was above the

action levels for Plutonium 239. A reanalysis of the same sample found similar levels. A resample of Station 6 was less than the investigation level. It appears that the higher than usual results were caused by either laboratory contamination, or spurious airborne plutonium contamination generated from off site. There was no evidence that vegetation was absorbing plutonium from the site soils, as root uptake is expected to be very low.

Because there are insufficient positive results for plutonium in vegetation, no graphs are provided.

Vegetation Spectrometry Analysis of Gamma Emitters

In 2017, one sample from Trench 16 detected cesium-137. A resample from this area did not confirm the result, and surveys in the area did not detect elevated radiation levels. Our assumption is that this result is a spurious reading or from local or global fallout, and did not reflect contamination from our site.

There is insufficient data to trend or create a graph for cobalt-60 and cesium-137 in vegetation.

Trench Cap Vegetation Tritium

Trench cap vegetation are analyzed for tritium by extracting the water from the plant mass, and counting in a liquid scintillation counter.

Tritium exists in the vadose zone and ground water under our site, with the highest concentrations upgradient and north of the site in groundwater. The levels detected in samples are within the range of tritium concentration found in vegetation samples.

Except as noted, the 2017 tritium samples were within their normal range.

5.4 Soil

Soil samples are collected in order to detect long term buildup in soil of airborne radionuclides. The samples are collected from undisturbed soil from an area of 12 inches by 12 inches by one inch deep. Analyses include gross beta, total uranium, isotopic plutonium, and gamma emitting radionuclides. Soil samples were collected in March and October in 2017.

The following table compares DOE limits to USEW limits. Soil concentrations in upwind areas may be 4 orders of magnitude higher than the concentration limits imposed by WDOH.

Table 5.3 Comparison of DOE and USEW Soil Concentration Limits

Contaminant	DOE Accessible Soil Limit† (pCi/g)	USEW Investigation/Action Level (pCi/g)
Cobalt-60	7.1	0.3
Strontium-90	2,800	35 (gross beta)
Cesium-137	30	0.25
Uranium-234	630	1 (Total U)
Uranium-235	170	1 (Total U)
Uranium-238	370	1 (Total U)
Plutonium-239/-240	190	0.03

†Hanford Site soil that is not behind security fences; refer to (Rittmann, 1992).

Gross Beta in Soil

Soil samples were within the gross beta action level of 35 pCi/g (dry). Comparison of 2017 results with data available from previous years shows gross beta concentrations remaining consistent. Any variation is probably due to sampling and analysis uncertainties, and not changes in the soil concentrations. Gross beta in soil results have not been provided in recent Hanford Near Facility Environmental Reports (U.S. Department of Energy, September 2017). USEW gross beta results are similar to undisturbed areas of Hanford historical results. (Pacific Northwest National Labs, 2008)

Uranium in Soil

Total uranium concentration in soil is measured using alpha spectroscopy, mathematically combining the concentration of U-234, U-235 and U-238.

The results show uranium concentrations are consistent with soils in the Hanford area.

One sample from Station 3 was found to contain total uranium in excess of the investigation level. Resampling did not confirm the initial result. There were no apparent causes for this elevated level. The concentration found is not inconsistent with background levels.

Trend analysis shows that concentrations are within the usual range.

Plutonium in Soil

Soil samples from environmental monitoring stations were analyzed for plutonium-238 and plutonium-239/240. Station 7 and 8 in the October samples were above the requested MDA of 0.01 pCi/g.

Trend analysis is conducted by ensuring the levels are routinely below the detection levels. No graphs are provided for plutonium isotopes.

Gamma Emitting Radionuclides in Soil

Investigation levels are set at five times the theoretical MDC with the exception of cesium-137 and cobalt-60 which are set at 0.25 and 0.3 pCi/g respectively. None of the soil samples exceeded the investigation levels. The northeast corner, Station 1 (background) samples, and the Northwest corner to a lesser extent are higher than the other stations.

Trend analysis consists of ensuring gamma emitting radionuclides are below the MDC limit, no graphs are provided.

5.5 Direct Gamma

Penetrating radiation is measured at numerous site perimeter locations using TLD. These locations define the site boundary where an individual not associated with LLRW site operation could be exposed to external radiation from the site.

Penetrating radiation is measured at the following locations:

- One on each of the east and south fence lines and two on the north and west fence lines
- One at each of the northeast, northwest, southeast, and southwest facility corners
- One on the fence line at the closest point to each active disposal unit
- One every 200 feet adjacent to Trench 18
- A background TLD positioned at environmental air monitoring station number one
- One TLD on the east fence across from the High Radiation Storage area

TLD locations are shown on Figure 2.1.

The maximum TLD station for 2017 is 93 mrem at Station 12, or 23.3 mrem when the 25% occupancy factor is used. Station values can be found in attachment G, H or J. This value was calculated using the following equation:

$$Dose\ (mrem) = \left(\sum quarterly\ dose\ at\ maximum\ station\right) \times 0.25\ occpancy\ factor.$$

Environmental TLDs are supplied by Mirion Technologies, Inc. The minimum reportable exposure is one mrem.

5.6 Dose Assessment

The dose to members of the general public was calculated using the following equation:

$$Dose\ \left(\frac{mrem}{year}\right) = Maximum\ direct\ gamma\ dose\ \left(\frac{mrem}{year}\right) +$$

$$Dose\ from\ air\ station\ result\left(\frac{mrem}{year}\right)$$

Table 5.4 Tabular Reporting of Annual Dose

Pathway	*Dose (mrem)*	*Limit from License (mrem)*	*Limit in Air Emissions (mrem)*
Air (fence)	0.00	25	N/A
Air (Cap88)	1.1E-4	N/A	1

Direct Gamma	23	100	N/A
All pathway	23	100	N/A

5.7 Maximally Exposed Individual (MEI)

The MEI is a hypothetical person whose location and lifestyle is unlikely to exist, but is used as the pathway for radiation dose from possible effluents from the site. This exposure pathway scenario is chosen to represent a hypothetical upper bound of potential dose to an individual, rather than an anticipated or actual dose. There is no established MEI at USEW; rather dose is calculated using the highest values from the fence line measurements.

USEW inspects the fence daily during operations. In 2017, there were no people living at or near the fence line of this facility. Any calculated dose is purely hypothetical.

The potential effluents that could cause a dose to the MEI are contaminants in the air.

5.8 Comparison to the 25 mrem per Year Limit

Washington Administrative Code (WAC) 246-250-160 requires that the site is operated so that reasonable assurance exists that exposures to individuals are within the requirements established in the performance objectives in WAC 246-250-170 through 246-250-200. Among other things, they require specifically that the dose *from effluents* to any member of the public is less than 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ. While this dosimetry scheme is not easily defined using ICRP 26/30 (International Commission on Radiological Protection, 1977) methodology that the current regulations are based on, USEW will show that the Committed Effective Dose Equivalent (CEDE) from effluents are less than 25 mrem per year from air emissions.

