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Offsite Groundwater Assessment
Remedial Site Evaluation
Oak Ridge, Tennessee

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ACRONYMS

BCV	Bear Creek Valley
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COPC	contaminant of potential concern
CSM	conceptual site model
DOE	U.S. Department of Energy
DQO	data quality objective
DWS	drinking water standard
EEVOC	East End Volatile Organic Compound
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ETTP	East Tennessee Technology Park
FY	fiscal year
GWA	Groundwater Assessment
HI	hazard index
OFFBC	offsite Bear Creek Valley
OFFBV	offsite Bethel Valley
OFFET	offsite East Tennessee Technology Park
OFFMV	offsite Melton Valley
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
RSE	Remedial Site Evaluation
RSE WP	Remedial Site Evaluation Work Plan
SAP	sampling and analysis plan
SL	screening level
SMO	Sample Management Office
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
UEFPC	Upper East Fork Poplar Creek
USGS	U.S. Geological Survey
VOC	volatile organic compound
Y-12	Y-12 National Security Complex

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OFFSITE GROUNDWATER ASSESSMENT
REMEDIAL SITE EVALUATION, OAK RIDGE, TENNESSEE

This report presents results of an Offsite Groundwater Assessment (GWA) Remedial Site Evaluation (RSE) conducted in fiscal year (FY) 2014 through FY 2016. The U.S. Department of Energy (DOE), in coordination with the Tennessee Department of Environment and Conservation (TDEC) and the U.S. Environmental Protection Agency (EPA), conducted the study to investigate groundwater quality and potential offsite migration of contaminants of potential concern (COPCs) from the DOE Oak Ridge Reservation (ORR). The study was selected as a first priority project to begin implementation of a Groundwater Strategy for the ORR (DOE/OR/01-2628/V1&V2/D2). The strategy, an interagency approach for addressing legacy contamination in ORR groundwater, was developed and agreed to by DOE, TDEC, and EPA in FY 2014.

1.1 OBJECTIVES AND EVALUATION AREA

The study objectives were to obtain verified and validated data from offsite wells and springs in order to determine the presence or absence of ORR-related contaminants. In addition, potential threats to human health and the environment were evaluated.

The evaluation area is located west and north of the Clinch River at the western boundary of the ORR. As illustrated in Figure 1, the area is subdivided into four subareas based on hydrogeology and the locations of available, offsite wells and springs for sample collection: (1) offsite Bear Creek Valley (OFFBC), (2) offsite Bethel Valley (OFFBV), (3) offsite East Tennessee Technology Park (OFFET), and (4) offsite Melton Valley (OFFMV).

1.2 PLANNING AND IMPLEMENTATION

Data quality objectives (DQOs) meetings with DOE, EPA, and TDEC representatives were held in 2013 to define the type, quality, and quantity of data needed to evaluate offsite groundwater quality and potential movement. A sampling and analysis plan (SAP) with potential existing well and spring sampling locations was documented in the approved RSE Work Plan (RSE WP; DOE/OR/01-2649&D1 and Erratum). In 2014, DOE began contacting property owners, visiting potential sampling locations, and finalizing access agreements. Extensive efforts were made to obtain access agreements for sampling at locations identified in the RSE WP and at other identified locations. Contact with over 100 property owners was made or attempted and over 60 site visits were completed to evaluate sampling locations. The final list of sampling locations was documented in SAP addenda.

Sampling was completed at a total of 49 locations (34 wells and 15 springs) in Roane County. The study included three rounds of sampling and analysis for a comprehensive suite of chemical and radionuclide constituents. The first sampling event began in January 2015. For this event, TDEC personnel collected co-samples with DOE at six locations. The second sampling event was completed in September 2015. The last sampling event, completed in February 2016, was performed on a smaller group of locations that was selected after review of results from the first two events.

DOE contractors performed sample collection and sample shipment; analyses of these samples at a laboratory approved by DOE's Sample Management Office (SMO); and data verification and validation of analytical results.

