NRC Staff's Comment - confirm which groundwater samples had confirmed that only U-234, U-235, U-238 and Tc-99 where the primary radionuclides of concern.

Westinghouse Response March 13, 2018

Discussion - Groundwater Radionuclides of Concern

Prior to the development of the Hematite Decommissioning Plan, a review of all available historical groundwater data was reviewed, and it was concluded at the time that Groundwater in the Jefferson City and Roubidoux HSUs was not impacted by the radionuclides of Thorium, Radium, and was only slightly impacted by Tc-99 and Uranium, but well below the EPA drinking water standard.

The Hematite Radiological Characterization Report (HRCR) summarizes the conclusion that only Uranium isotopes and Technetium-99 are the primary radionuclides of concern in groundwater through review of previously developed groundwater reports. In document EO-09-002, Radionuclide Activity in Bedrock Groundwater, July 2009 it was also concluded that:

> *"The silty clay soil immediately underlying the sources of radioactive contamination in the soil has attenuated migration of radiological contaminants in the soil, thus protecting the potential sources of potable water near the Hematite Site. The planned removal of the contaminated soil associated with these sources will remove the threat to groundwater sources of drinking water.*
>
> *The radioactive contaminants in the soil within the Central Tract Area have migrated into the Silty Clay Aquitard HSU. The silty clay soil severely retards the further downward migration of radioactive contamination to the Sand/Gravel HSU. With two exceptions identified at wells GW-V and GW-X, the silty clay soil also severely retards horizontal migration of radiological contamination.*
>
> *Total uranium does not exceed the background threshold value in the potential sources of drinking water (Sand/Gravel HSU, Jefferson City-Cotter Bedrock HSU, and Roubidoux HSU).*
>
> *Tc-99 has been found in one well in the Sand/Gravel HSU at 1/6th of the drinking water standard (representing dose contribution of less than 1 mrem/year). However, due to the presence of volatile organics exceeding drinking water standards, this potential source cannot be used for drinking water. The furthest extent of Tc-99 contamination is about halfway between the rail line and Joachim Creek, at about 1/500th of the drinking water standard."*

While low levels or Radium and Thorium were detected in isolated areas of the site, from leachate wells installed within the former Burial Pits, it was also concluded that the planned remediation of the impacted area would eliminate any future concern for potential future impacts. Report EO-09-002 goes on to conclude the following:

"Radionuclide activity in the bedrock groundwater underlying the Hematite Facility is generally below background levels with the exception of reported positive Tc-99 activity in widely spaced bedrock wells PZ-03, BR-01-JC, BR-03-JC, and BR-08-JC. Two of the wells (BR-01-JC and PZ-03) are located on the facility area and the remaining wells (BR-03-JC, BR-08-JC) are located on the Joachim Creek floodplain south of the Hematite Facility. Gross-β activity in the wells BR-03-JC, BR-08-JC, and PZ-03 followed similar trends suggestive of background activity while gross-β activity fluctuated widely in well.

BR-01-JC between June and December 2007. After December 2007 gross-β activity in well BR-01-JC followed trends similar to the remaining bedrock wells. The source of the fluctuations in well BR-01-JC is not definitively known but may be related to the installation of dedicated sampling equipment in the 1" diameter well and subsequent equilibration of the well. Time series analysis of reported Tc-99 and gross- β activity in bedrock groundwater shows that the analytical results are oscillatory around zero activity and are not indicative of Tc-99 groundwater contamination or a developed Tc-99 plume affecting the bedrock groundwater."

The conclusion was drawn that only Tc-99, and to a much lesser extent Uranium, were present in groundwater in detectable levels. Therefore as stated in DP Chapter 14.5.3, *Sampling Method*:

"Groundwater sampling will be conducted following site procedures using a low-flow technique that provides representative samples while reducing investigation derived waste. For each well, unfiltered and filtered groundwater samples will be collected and analyzed; turbidity will be measured in the field on unfiltered groundwater. Samples will be analyzed for gross alpha, gross beta, isotopic Uranium, and Tc-99. Comparison of radionuclide activities in paired filtered and unfiltered samples will be used to determine whether radionuclide migration, if any, is occurring through clay/colloidal transport."

Through RAI's, the analysis for gross alpha and beta was removed, so proceeding forward, the DP only required Iso-U and Tc-99 analysis for ground water.

Furthermore, only Dose to Source Ratios were only carried forward for U and Tc-99 into Chapter 14, as it was known that Ra-226, and Th-232 were both limited to very small areas of the site.

Section 14.1.1 of the DP makes this statement regarding Ra-226 and Th-232 in soil:

"Thorium-232 is present naturally in background soil, and has been identified at concentration greater than the Background Threshold Value for Th-232 at a limited number of locations within the area of the buried waste. Radium-226 (Ra-226 + C) was identified as a ROC and has been identified primarily at two locations in the Burial Pit Area. The elevated Ra-226 was likely introduced into the burial pits with waste as a result of the installation of contaminated equipment into the process operations. Although only low concentrations of Th-232 and Ra-226 have been identified at locations outside of the Burial Pit Area, these radionuclides will be considered ROCs site-wide."