The estimated average annual dose from the air pathway is 1.1E-4 mrem per year for 2017.

5.9 Outside the Fence Monitoring Activities

USEW does not monitor for radionuclides outside of the immediate area of the waste site.

6.0 GROUNDWATER

USEW samples groundwater at 10 well locations to detect the presence of possible contamination from facility operations or other activities on the Hanford Reservation. Wells 3, 4, 5, 7, 8 and 10 are down gradient and Wells 6, 9, 9a and 13 are upgradient. Well 7 is to the northwest of the expected groundwater flowing under our facility. The groundwater samples were analyzed for potential radiological and chemical contaminants.

Groundwater Well 10 was replaced in 2017 due to the failure of the installed bladder pump. Because of this failure, all samples for the first quarter for Well 10 were collected from the evacuation pump. Likewise, Well 5 in the 2nd quarter was sampled from the evacuation pump due to a mechanical issue with the bladder pump. The pump in Well 5 was repaired without removing it from the well.

6.1 Groundwater Gross Alpha and Beta Activity

Gross beta and gross alpha are sensitive methods of detecting radioactivity in groundwater. Gross alpha and gross beta measurements are useful for screening and identifying trends in

radionuclide concentrations. However, the variability in naturally occurring radioactivity hinders distinguishing between naturally occurring radioactivity and low level contamination that may have migrated to groundwater. In addition, the USEW site is located down-gradient from the Hanford 200 West area that contains process facilities which have impacted groundwater, adding to the naturally occurring alpha and beta emitting radionuclides.

There are no indications of increased gross alpha activity in any groundwater locations. Gross alpha results from upgradient and down gradient wells are similar. In addition, all values are less than investigation levels, are consistently close to the minimum detectable concentrations and within their historic range. Gross alpha showed no observable trends.

The Environmental Protection Agency (EPA) has set a maximum contaminant level (MCL) of 15 pCi/l for gross alpha in drinking water.

There were no indications of increased gross beta activity in any groundwater samples attributed to USEW operations. Gross beta activity in the upgradient wells appear to be impacted by a Tc-99 plume under our site originating at DOE facilities upgradient. There was one gross beta result (Well 13 2nd quarter) above our investigation level, but it was attributed to DOE activity.

6.2 Groundwater Tritium, Carbon-14, and Technetium 99

Tritium is present in groundwater at the Hanford site due to both natural processes and previous tritium contaminated liquid waste ground discharges from Hanford Department of Energy facilities. As presented in DOE's Hanford Site Environmental Report 2017, tritium concentrations can exceed 200,000 pCi/l in the regions surrounding the 200 East and 200 West areas. As expected, tritium contamination from these plumes is affecting the levels observed in USEW monitoring wells. Since down-gradient wells tend to have lower tritium concentrations than upgradient wells, there appears to be no detectable increase in groundwater tritium due to USEW operations.

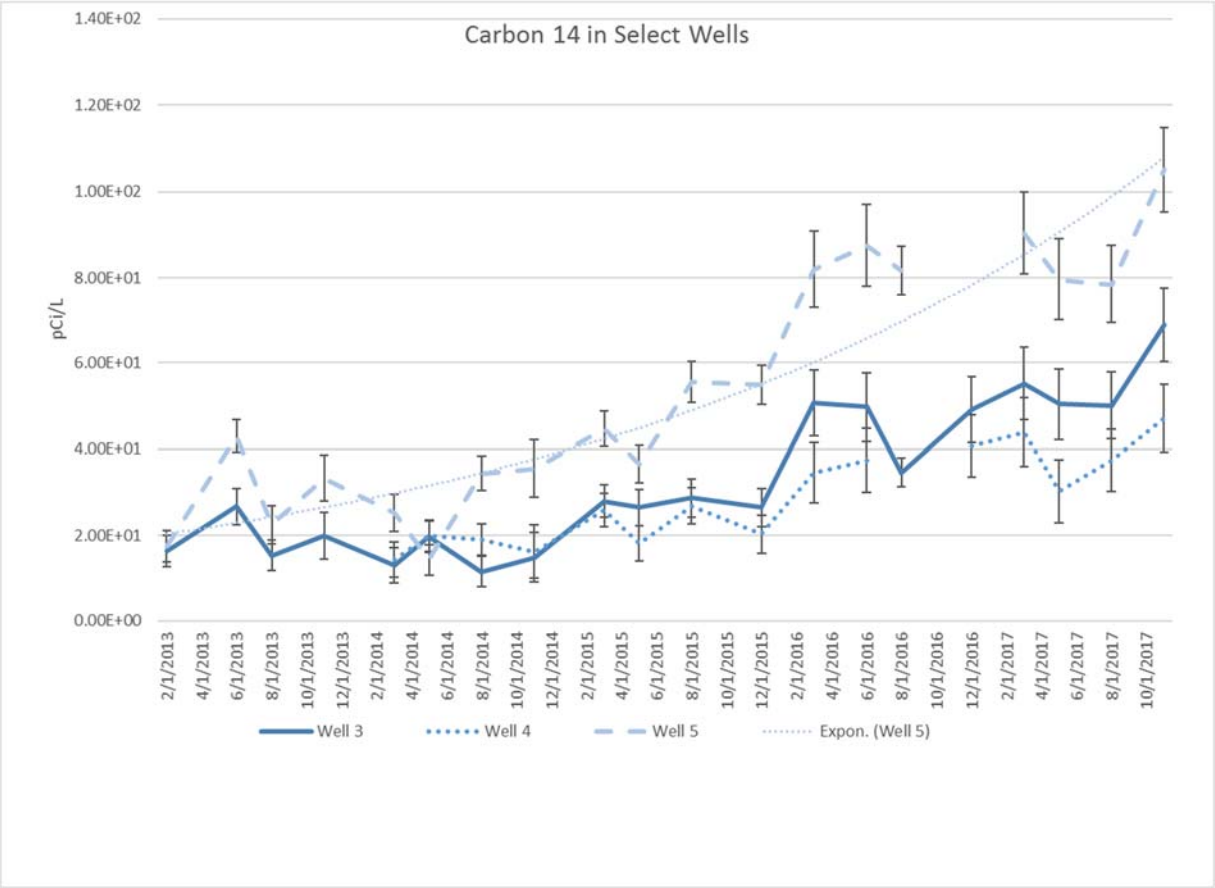
MW-9 and 9a are upgradient wells that draw their samples from the same location but at different depths. MW-9a is completed deeper than MW-9 at approximately the center of the unconfined aquifer (345' to 375' below the surface).

The 2017 Hanford Site Groundwater Monitoring Report shows several plumes following the tritium plume. Some constituents are fully dissolved in the groundwater and migrate with the groundwater flow, as is the case for tritium, while others interact with the aquifer sediment to some degree (i.e., “sorb” by either adsorption or precipitation) and migrate at a slower rate than the groundwater flow. For example strontium-90 which strongly sorbs to aquifer sediments would move slowly in comparison to tritium. Technetium 99 dissolves easily and is not readily removed in interactions with soil, causing it to move with ground water. The C-14 migration rate is greatly dependent on the chemical species that contains the radioactive carbon.