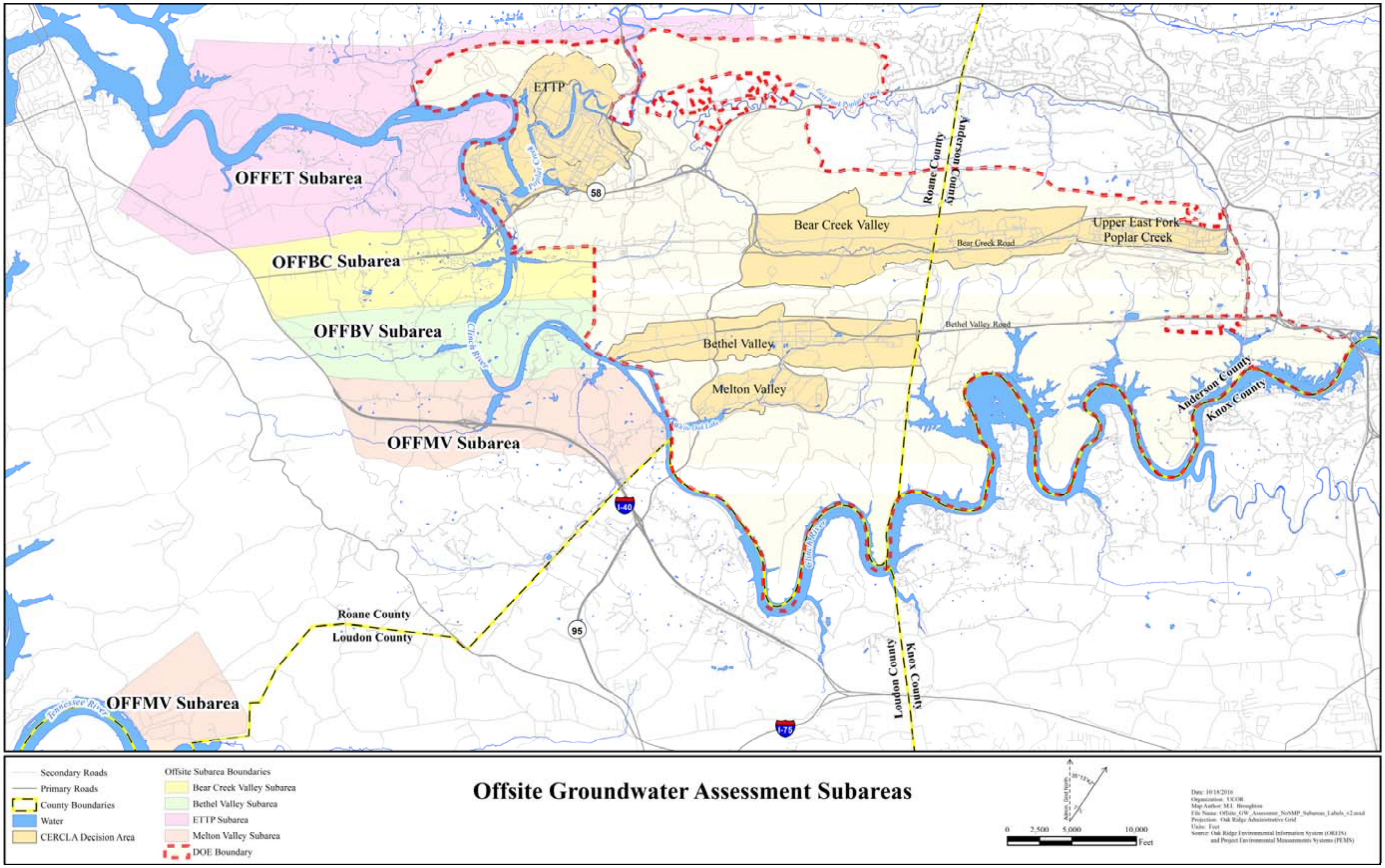

Figure 1. Offsite GWA evaluation area.

1.3 SITE-SPECIFIC INFORMATION

The ORR and the Offsite GWA evaluation area are located in a geologically complex region. Geologic conditions dictate the characteristics of groundwater occurrence, geochemistry, and movement. In step with the complexities of the geology, the conceptual site model (CSM) is complex. Groundwater on the ORR may be generally stratified into shallow, intermediate, and deep flow regimes, each of which have distinct hydrogeologies and geochemistries. While the majority of groundwater contaminant plumes on the ORR follow the prevailing shallow groundwater flow pathways, which are generally parallel to geologic strike (i.e., northeast–southwest), there are deep sources of contamination for which flowpaths and directions are not well-established and characterized.