Ra-226 and Th-232 were not considered ROCs for groundwater during the development of Chapter 14, since as stated above, both radionuclides were only ever identified above background levels in small isolated areas of the site, and entirely in the overburden. Remediation of the Ra-226 area in the northern burial pit was completed in 2014, and remediation of the Th-232 area in the southern Burial pit area was completed in 2013.

As all soil site wide was monitored for Ra-226, and Th-232, with no additional areas identified that exceeded normal background levels, the conclusion that Ra-226 and Th-232 are not ROCs for groundwater is supported.

After submittal of the Hematite Decommissioning Plan, Rev 0, Technical Basis Document HDP-TBD-EHS-001, Subsurface Water Overview, January 2011, was developed and states:

> *"Each of these HSUs has been analyzed to determine whether they are a viable source for drinking water or irrigation water:*
>
> - *The Silty Clay Aquitard HSU is not viable as a sustainable water supply for the purposes of drinking water, irrigation, or industrial use based on its mean hydraulic conductivity (2.85 x 10-5 cm/sec), its low mean matrix permeability (3.48 x 10-8 cm/sec) and its apparent lack of internal interconnected flow pathways. The State of Missouri Well Construction Code (10 CSR 23-3) for the Hematite location requires "No less than twenty feet of casing shall be set above the screened or perforated interval of the well".*
>
> *This restriction would preclude development of a water supply for domestic or irrigation purposes from the Silty Clay Aquitard HSU (unless the State of Missouri approved a variance to its regulations).*
>
> *The Sand/Gravel HSU underlying the immediate facility area has insufficient quantities of shallow water to sustain feasible and economic production based on its limited extent and thickness. The sand and gravel deposits are an effective underdrain for the Silty Clay Aquitard HSU and could provide a viable water resource south of the Site buildings.*
>
> *However, due to the presence of volatile organics exceeding drinking water standards, the Sand/Gravel HSU is currently restricted for use (through deed restrictions) as a source of potable water.*
>
> - *The Jefferson City-Cotter Bedrock HSU is a viable water supply.*
> - *The Roubidoux Bedrock HSU is a viable water supply.*
>
> *Based on 10 CFR 20.1402 and 10 CFR 40, the term "groundwater" is applied to sources of subsurface waters that are sources of drinking water or aquifers that are capable of yielding a significant amount of groundwater to wells or springs. Based on these regulatory descriptions of groundwater, the water in the Sand/Gravel, Jefferson City-*

Cotter Bedrock, and Roubidoux Bedrock HSUs is groundwater. The term "leachate" is used for the water in the Silty Clay Aquitard HSU and is used to describe wells that are screened only in the Silty Clay Aquitard HSU."

"The silty clay soil immediately underlying the sources of radioactive contamination in the soil has attenuated migration of radiological contaminants in the soil, thus protecting the potential sources of potable water near the Hematite Site. The planned removal of the contaminated soil associated with these sources will remove the threat to groundwater sources of drinking water.

The radioactive contaminants in the soil within the Central Tract Area have migrated into the Silty Clay Aquitard HSU. The silty clay soil severely retards the further downward migration of radioactive contamination to the Sand/Gravel HSU. With two exceptions identified at wells GW-V and GW-X, the silty clay soil also severely retards horizontal migration of radiological contamination.

Total uranium does not exceed the background threshold value in the potential sources of drinking water (Sand/Gravel HSU, Jefferson City-Cotter Bedrock HSU, and Roubidoux HSU).

Tc-99 has been found in one well in the Sand/Gravel HSU at 1/6th of the drinking water standard (representing dose contribution of less than 1 mrem/year). However, due to the presence of volatile organics exceeding drinking water standards, this potential source cannot be used for drinking water. The furthest extent of Tc-99 contamination is about halfway between the rail line and Joachim Creek, at about 1/500th of the drinking water standard."

Westinghouse is confident that the determination of the Primary ROCs being Uranium and Tc-99 was appropriate as record research indicates that this was reviewed by the NRC at the time of the Hematite DP approval as captured in the SER for the DP section 4.5, *Groundwater*, which states:

"*In the HRCR, the potential radionuclides of concern (ROC) for the site are uranium isotopes (Uranium-234, Uranium-235, and Uranium-238), Technetium-99, Thorium-232, Radium-226, Americium-241, Neptunium-237, and Plutonium-239. The chemical analyses of groundwater samples collected from the monitoring wells completed in various hydrostratigraphic units confirmed that only Uranium-234, Uranium-235, Uranium-238 and Technetium-99 are the primary radionuclides of concern in groundwater.*"

With completion of remediation and restoration activities, program review also concludes that the original conclusion that Ra-226, and Th-232 are not ROCs for groundwater monitoring is sound. At no time during remediation activities was information uncovered, or a situation identified that would have challenged the original conclusions drawn during the development of Chapter 14 of the DP, or the conclusions of the SER for the Hematite DP.