Although well below investigation levels, wells MW-3, 4 and 5 appear to have slightly higher carbon-14 concentrations than the other wells. Most of the well concentrations are at the detection limits. The concentration in MW-3, 4, and 5 appear to be increasing with time. MW-5 appears to have the highest concentration, and the greatest rate of increase. The increase appears to coincide with the change in laboratories in 2016. In the chart below, 2 data points were rejected as anomalies (MW-5 from November 29 2016 and MW-4 from August of 2016). One explanation of this increase is that carbon 14 is increasing in these wells. It could also be that the lab used after 2016 is slightly different from the previous lab, and a step increase occurred in

2016. There is insufficient data points to determine which is correct. These levels are lower than the investigation levels, and below the national drinking water standard. These well sample results are of interest and should continue to be monitored.

Figure 6-1 Carbon 14 in Select Wells



The concentration of carbon-14 that would lead to a 4 mrem per year exposure using the assumptions of the EPA drinking water standards is 2000 pCi/l. The investigation level for carbon-14 is 250 pCi/l.

Analysis for technitium-99 in groundwater was started in 2000. Technitium-99 appears to follow a similar concentration pattern as tritium and gross beta. Technitium-99 has similar transportation in groundwater properties to tritium, and was disposed in a similar fashion by DOE at Hanford. Technitium-99 is the largest contributor to gross beta in the upgradient wells. The concentration of technitium-99 that would result in a 4 mrem per year exposure using the assumptions of the EPA drinking water standards is 900 pCi/l.

6.3 Groundwater Gamma Emitting Radioisotopes in Groundwater

Water samples are analyzed by gamma spectrometry. No results exceeded 5 times the MDAs for man-made gamma emitting radioisotopes in groundwater in 2017. Therefore, site operations had no discernible effect on groundwater gamma emitting isotope concentrations.

There are no graphs for gamma spec in groundwater, and the trend analysis is simply to confirm that the levels remain less than the detection level of the analysis.

6.4 Groundwater Plutonium

Groundwater samples taken from site monitoring wells were analyzed for plutonium-238 and plutonium-239/240. No samples exceeded investigation levels. All samples in 2017 are below the MDA. Graphs are not provided for plutonium. Trend analysis is to confirm that the concentration continues to remain below detection levels.

Studies of the Hanford site indicate that plutonium should not migrate to groundwater. For example, PNNL-18640 Transuranic Contamination in Sediment and Groundwater at the U.S. DOE Hanford Site (Cantrell, PNNL 18640, 2009) states:

> "The primary reason that disposal of these large quantities of transuranic radionuclides directly to the vadose zone at the Hanford Site has not resulted in widespread groundwater contamination is that under the typical oxidizing and neutral to slightly alkaline pH conditions of the Hanford vadose zone, transuranic radionuclides (plutonium and americium in particular) have a very low solubility and high affinity for surface adsorption to mineral surfaces common within the Hanford vadose zone. Other important factors are the fact that the vadose zone is typically very thick (hundreds of feet) and the net infiltration rate is very low due to the desert climate."

The experience of the Hanford site also implies that given the groundwater conditions at Hanford, plutonium should not migrate even if it makes it to groundwater. The plutonium mobility study (Cantrell, PNNL -017839, 2008) states:

> "...both Pu(V) complexes and Pu(IV)O2(am) colloids or nanoclusters are well known for their high adsorption affinity for oxide and hydroxide mineral surfaces. As a result, these species are not likely to remain in solution as pH values approach those of typical Hanford Site groundwater (mildly alkaline, ~ pH 8)."

The EPA has a generic limit for alpha emitters such as plutonium of 15 pCi/l for drinking water standards.

6.5 Groundwater Uranium

Total uranium consists of the sum of uranium-234, 235 and 238 concentrations. All total uranium sample concentrations were less than the investigation level. The EPA has a limit for uranium of 30 µg/l for drinking water (the specific activity of natural uranium is 0.711 pCi/µg).

Uranium in MW-8 is slightly higher than the upgradient well MW-13. The difference is very small, but measureable and consistent. While statistically different, the observation is not specifically an indication that contaminants from the waste site have reached the groundwater. The concentrations of uranium are decreasing slightly. If the waste site were contributing to the contaminants, the downstream concentration would be increasing. The difference is probably a function of the overall decrease in the volume of water in the aquifer, the different hydraulic gradients of these two wells, coupled with uranium plumes from Hanford operations and the continued efforts by Hanford to remove contaminants from the 200 UP area. This phenomenon should be reviewed each year.

6.6 Non-radiological Analysis

The procedure for gathering non-radiological samples was the same as that for radiological samples with the exception that non-radiological samples are placed in an ice chest and are cooled.

Groundwater samples were analyzed for specific conductivity, total organic carbon (TOC), total organic halogens (TOX), nitrates, chlorides, sulfates, dissolved solids, benzene, ethyl-benzene, toluene and xylene. Groundwater is also analyzed for the following 40 CFR 264, Appendix IX constituents: barium, cadmium, chromium, mercury, and silver. Analysis also includes potassium, calcium, magnesium, manganese, iron, and sodium. Comparison of down gradient Wells 3, 4, 5, 7, 8, and 10 to the upgradient Wells 6, 9, and 13 show no discernible difference in Appendix IX metals or other metals. Appendix G (electronic database) contains the 2017 analytical data for non-radiological contaminants.

Table 6.2 shows the Minimum Detectable Concentrations (Detection Levels - DL) for non-radiological well sampling constituents.

The DOE groundwater reports provide additional information supporting the impact of 200 West DOE activities on USEW's monitoring wells. The 200-UP groundwater interest area includes the 200-UP-1 groundwater operable unit (OU) in the southern portion of the 200 West Area, and adjacent portions of the surrounding 600 Area. With the exception of the Environmental Restoration Disposal Facility, the facilities and waste sites within 200-UP are associated with early operation of the Reduction-Oxidation Plant (plutonium and uranium separation) and U Plant (uranium recovery). U.S. Department of Energy (DOE) conducts groundwater monitoring in 200-UP under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) for the 200-UP-1 OU and the ERDF; and under the Resource Conservation and Recovery Act of 1976 for Waste Management Area (WMA) S-SX, WMA U, and the 216-S-10 Pond and Ditch. Monitoring of radionuclides is also performed to meet the Atomic Energy Act of 1954 (AEA) requirements.

DOE groundwater monitoring within the 200-UP-1 OU is performed under a sampling schedule incorporated into the Remedial Design/Remedial Action work plan (DOE/RL-2013-07). Technetium-99, uranium, tritium, iodine-129, nitrate, chromium, and carbon tetrachloride form extensive groundwater plumes in the area. These contaminants originated from operations in this area except for carbon tetrachloride which has migrated into 200-UP from 200-ZP. The contaminants chloroform, 1,4-dioxane, strontium-90, selenium-79, and trichloroethene (TCE) have been found in groundwater to a limited extent and are routinely sampled in selected wells. (U.S. Department of Energy, September 2017).