Previous site investigations have identified contaminants specific to ORR source areas and processes. However, some of the constituents identified as ORR COPCs may be present in offsite groundwater for reasons unrelated to ORR releases. Some can be naturally-occurring and for some there are potential anthropogenic (man-introduced) sources. Because of their significance as "indicator" COPCs, fission and activation products, transuranic elements, and uranium isotope signatures receive the majority of consideration in the contaminant source evaluation.

1.4 SUMMARY OF RESULTS

Analytical and field parameter measurement results from the three rounds of Offsite GWA sampling are summarized in Table 1 and 2, respectively. Table 1 shows frequency of detection and minimum, maximum, and average of the detected results by analyte. Many chemical and radionuclide analytes were detected at very low concentrations. These detections were reported as approximate values due to the low detection limits used and analytical limitations. Table 1 also indicates which analytes are evaluated in the report as potential ORR COPCs and whether there are other potential non-ORR sources (naturally-occurring or anthropogenic [man-made]). Table 2 summarizes the number of field parameter results and the minimum, maximum, and average of the results by parameter.

1.5 EVALUATION AND CONCLUSIONS

A summary of the evaluation and conclusions with regard to the study objectives are as follows.

1.5.1 Groundwater geochemistry

The geochemical water type most frequently sampled at Offsite GWA locations is indicative of the shallow groundwater flow systems throughout the ORR. A lesser number of locations sampled exhibited groundwater that compositionally represent a mixture of shallow groundwater and groundwater which is typical of the deeper, intermediate groundwater flow system.

A qualitative, statistically non-rigorous comparison with the best available data from the U.S. Geological Survey (USGS) was undertaken for select constituents, not to determine exceedances as compared to "background values", but rather to determine how values measured in offsite samples relate to those typically reported in USGS studies. Use of the USGS data sets provides only a general context for evaluating offsite groundwater composition and cannot be used to draw conclusions about constituent concentrations that are naturally-occurring in the ORR area. With the exception of tritium, the comparison indicates that constituents in offsite groundwater do not exhibit significant deviations from USGS data. Tritium exhibits concentrations typically above those exhibited by the USGS reference data sets.

Table 1. Offsite GWA summary of detected analytes in well and spring samples (unfiltered) by analyte

Analysis type	Chemical name	Potential source[a]			Number of detected results	Number of results	Number of results exceeding Primary DWS	Detected			Units
		ORR COPC	Non-ORR								
			Naturally-occurring	Anthropogenic				Minimum	Maximum	Average	
ANION	Chloride				125	125		0.557	22.1	2.91E+00	mg/L
ANION	Fluoride	X	X	X	116	125	0	0.0333	2	2.29E-01	mg/L
ANION	Nitrate/Nitrite as Nitrogen	X	X	X	104	125	0	0.0189	3.87	5.16E-01	mg/L
ANION	Orthophosphate				2	124		0.0684	0.0809	7.47E-02	mg/L
ANION	Sulfate				125	125		0.533	126	1.05E+01	mg/L
METAL	Aluminum	X	X	X	77	125		0.0151	6.89	7.58E-01	mg/L
METAL	Arsenic	X	X	X	19	125	0	0.00174	0.00768	2.74E-03	mg/L
METAL	Barium				123	125	0	0.0076	0.564	9.26E-02	mg/L
METAL	Beryllium				5	125	0	0.000231	0.000539	4.24E-04	mg/L
METAL	Boron	X	X	X	121	125		0.00415	1.01	6.24E-02	mg/L
METAL	Cadmium				10	125	0	0.000114	0.00145	3.04E-04	mg/L
METAL	Calcium				124	125		0.0516	94.2	4.37E+01	mg/L
METAL	Chromium	X	X	X	26	125	0	0.00106	0.0612	6.20E-03	mg/L
METAL	Cobalt	X	X	X	72	125		0.000102	0.00794	6.06E-04	mg/L
METAL	Copper				107	125	0	0.000386	0.274	1.03E-02	mg/L
METAL	Iron				82	125		0.0317	36	1.24E+00	mg/L
METAL	Lead	X	X	X	52	125	3[b]	0.0005	0.0872	4.90E-03	mg/L
METAL	Lithium	X	X	X	64	125		0.00227	0.813	3.17E-02	mg/L
METAL	Magnesium				124	125		0.0167	40.7	1.60E+01	mg/L
METAL	Manganese	X	X	X	89	125		0.00102	2.84	1.08E-01	mg/L
METAL	Mercury	X	X	X	75	125	0	0.201	286	9.93E+00	ng/L
METAL	Nickel	X	X	X	17	125	0	0.00152	0.016	4.29E-03	mg/L
METAL	Phosphorous				36	125		0.0151	0.326	4.51E-02	mg/L
METAL	Potassium				125	125		0.0706	10.7	1.40E+00	mg/L
METAL	Selenium				3	125	0	0.0017	0.00203	1.85E-03	mg/L
METAL	Silicon				125	125		0.881	20.8	5.37E+00	mg/L
METAL	Sodium				125	125		0.406	173	1.34E+01	mg/L