It is expected that plumes from 200 West will continue to have a slowly increasing effect on USEW's groundwater. The effect will probably continue to be detectable gross beta, technitium-99 and tritium along with the chemicals discussed above.

Groundwater data showed no indication of scintillation cocktail constituents of benzene, ethyl benzene, toluene, and xylene.

Wells 3, 4, and 5 analyses consistently detect TCE, chloroform, and hexavalent chromium. In the first quarter 2017, TCE was detected in well 9. TCE undergoes a degradation to a number of other chemicals, including 1,1-dichloroethene, 1,2-dichloroethene (cis- and trans-), and chloromethane (i.e., vinyl chloride). Two of the TCE degradation products are routinely detected in wells 3, 4 and 5 (cis-1,2 Dichloroethene and 1,1-Dichloroethene). Trans -1,2-

Dichloroethene was detected in Well 5 in 2017. Chloroform is detected in all wells with the highest concentrations in wells 3, 4 and 5.

Chromium was detected in all wells. Hexavalent chromium is also analyzed in all wells, and shows no statistical difference from chromium concentrations. There is a chromium plume under the site that originated in the Hanford 200 West Area from previous DOE operations. The 2016 Hanford Environmental Report (U.S. Department of Energy, September 2017) shows the USEW site on top of the estimated plume location, with the center of the plume (and higher concentrations) coming in the future. The DOE estimates that hexavalent chromium exists under our site at concentrations up to 480 µg/l. This contamination is attributed to two primary sources: an overfill event of 91,000 L (24,000 gal) from Tank S-104 in the S Tank Farm (Sections 3.7.2 and 4.6 in RPP-RPT-48589, *Hanford 241-S Farm Leak Assessment Report*), and a 190,000 L (51,000gal) leak from Tank SX-115 during 1965 in the SX Tank Farm. (Field, Fort, Shrum, & Wood, 2011)

The Record of Decision (ROD) for the 200-UP-1 OU was published in 2012 (U.S. Department of Energy, 2012). The effect of this ROD is that eventually a pump and treat well network and a hydraulic containment network will be installed to mitigate or contain the various plumes in the eastern part of the OU, which includes USEW. There has been some work occurring near our site (well drilling and monitoring), but the results or discussion on these activities have not been published. It is expected that several wells will help to define the southern limits of the chromium plume. It is also expected that the pump and treat system will include injection wells and extraction wells, and use existing water treatment facilities in the 200 West area.

Table 6.1 Typical Chemical Reporting and Detection Levels

Analyte Description	CAS Number	MDL	Units
Acetone	67-64-1	0.554	µg/L
Benzene	71-43-2	0.100	µg/L
Bromobenzene	108-86-1	0.119	µg/L
Bromochloromethane	74-97-5	0.143	µg/L
Bromodichloromethane	75-27-4	0.138	µg/L
Bromoform	75-25-2	0.170	µg/L
Bromomethane	74-83-9	0.250	µg/L
2-Butanone (MEK)	78-93-3	0.469	µg/L
n-Butylbenzene	104-51-8	0.181	µg/L
sec-Butylbenzene	135-98-8	0.164	µg/L
tert-Butylbenzene	98-06-6	0.181	µg/L
Carbon disulfide	75-15-0	0.100	µg/L
Carbon tetrachloride	56-23-5	0.181	µg/L
Chlorobenzene	108-90-7	0.109	µg/L
Dibromochloromethane	124-48-1	0.143	µg/L
Chloroethane	75-00-3	0.163	µg/L
Chloroform	67-66-3	0.100	µg/L
Chloromethane	74-87-3	0.102	µg/L
2-Chlorotoluene	95-49-8	0.153	µg/L
4-Chlorotoluene	106-43-4	0.154	µg/L
Dibromomethane	74-95-3	0.210	µg/L
1,2-Dichlorobenzene	95-50-1	0.100	µg/L
1,3-Dichlorobenzene	541-73-1	0.106	µg/L
1,4-Dichlorobenzene	106-46-7	0.100	µg/L
Dichlorodifluoromethane	75-71-8	0.138	µg/L
1,1-Dichloroethane	75-34-3	0.0700	µg/L
1,2-Dichloroethane	107-06-2	0.215	µg/L
cis-1,2-Dichloroethene	156-59-2	0.100	µg/L
trans-1,2-Dichloroethene	156-60-5	0.103	µg/L
1,1-Dichloroethene	75-35-4	0.100	µg/L
1,2-Dichloropropane	78-87-5	0.100	µg/L
1,3-Dichloropropane	142-28-9	0.100	µg/L
2,2-Dichloropropane	594-20-7	0.177	µg/L
cis-1,3-Dichloropropene	10061-01-5	0.158	µg/L
trans-1,3-Dichloropropene	10061-02-6	0.100	µg/L
1,1-Dichloropropene	563-58-6	0.104	µg/L
Ethylbenzene	100-41-4	0.122	µg/L
Hexachlorobutadiene	87-68-3	0.100	µg/L
2-Hexanone	591-78-6	0.248	µg/L
Isopropylbenzene	98-82-8	0.167	µg/L
p-Isopropyltoluene	99-87-6	0.171	µg/L
Methylene Chloride	75-09-2	0.270	µg/L
4-Methyl-2-pentanone (MIBK)	108-10-1	0.216	µg/L
Methyl tert-butyl ether	1634-04-4	0.146	µg/L
Naphthalene	91-20-3	0.208	µg/L
N-Propylbenzene	103-65-1	0.164	µg/L
Styrene	100-42-5	0.134	µg/L
1,1,1,2-Tetrachloroethane	630-20-6	0.117	µg/L
1,1,2,2-Tetrachloroethane	79-34-5	0.100	µg/L
Tetrachloroethene	127-18-4	0.180	µg/L
Toluene	108-88-3	0.140	µg/L
1,2,3-Trichlorobenzene	87-61-6	0.174	µg/L
1,2,4-Trichlorobenzene	120-82-1	0.100	µg/L
1,1,1-Trichloroethane	71-55-6	0.171	µg/L
1,1,2-Trichloroethane	79-00-5	0.132	µg/L
Trichloroethene	79-01-6	0.250	µg/L
Trichlorofluoromethane	75-69-4	0.110	µg/L
1,2,3-Trichloropropane	96-18-4	0.183	µg/L
1,2,4-Trimethylbenzene	95-63-6	0.170	µg/L
1,3,5-Trimethylbenzene	108-67-8	0.163	µg/L
Vinyl acetate	108-05-4	0.180	µg/L
Vinyl chloride	75-01-4	0.194	µg/L
Xylenes, Total	1330-20-7	0.274	µg/L
Barium	7440-39-3	0.000900	mg/L
Cadmium	7440-43-9	0.000200	mg/L
Calcium	7440-70-2	0.0450	mg/L
Chromium	7440-47-3	0.00400	mg/L
Iron	7439-89-6	0.0200	mg/L
Magnesium	7439-95-4	0.0200	mg/L
Manganese	7439-96-5	0.000900	mg/L
Potassium	7440-09-7	0.0450	mg/L
Silver	7440-22-4	0.000900	mg/L
Sodium	7440-23-5	0.0200	mg/L
Mercury	7439-97-6	0.0000600	mg/L
Chloride	16887-00-6	0.0200	mg/L
Sulfate	14808-79-8	0.0500	mg/L
Nitrate as N	14797-55-8	0.00700	mg/L
Total Dissolved Solids (TDS)	STL00242	3.50	mg/L
Halogens, Total Organic	STL00249	7.70	µg/L
Phenols, Total	64743-03-9	0.00680	mg/L
TOC Result	STL00338	0.155	mg/L
Total Organic Carbon - Average	7440-44-0	0.155	mg/L
Cr (VI)	18540-29-9	0.00150	mg/L