Table 1. Offsite GWA summary of detected analytes in well and spring samples (unfiltered) by analyte (cont.)

Analysis type	Chemical name	Potential source[a]			Number of detected results	Number of results	Number of results exceeding Primary DWS	Detected			Units
		ORR COPC	Non-ORR								
			Naturally-occurring	Anthropogenic				Minimum	Maximum	Average	
METAL	Strontium				123	125		0.00483	3.34	2.16E-01	mg/L
METAL	Thallium	X	X	X	5	125	0	0.000507	0.000641	5.77E-04	mg/L
METAL	Uranium	X	X	X	118	125	0	0.000067	0.00372	5.07E-04	mg/L
METAL	Vanadium	X	X	X	24	125		0.00106	0.0133	3.99E-03	mg/L
METAL	Zinc				84	125		0.00343	1.54	6.95E-02	mg/L
RADS	Actinium-228				3	125		9.26	11.4	1.00E+01	pCi/L
RADS	Alpha activity				30	125	1[b]	1.05	16.7	4.49E+00	pCi/L
RADS	Americium-241	X		X	8	125		0.00811	0.0138	1.15E-02	pCi/L
RADS	Beta activity				48	125	0	1.6	17	4.12E+00	pCi/L
RADS	Bismuth-212				8	124		31.3	65.6	4.45E+01	pCi/L
RADS	Bismuth-214	X	X		121	125		8.2	533	1.23E+02	pCi/L
RADS	Cesium-137	X		X	2	125	0	3.28	3.32	3.30E+00	pCi/L
RADS	Cobalt-60	X		X	1	125	0	4.29	4.29	4.29E+00	pCi/L
RADS	Curium-243/244	X		X	1	125		0.0177	0.0177	1.77E-02	pCi/L
RADS	Lead-212				12	125		4.2	8.14	5.82E+00	pCi/L
RADS	Lead-214	X	X		118	125		11.6	590	1.36E+02	pCi/L
RADS	Neptunium-237	X		X	5	125		0.0107	0.0251	1.68E-02	pCi/L
RADS	Plutonium-239/240	X		X	1	125		0.0126	0.0126	1.26E-02	pCi/L
RADS	Potassium-40				6	125		26.3	104	5.20E+01	pCi/L
RADS	Protactinium-234m	X	X		119	125		0.0229	1.17	1.71E-01	pCi/L
RADS	Radium-226	X	X		92	125	1[b]	0.103	2.9	7.81E-01	pCi/L
RADS	Radium-228				31	125	1[b]	0.235	3.43	7.69E-01	pCi/L
RADS	Radon-222				2	2		450	608	5.29E+02	pCi/L
RADS	Strontium-90	X		X	9	125	0	0.251	1.1	5.59E-01	pCi/L
RADS	Technetium-99	X		X	14	125	0	0.215	0.61	3.78E-01	pCi/L
RADS	Tritium	X	X	X	46	126	0	66.5	1880	2.16E+02	pCi/L
RADS	Uranium-233/234	X	X		125	125		0.0265	4.25	3.15E-01	pCi/L
RADS	Uranium-235/236	X	X		60	125		0.00979	0.103	3.45E-02	pCi/L

Table 1. Offsite GWA summary of detected analytes in well and spring samples (unfiltered) by analyte (cont.)