6.3 Groundwater Elevations

The elevation above the datum for the depth to water and depth to bottom are shown in the following tables. In January 2014, the wells were surveyed by Rogers Surveying and the elevation of each sounding tube values were corrected. The values shown in this table represent the readings in depth to water from the sounding tube top corrected for the new datum (NAVD88, North American Vertical Datum of 1988). Previous elevations were found using the NAVD29 datum, and other unknown factors created unexplained differences. USEW is located in an area between a steep hydraulic gradient and a shallow gradient. Water flows from the southwest to the northeast.

Table 6.2 Well Depth to Bottom (DTB)

Date	*Location*	*Measurement type*	*Measurement*	*Units*	*Conversion to NAVD88 datum (ft)*	*Depth (Ft, above datum=0)*
3/13/2017	Well 6	DTB	369.2	Ft	**736.86**	**367.66**
3/13/2017	Well 13	DTB	352	Ft	**728.9**	**376.90**
3/13/2017	Well 9	DTB	352.9	Ft	**727.25**	**374.35**
3/14/2017	Well 9a	DTB	378.4	Ft	**727.37**	**348.97**
3/14/2017	Well 5	DTB	352.46	Ft	**727.05**	**374.59**
3/14/2017	Well 8	DTB	349.9	Ft	**730.08**	**380.18**
3/15/2017	Well 10	DTB	364.64	Ft	**739.72**	**375.08**
3/15/2017	Well 7	DTB	378	Ft	**750.28**	**372.28**
3/15/2017	Well 4	DTB	369.9	Ft	**735.11**	**365.21**
3/16/2017	Well 3	DTB	354	Ft	**729.02**	**375.02**

DTB = Depth to Bottom of well case.

Table 6.3 Groundwater Elevations (feet)

Date	*Location*	*Measurement Type*	*Measurement*	*Units*	*Conversion to NAVD88 datum (ft)*	*Depth (ft above datum)*
3/13/2017	Well 6	DTW	334.62	Ft	**736.86**	**402.24**
3/13/2017	Well 13	DTW	323.9	Ft	**728.9**	**405.00**
3/13/2017	Well 9	DTW	323.7	Ft	**727.25**	**403.55**
3/14/2017	Well 9a	DTW	324.04	Ft	**727.37**	**403.33**
3/14/2017	Well 5	DTW	327.16	Ft	**727.05**	**399.89**
3/14/2017	Well 8	DTW	330.44	Ft	**730.08**	**399.64**
3/15/2017	Well 10	DTW	340	Ft	**739.72**	**399.72**
3/15/2017	Well 7	DTW	350.68	Ft	**750.28**	**399.60**
3/15/2017	Well 4	DTW	335.46	Ft	**735.11**	**399.65**
3/16/2017	Well 3	DTW	329.84	Ft	**729.02**	**399.18**
5/22/2017	Well 6	DTW	334.72	Ft	**736.86**	**402.14**
5/22/2017	Well 13	DTW	324.04	Ft	**728.9**	**404.86**
5/22/2017	Well 9	DTW	323.85	Ft	**727.25**	**403.40**
5/23/2017	Well 9a	DTW	324	Ft	**727.37**	**403.37**
5/23/2017	Well 5	DTW	327.24	Ft	**727.05**	**399.81**
5/23/2017	Well 8	DTW	330.38	Ft	**730.08**	**399.70**
5/24/2017	Well 10	DTW	340.24	Ft	**739.72**	**399.48**
5/24/2017	Well 7	DTW	350.87	Ft	**750.28**	**399.41**
5/24/2017	Well 4	DTW	335.49	Ft	**735.11**	**399.62**
5/25/2017	Well 3	DTW	329.48	Ft	**729.02**	**399.54**
8/14/2017	Well 6	DTW	334.82	Ft	**736.86**	**402.04**
8/14/2017	Well 13	DTW	324	Ft	**728.9**	**404.90**
8/14/2017	Well 9	DTW	323.86	Ft	**727.25**	**403.39**
8/15/2017	Well 9a	DTW	324.16	Ft	**727.37**	**403.21**
8/15/2017	Well 5	DTW	327.38	Ft	**727.05**	**399.67**
8/15/2017	Well 8	DTW	330.57	Ft	**730.08**	**399.51**
8/16/2017	Well 10	DTW	340.22	Ft	**739.72**	**399.50**
8/16/2017	Well 7	DTW	350.85	Ft	**750.28**	**399.43**
8/16/2017	Well 4	DTW	335.65	Ft	**735.11**	**399.46**
8/17/2017	Well 3	DTW	329.58	Ft	**729.02**	**399.44**
11/13/2017	Well 6	DTW	334.44	Ft	**736.86**	**402.42**
11/13/2017	Well 13	DTW	323.7	Ft	**728.9**	**405.20**
11/13/2017	Well 9	DTW	323.5	Ft	**727.25**	**403.75**
11/14/2017	Well 9a	DTW	324.2	Ft	**727.37**	**403.17**
11/14/2017	Well 5	DTW	327.43	Ft	**727.05**	**399.62**
11/14/2017	Well 8	DTW	330.52	Ft	**730.08**	**399.56**
11/15/2017	Well 10	DTW	340.72	Ft	**739.72**	**399.00**
11/15/2017	Well 7	DTW	350.43	Ft	**750.28**	**399.85**
11/15/2017	Well 4	DTW	335.12	Ft	**735.11**	**399.99**
11/16/2017	Well 3	DTW	329.14	Ft	**729.02**	**399.88**