Analysis type	Chemical name	Potential source[a]			Number of detected results	Number of results	Number of results exceeding Primary DWS	Detected			Units
		ORR COPC	Non-ORR								
			Naturally-occurring	Anthropogenic				Minimum	Maximum	Average	
RADS	Uranium-238	X	X		119	125		0.0229	1.17	1.71E-01	pCi/L
VOA	2-Butanone	X	X	X	2	125		5.82	86.1	4.60E+01	µg/L
VOA	Acetone	X	X	X	2	125		1.67	73.2	3.74E+01	µg/L
VOA	Chloroform	X		X	1	125	0	0.5	0.5	5.00E-01	µg/L
VOA	Methylene chloride	X		X	8	125	0	1	2.02	1.40E+00	µg/L
WETCHEM	Bicarbonate				125	125		56.9	283	1.77E+02	mg/L
WETCHEM	Carbonate				10	125		4.46	124	4.38E+01	mg/L
WETCHEM	Dissolved Solids				125	125		21.4	439	1.97E+02	mg/L
WETCHEM	Suspended Solids				73	125		0.6	186	1.62E+01	mg/L

[a] The only constituents for which potential source information (ORR COPC; non-ORR [naturally-occurring, anthropogenic]) is listed are those identified in Table 3.4 of this report. It is recognized that the potential source information is not all-inclusive.

[b] Primary DWS for analytes with exceedances are as follows: 15 pCi/L for alpha activity, 0.015 mg/L for lead (action level for public water supply treatment systems), and 5 pCi/L for combined Ra-226/Ra-228.

COPC = contaminant of potential concern
DWS = drinking water standard
GWA = Groundwater Assessment
ORR = Oak Ridge Reservation
RADS = radioanalytical analysis
VOA = volatile organic analysis
WETCHEM = wet chemistry

Table 2. Offsite GWA summary of field parameters measured in well and spring samples

Analysis type	Chemical name	Number of result	Minimum	Maximum	Average	Units
PHYSC	Conductivity	115	92	576	3.45E+02	µmho/cm
PHYSC	Dissolved Oxygen	115	0.13	15.57	5.60E+00	ppm
PHYSC	pH	115	5.72	9.85	7.32E+00	Std Unit
PHYSC	Redox	115	-108	319.1	1.11E+02	mV
PHYSC	Temperature	115	3.29	25.43	1.52E+01	deg C
PHYSC	Turbidity	115	0.1	158	1.05E+01	NTU

GWA = Groundwater Assessment
NTU = nephelometric turbidity unit
PHYSC = physical (field parameter)

1.5.2 Threats to human health and the environment

1.5.2.1 Primary drinking water standard exceedances

In the first round of sampling, there were primary drinking water standard (DWS) exceedances at three locations. The exceedances were for lead, gross alpha activity, and combined Ra-226 and Ra-228, constituents that can be naturally-occurring. The exceedances corresponded with higher suspended solids and turbidity in the samples and were not repeated in the second and third rounds of sampling. In coordination with TDEC and the Tennessee Department of Health, DOE sent letters containing sampling results and information about primary DWS exceedances to property owners.

1.5.2.2 Threats to human health

Threats to human health were evaluated using data from the 49 locations. A point risk evaluation that evaluates chronic (or long-term) risk was performed assuming the use of the wells and springs as domestic water sources, which is a conservative exposure scenario. The evaluation followed the basic tenets of risk assessment performed under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as developed by EPA. Data were compared to human health risk-based screening levels in order to provide a list of constituents (risk COPCs) at each location requiring further evaluation in the point risk evaluation. Risks were quantified for the identified risk COPCs at each location using the 1) mean value and 2) maximum value of the sampling results. These mean and maximum values at a location are termed the exposure point concentrations (EPCs). It should be noted that this is a limited evaluation using a relatively small data set. In addition to the limited data set, other uncertainties, such as the ability to detect and quantify constituents at particularly low risk levels, can impact the calculated risks and, therefore, should be acknowledged. These uncertainties limit detailed interpretation of sampling results with regard to threats to human health.

Risks include two types: carcinogenic risk expressed as total risk, which is a measure of the potential for cancer, and noncarcinogenic risk expressed as a hazard index (HI), which is a measure of the potential for systemic illness. For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-6} and 10^{-4} (or risks of 1 in 1,000,000 to 1 in 10,000). For noncarcinogens, HIs less than 1 are considered acceptable.

Carcinogenic risk. The evaluation showed a point total risk at all 49 locations within the EPA acceptable risk range. Based on the limited evaluation, there are currently no indications that carcinogenic risks exceed the upper bound of the EPA risk range (greater than 1 x 10^{-4}) using both the mean and maximum EPCs.