DTW = Depth to Water

Figure 6.2 Groundwater Elevation Trend

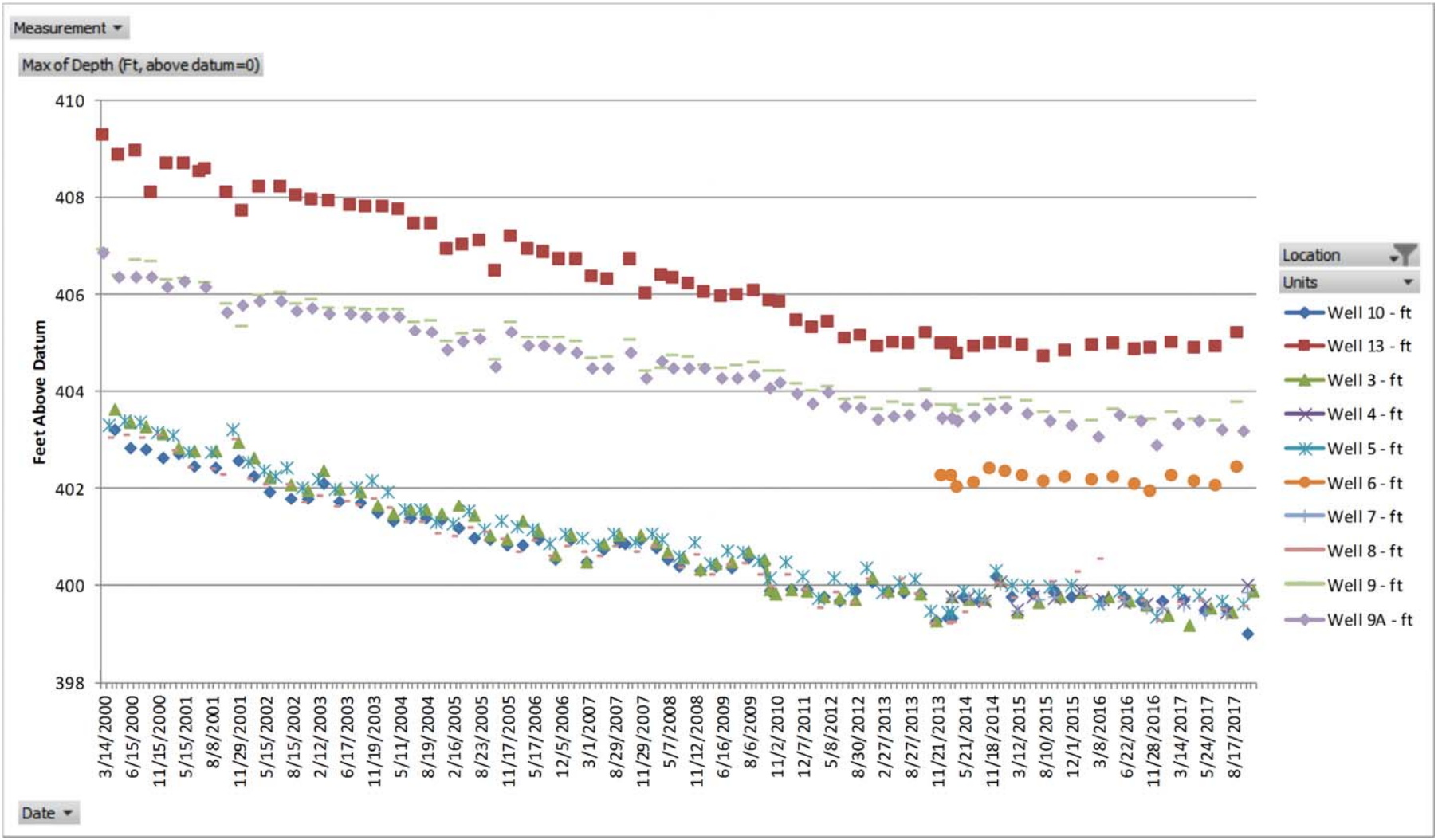
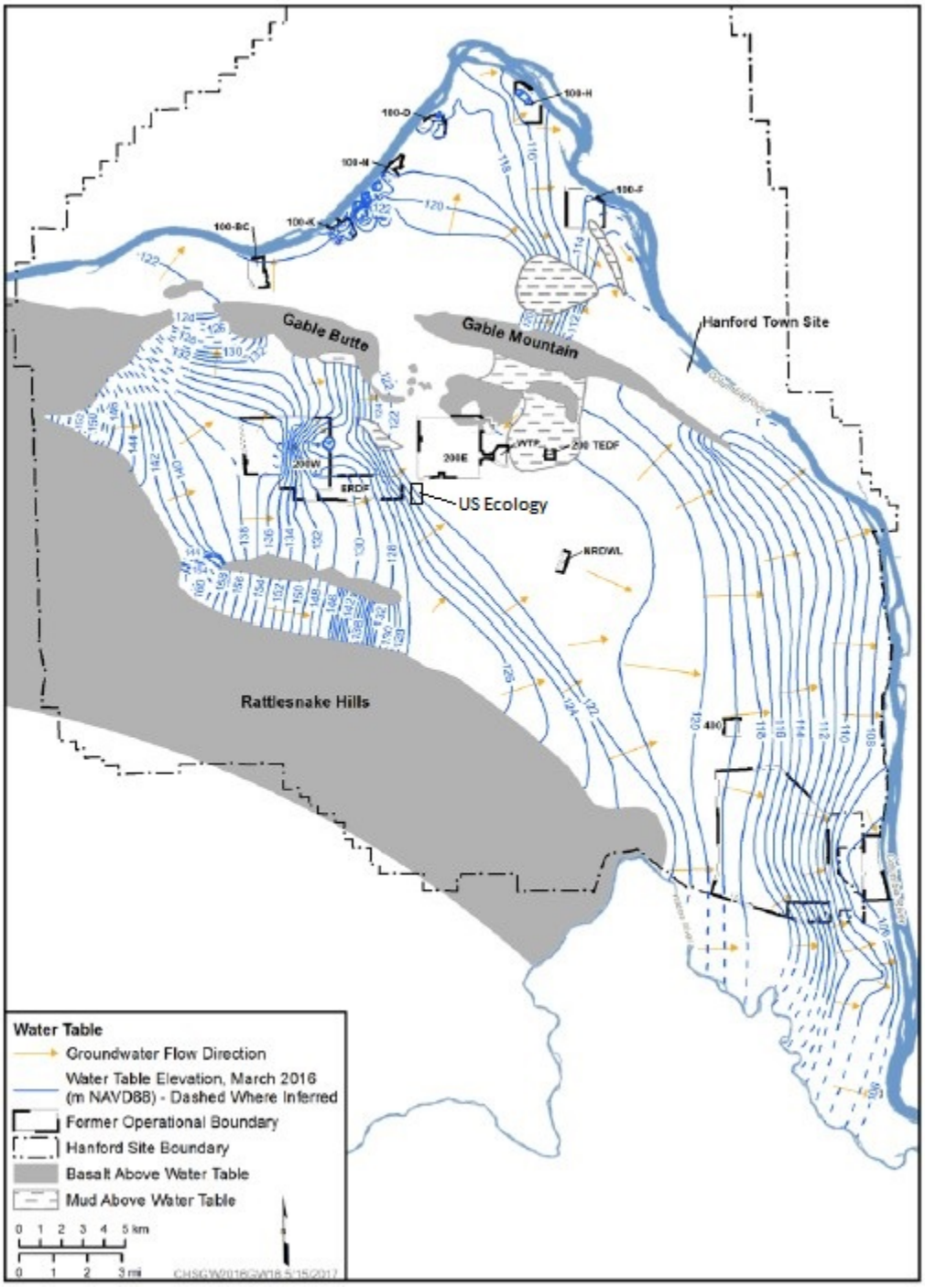


Figure 6.3 Hanford Site Water Table and Direction of Groundwater Flow.