Noncarcinogenic risk. The evaluation showed 44 locations are associated with a point HI less than or equal to 1 (acceptable), while five locations are associated with a point HI greater than 1 using the mean EPCs. The use of maximum EPCs resulted in 42 locations with a point HI less than or equal to 1 and seven locations with HIs greater than 1.

For the locations with a point HI greater than 1, the individual constituents with HIs that exceed 1 are lithium, fluoride, manganese, and thallium. Lithium, manganese, and thallium can be naturally-occurring. Lithium concentrations that exceed an HI of 1 are in wells that have unverified depth estimates of 500 and 600 ft below ground surface (bgs) based on available anecdotal information. If the depths are accurate, the lithium concentrations observed may be associated with the connate brine.

Fluoride can also be naturally-occurring and is commonly added to municipal water supplies and toothpaste to aid in the prevention of tooth decay. Fluoride concentrations at all locations are less than the primary DWS. One of the locations has HIs of 1.1 and 1.5 based on the mean and maximum EPCs, respectively. While these HIs are slightly greater than the EPA HI threshold, the two primary contributors (fluoride and lithium) have different toxic endpoints and individual constituent HIs that are less than 1. As a result, there is no unacceptable noncarcinogenic risk at that location.

Lithium, fluoride, manganese, and thallium are also listed as ORR COPCs. The lack of a groundwater background study for the ORR area limits the interpretation of whether constituent concentrations observed (and the associated risks) are in fact related to background or from another potential source. Exposures for these constituents are likely overestimated due to uncertainties in the risk assessment process. Additionally, two locations with HI exceedances are surface springs and are not used as a drinking water source, therefore the HI is conservative.

EPA has not developed toxicity values for lead; therefore, lead is not quantitatively evaluated in the point risk evaluation. Lead concentrations were compared to primary DWS as discussed above to identify exceedances.

1.5.2.3 Threats to the environment

A screening evaluation of threats to the environment was performed by comparing results from the springs sampled to ambient water quality criteria for protection of fish and aquatic life. From this screening, it is not evident that significant impact to ecological receptors is occurring or may occur that requires further evaluation. The few observed exceedances for pH and dissolved oxygen may be due to bacterial and/or algal growth in these surface water bodies, which is a natural phenomenon, although anthropogenic influences that may be contributing cannot be ruled out.

1.5.3 Contaminant source evaluation

A contaminant source evaluation was performed using spatial and temporal analysis, statistical analysis, and other methods. Offsite GWA results were evaluated for indicators of potential sources of detected COPCs.

1.5.3.1 COPCs and potential sources

Chemical and radionuclide COPCs known to be present in ORR legacy waste were detected in Offsite GWA results, however, there are multiple sources on and off the ORR, and available data are not adequate to determine the actual source or sources.

With the exception of nitrate/nitrite and uranium, few detections were obtained for COPCs that are known to migrate significant distances in ORR plumes, such as Tc-99, Sr-90, and volatile organic compounds (VOCs). The detections noted were at low concentrations and sporadic and discontinuous in character. Most organic COPCs frequently identified in ORR groundwater plumes, including carbon tetrachloride, trichloroethene, and perchloroethene, were not detected. Though detected in the majority of samples, no elevated nitrate/nitrite or total uranium values (that exceeded screening levels [SLs]) were observed.

Uranium isotope signatures in offsite samples were compared to onsite surface and spring waters in Bear Creek Valley (BCV), which drains disposal areas containing the largest and most significant source of uranium contamination on the ORR. For this comparison to BCV data on the ORR, the Offsite GWA results were treated as one population because results from the respective subareas do not define separate trends by watershed. The comparison shows that uranium in offsite samples is significantly different isotopically and compositionally than uranium in waters within, and exiting, the BCV system.

Key COPCs for the ORR, including fission and activation products and transuranic elements, do not occur with spatial and temporal distribution that would be typical of those observed to result from an uncomplicated shallow groundwater plume. Given the complexities and uncertainties of ORR hydrogeology, however, the observed patterns do not rule out emplacement by groundwater transport. The data and analysis do indicate other potential mechanisms for the emplacement of trace quantities of COPCs detected in offsite samples be considered. While outside of the groundwater focus of the initial RSE study, such mechanisms may include deposition from atmospheric fallout related to nuclear weapons testing and nuclear facilities elsewhere in the United States and worldwide, airborne releases from historic and ongoing operations of ORR facilities, and operation of non-DOE facilities in the ORR vicinity.

The locations of tritium detections and the greatest tritium concentrations are not consistent with migration offsite by a groundwater plume. The highest observed tritium concentrations occur distally to potential ORR sources and the long axis of the detection locations, which should mimic the major plume transport direction, is not oriented back to likely ORR sources. The distribution suggests tritium may be present due to other (i.e., possibly airborne) sources such as ongoing air releases from Oak Ridge National Laboratory (ORNL), Tennessee Valley Authority (TVA) Watts Bar Nuclear Plant, and potential releases from commercial waste processing facilities located within close proximity to the greatest observed tritium concentrations. The detection of elevated levels of tritium in rainfall located remote from ORR sources demonstrates that there are multiple sources of tritium in the environment that may cause some of the observed tritium in offsite groundwater.

1.5.3.2 Potential groundwater pathways for offsite migration of ORR contaminants

With the current understanding of hydrologic conditions and behavior on the ORR, the Offsite GWA data does not definitively support an offsite groundwater plume migration scenario within a groundwater regime. Although the evaluation cannot rule out all potential ORR pathways, the observed offsite detection of low levels of a limited number of ORR COPCs is not consistent with the most likely predicted pattern of occurrence for ORR contaminants migrating offsite.

Legacy releases by air from ORR facilities and current releases by air from DOE and non-DOE facilities may account for the presence of some of the detected COPCs. Following airborne migration and subsequent deposition to surface soils and waters, COPCs can migrate to groundwater. The complexity of the operative processes, the specific depositional patterns, and the fraction of the deposited material reaching the water table are clearly a function of many parameters, and detailed evaluation goes beyond the scope of this study. Therefore, the possibility of such mechanisms must be acknowledged, but their impact is not quantified.

Groundwater flow through karstified terrains is complex to document and quantify. There is a documented example of focused rapid migration through carbonate lithologies containing karst features on the ORR (e.g., the East End Volatile Organic Compound [EEVOC] Plume in Upper East Fork Poplar Creek [UEFPC] at the Y-12 National Security Complex [Y-12]). Additionally, tracer studies at the Y-12 and East Tennessee Technology Park (ETTP) sites demonstrate rapid groundwater movement in karstified carbonate lithologies on local to moderate scales. However, current data and interpretations do not indicate that such flow behavior is active on a scale to produce the observed occurrence patterns of COPCs at the offsite locations investigated.

1.6 DATA GAPS AND UNCERTAINTIES

Many of the limitations discussed below were acknowledged in the approved RSE WP and are restated to identify the data gaps and uncertainties associated with the available data. These uncertainties must be factored into interpretation and use of the offsite data and conclusions. They should also be considered with regard to the effectiveness of additional future sampling of offsite wells.

The lack of detailed hydrogeologic information at the borders of the ORR and adjoining offsite areas is a significant data gap. The shortage of information about hydraulic head distribution, groundwater flowpath characteristics and distribution, and the general composition and variability of groundwater, presents limitations for rigorous scientific interpretation of the data. Lack of a groundwater background study for the ORR prevents a quantitative assessment of ORR background concentrations. Therefore, a qualitative comparison was undertaken with the best available data from the USGS.

Legacy airborne releases from DOE facilities on the ORR, which are incompletely documented, as well as ongoing ORR and non-ORR airborne emissions and associated deposition in the area, make quantification and assessment of the role and impact of such releases to the observed offsite groundwater results difficult.

A large source of uncertainty for the Offsite GWA is the lack of critical information on the construction, condition, maintenance, and use of wells sampled. The lack of knowledge about specific portions of the subsurface sampled by a well, hydraulic head data, and integrity of the water supply systems sampled presents significant limitations when the data are to be used to evaluate contaminant origin and migration pathway. Estimates of total well depth are available for some of the wells sampled based on anecdotal information, but are not inclusive of the entire set of wells and were not able to be verified during the field work completed due to well access constraints.

The Offsite GWA data set was limited to wells and springs on properties where DOE obtained access to sample over three rounds of sampling. Conclusions regarding the long-term impacts of exposure to potential constituents present in groundwater and spring water can be made based on the limited evaluation performed, but uncertainties should be acknowledged. In addition to the lack of a robust data set, there is not a definitive understanding of well usage patterns and influences on potential water quality. Additionally, the ability to detect and quantify some constituents at very low risk levels can impact the calculated risks.

1.7 REFERENCES

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