(U.S. Department of Energy, September 2017) Elevation in meters.

6.8 Special Water Sampling

No special water sampling was conducted in 2017.

6.9 Comparison of USEW Data with Surrounding Department of Energy Wells

Below are wells that are generally in an upgradient direction that contain tritium, uranium and technetium-99. The location can be found by consulting the Phoenix website. These are contaminants that are routinely found in USEW well water. In addition, these contaminants will be removed from groundwater by water treatment plants in the 200-UP operating unit.

DOE is building 7 new groundwater remediation wells in the vicinity of the USEW site. Three injection wells are being built to the west of the USEW site to contain the tritium plume, and four wells are being built to the southwest to treat the chromium plume.

Table 6.4 Upgradient DOE Wells

DOE Well Number	*Analyte*	*Date Sampled*	*Result pCi/l*
699-35-66A	Tritium	3/9/2017	60,600
699-32-62	Tritium	4/11/2016	5330
699-36-61A	Tritium	6/19/2017	53,600
699-34-61	Tritium	3/17/2017	7230
699-35-66A	Technitium-99	9/27/2017	154
699-32-62	Technitium-99	11/7/2012	34
699-36-61A	Technitium-99	6/19/2016	11.1
699-34-61	Technitium-99	10/1/2013	35
699-35-66A	Uranium	9/27/2017	1.89
699-32-62	Uranium	04/05/2017	2
699-36-61A	Uranium	6/19/2017	1.7
699-34-61	Uranium	3/17/2016	1.84

(Pacific Northwest National Laboratory, n.d.)

7.0 QUALITY ASSURANCE

7.1 Corporate Policy Concerning Quality Assurance

"The policy of USEW, a wholly owned subsidiary of US Ecology Inc., is to consistently and professionally provide our clients a service that achieves a level of quality, meeting or exceeding defined industry and regulatory requirements, as well as ethical standards. USEW's objective is to maintain a Quality Assurance

(QA) Program representative of appropriate industry standards. The requirements contained in this QA Manual apply to all USEW quality-related activities.

This manual describes the QA Program developed by USEW and reflects the quality assurance requirements of NUREG 1293, titled "Quality Assurance Guidance for a Low-Level Radioactive Waste Disposal Facility". In instances where additional project specific requirements are imposed, a project Quality Assurance Program Plan (QAPP) will identify the associated requirements.

The President of US Ecology, Inc. has ultimate responsibility for all activities performed in accordance with this Quality Assurance Manual. The Quality Assurance and Regulatory Compliance Coordinator (QA&RCC) is assigned the responsibility and authority to organize and maintain the QA program and assures its implementation. The QA&RCC has the organizational freedom to identify quality problems, initiate, recommend and provide solutions to quality problems." (US Ecology Washington, 2012)

7.2 Quality Assurance Plan Summary

The USEW Quality Assurance Plan is described in (US Ecology Washington, 2012). USEW procedures are contained in (US Ecology Washington, 2014). The basis for development of the site QA plan is NUREG 1293, Rev 1, April, 1991. The procedures for conducting sampling and the statistical methods used to analyze and validate the sample data are contained in the Richland Operating Procedures (Appendix E).

Internal surveillances are conducted per the schedules of the QA manual (US Ecology Washington, 2012). In 2017, there were five surveillances conducted of environmental monitoring operations.

Qualified Radiation Control and Safety Technicians (RC&STs) collect environmental samples in accordance with operational procedures contained in the USEW Richland Operating Procedures Manual. RC&ST qualification covers all aspects of the environmental monitoring program and includes training, demonstration of practical factors, and written and oral examinations.

Test America Laboratories Richland (TALR) performs the routine radiochemical and chemical analyses of environmental monitoring samples. TALR maintains an internal quality assurance program that involves routine calibration of counting instruments, daily source and background checks, yield determinations of radiochemical procedures, replicate analysis to check precision, and analyses of reagents to ensure purity of chemicals. Calibration standards traceable to the National Institute of Standards and Technology (NIST) are used for radiochemical calibrations when available.

In addition, TALR participates in the Laboratory Intercomparison Studies Program administered by Environmental Resource Associates (ERA). This program serves as a replacement for the studies previously conducted by the US Environmental Protection Agency's Environmental Monitoring Systems Laboratory. These programs provide a regular means of evaluating laboratory analytical performance by cross comparison of various environmental media samples (water, milk, air filters, soil, foodstuffs, and tissue ash) containing one or more radionuclides in known amounts. After the samples are

analyzed, results are forwarded to ERA for comparison with known values and with results from other laboratories. ERA has established criteria for evaluating the accuracy of results.

Environmental gamma radiation levels are measured using TLDs placed along the site boundary. TLDs are exchanged quarterly. Real time confirmatory measurements are made using microR radiation survey instruments and integrating self-reading dosimeters. Washington Department of Health and Hanford Contractor TLDs are in the same location as several of the environmental TLD locations.

Environmental TLDs were supplied by Mirion Technologies, Inc. Mirion Technologies, Inc. is accredited by the National Voluntary Laboratory Accreditation Program for dosimetry processors. This program is administered by NIST for ensuring accuracy and precision of TLD results.

Radiation counting instruments used to count air samples and iodine cartridges are checked daily and evaluated using statistical quality control. Gas proportional counters used for counting air samples are checked monthly for operating characteristics and χ^2. Radiation detection instruments used to measure fence-line dose rates in support of TLD monitoring are calibrated by an independent calibration facility. The companies contracted to perform calibration services are Ludlum Measurements Inc., Hi-Q, and Energy Northwest.

7.3 Vendor Audits

An integral part of supplier selection and qualification are quality assurance evaluations and onsite audits of the vendor. Each supplier of environmental, laboratory or calibration services is required to maintain an internal quality assurance program and to conduct operations in accordance with approved procedures. Vendor's quality assurance programs and operational procedures are reviewed annually. Onsite audits are conducted at least once every five years.

- Mirion Technologies, Inc. was audited in May, 2013
- Hi-Q was audited November 2016
- Energy Northwest was audited October, 2015
- Test America Laboratories Richland was audited in December, 2015
- Ludlum Instruments, Inc. was audited in February, 2015
- Environmental Inc. Midwest Labs, December 2017

These audits focus on implementation of quality assurance programs, calibration and processing procedures, and analysis of samples including air, soil, water, vegetation and TLD materials as appropriate. These audits indicated that these vendors are maintaining acceptable quality assurance programs.

7.4 Split Samples

In addition to the formal QA program described above, The Washington Department of Health (WDOH) obtains various environmental samples at the USEW sampling

locations. In 2017, WDOH and USEW obtained comparative samples for direct radiation, vegetation, soils, and groundwater samples.

As of this writing, the WDOH results were not available for 2015, 2016 or 2017.

8.0 LIST OF SAMPLES THAT EXCEEDED INVESTIGATION OR ACTION LEVELS

Table 8.1 is a summary of the 2017 exceedences in the environmental monitoring program.

Table 8.1 Results Above Investigation or Action Levels

Location	*Contaminant*	*Media*	*Date*	*Remarks*	*Result*	*Uncertainty*	*Units*	*Investigation Level*	*Frequency*
Work area	Beta	Air	1/27/2017	Naturally occurring	2.68E-13	4.5E-14	µCi/ml	1.00E-12	1
Station 6	Pu-239	Vegetation	J7/27/2017	Unknown origin	0.04	0.008	pCi/g	0.02	1
Trench 16	Cs-137	Vegetation	7/27/2017	Unknown origin	0.4	0.06	pCi/g	0.2	1
Station 3	Uranium	Soil	10/11/2017	Unknown origin	1.14	0.172	pCi/g	1	1
Well 6	H-3	Groundwater	3/13/2017	Upgradient	4.7E+03	3.00E+02	pCi/l	3600	7
Well 6	H-3	Groundwater	5/22/2017	Upgradient	5.03E+03	3.30E+02	pCi/l	3600	7
Well 6	H-3	Groundwater	8/14/2017	Upgradient	4.85E+03	3.20E+02	pCi/l	3600	7
Well 6	H-3	Groundwater	11/13/2017	Upgradient	4.51E+03	3.10E+02	pCi/l	3600	7
Well 7	H-3	Groundwater	3/15/2017	Upgradient	4.9E+03	3.10E+02	pCi/l	3600	7
Well 7	H-3	Groundwater	5/24/2017	Upgradient	5.43E+03	3.50E+02	pCi/l	3600	7
Well 7	H-3	Groundwater	8/16/2017	Upgradient	5.30E+03	3.40E+02	pCi/l	3600	7
Well 7	H-3	Groundwater	11/15/2017	Upgradient	5.67E+03	3.60E+02	pCi/l	3600	7
Well 13	Beta	Groundwater	5/22/2017	Upgradient	13.2	2.3	pCi/l	12	1

Frequency in last 20 months, AL = Action Level, MDL = Minimum Detectable Activity

9.0 APPENDICES

A. Air Emissions Assessment

B. Meteorological Data

C. Radioactive Materials License WN-I019-2

D. Air Emissions License RAEL-009

E. Richland Operating Procedures for Environmental Monitoring

F. Correspondence

G. Electronic Database

H. Printed Database

I. List of Acronyms

J. Graphs

10.0 REFERENCES

Cantrell, K. (2008, September). Plutonium Mobility Studies: 216-Z-9 Trench Sample Analysis Results. Richland, Washington: Pacific Northwest National labs.

Cantrell, K. (2009, August). Transuranic Contamination in Sediment and Groundwater at the U.S. DOE Hanford Site. *PNNL-18640*. Richland, Washington: Pacific Northwest National Labs.

CH2M. (2015). *Hanford Site Groundwater Monitoring Report for 2014.* Richland: U.S. Department of Energy. Retrieved from http://higrv.hanford.gov/Hanford_Reports_2014/Hanford_GW_Report/index.html

CH2MHill. (2013). *200-UP-1 Groundwater Operable Unit Remedial Design/remedial Action Work Plan.* Assistant Secretary for Environmental Management. Richland Wa: U.S. Departement of Energy.

CH2MHILL Plateau Remediation Company. (2014, August). *Hanford Site Groundwater Monitoring Report for 2013.* Richland: Department of Energy.

Department of Energy. (August 2016). *Hanford Site Groundwater Monitoring Report for 2015.* Richland: US Department of Energy.

Environmental Protection Agency. (2016). CAP88-PC Version 4.0.1.0. Washington D.C.: US EPA.

Field, J. G., Fort, L. A., Shrum, A., & Wood, M. I. (2011). *Hanford 241-S Farm Leak Assessment Report.* Richland Washington: Washington River Protection Solutions.

International Commission on Radiological Protection. (1977). *Annals of the ICRP: Recommendations of the Internal Commission on Radiological Protection.* ICRP. New York: Pergamon Press.

Ledoux, M. (1995). *Letter to John Erikson, Washington State Department of Health.* Richland, Washington.

Nation Council on Radiation Protection and Measurement. (1984, April). Report No. 076. *Radiological Assessment: Predicting the Transport, Bioaccumulation, and Uptake by Man of Radionuclides Released to the Environment*.

National Council on Radiation Protection and Measurement. (1976, December). NCRP Report no. 50. *Environmental Radiation Measurements*.

Pacific Northwest National Laboratory. (n.d.). *Phoenix Project*. (U. D. Energy, Editor) Retrieved from Pnnl-Hanford Online ENvironmental Information EXchange: http://phoenix.pnnl.gov/apps/gallery/index.html

Pacific Northwest National Labs. (2008). *(PNNL-18427, Hanford Site Environmental Surveillance Data Report.* Richland: Department of Energy.

Rittmann, P. D. (1992). *Soil Concentrations Limits for Accessible and Inaccessible Areas.* U.S. Department of Energy. Richland: Westinghouse Hanford Company.

U.S. Department of Energy. (2015B). *Performance Monitoring Plan for the 200-UP-1 Groundwater Operable Unit Remedial Action.* CH2MHill. Richland Washington: U.S. Department of Energy.

U.S. Department of Energy. (September 2016). *Hanford Site Environmental Monitoring Report for Calendar Year 2015.* U.S. Department of Energy, Richland.

U.S. Department of Energy. (September 2017). *Hanford Site Environmental Report for Calendar year 2016.* Richland Operations Office. Richland Washington: U.S. Department of Energy.

US Department of Energy. (2016A). *Hanford Site Groundwater Monitoring Report for 2015.* Richland Washington: US Department of Energy.

US Ecology Washington. (2012). *Quality Assurance Manual QA-MA-01 Rev. 2.* Richland, Washington: US Ecology Washington.

US Ecology Washington. (2014). *QA-MA-02 Quality Assurance Procedures Manual.* Richland, Wa: US Ecology Washington.

Vista Engineering Technologies. (2013, August 22). Conceptual Site Model US Ecology Low-Level Radioactive Waste Disposal Site. *VET-1405-01-RPT-001 Rev. 0, 0*. Richland, Wasington.

Washington State Department of Health. (2004, May 28). Final Environmental Impact Statement. *DOH Publication 320-031, 1*. Olympia, Wa, United State of America: Washington State Department of Health. Retrieved from http://www.doh.wa.gov/CommunityandEnvironment/Radiation/WasteManagement/CommercialLowLevelRadioactiveWasteDisposal/FinalEnvironmentalImpactStatementEIS