**Kennecott Technical Report**
**Request for Additional Information**

## 1) License Position or Statement

In Section 6.1.1.5 of the Technical Report (TR) (ML14251A113), the application states (citing the 1999 Environmental Assessment) that as of 1998 all the groundwater hazardous components have stabilized below the standards except uranium, confined to the northern edge of the tailings pile, and radium, which covers 127 acres of which nearly half is under the tailings impoundment.

**Basis:**
Staff has determined that the extent of combined radium-226/228 and natural uranium groundwater contamination described above, does not accurately reflect the information presented in the Annual Corrective Action Program (CAP) Review and Groundwater Monitoring Reports for 2004, 2009, 2012, and 2013. Staff also determined that exceedances of the Groundwater Protection Standards (GPS) for combined radium-226/228, natural uranium, manganese, and iron in specific wells have consistently or intermittently occurred during the period 2004 to 2013. Below is a more detailed discussion of each of the GPS as identified above:

*Combined Radium-226/228*

The GPS stipulated in the license for combined radium-226/228 is 5.8 pCi/L. The 5.8 pCi/L contour presented in the 2003 Ground Water Monitoring Report, based on the highest combined radium-226/228 result for each well in 2002, encloses an area largely demarcated within the limits of the tailings impoundment and seems generally consistent with the description of its 1998 extent provided in the application. However, for 2004, 2009, 2012 and 2013 the 5.8 pCi/L contour (based on the highest result per well) around the tailings impoundment demarcates a much larger area than in 2002 and reaches the mill buildings, beyond which its western extent is undefined. North of the tailings impoundment, a subarea of groundwater values above 5.8 pCi/L exists which in some years (2009, 2013) is circumscribed by a single 5.8 pCi/L contour that encompasses the area of the tailings impoundment and in others (2004, 2012) is circumscribed by a separate 5.8 pCi/L contour. Overall, the area enclosed by the 5.8 pCi/L contour in 2013 is larger and extends farther east than in previous years, for the first time reaching background monitoring well TMW-5. An exceedance was also observed in 2013 for the first time in well TMW-47, located southeast of the tailings impoundment.

Because the 5.8 pCi/L contour is unbounded on the west, the extent of combined radium-226/228 groundwater contamination in relation to the western limit of the bonded area needs to be defined. As acknowledged in the 2013 Annual CAP Review and Groundwater Monitoring Report, the volume of fluid (and thus the mass of contaminants) leaked from the Catchment Basin on the west side of the facility is unknown. Staff notes that monitoring wells TMW-10, TMW-72 and TMW-73, all within 70 meters for the western edge of the bonded area, have shown exceedances of the GPS since they were first sampled in 2006 or 2007. From 2007 until it was last sampled in 2011, TMW-10 consistently exceed the GPS by as much as a factor of 16, excluding a large outlier (414.2 pCi/L) reported for August 21, 2007. Values for TMW-73 from 2006 to 2013 have consistently exceeded the GPS by as much as a factor of 6.5. Values for TMW-72 between 2006 and 2013 have ranged

from 4.3 to 8.2 pCi/L and frequently exceeded the GPS. Staff also makes the following observations regarding combined radium-226/228 values for the Point of Compliance (POC) wells for the period between 2004 and 2013:

- Values have consistently exceeded the GPS in well TMW-18. Values in TMW-18 have generally ranged from 12.4 to 26.8 pCi/L, with out-of-range values of 6 and 40.8 pCi/L reported for 7/28/2008 and 1/10/2005, respectively;
- For well TMW-16, values have consistently exceeded the GPS by up to a factor of 3;
- For well TMW-15, values have frequently exceeded the GPS between 2004 and 2013;
- Sporadic spikes in exceedance of the GPS were reported for well TMW-17 in 2005, 2008, 2010, 2011, and 2013.

*Natural Uranium*

The GPS stipulated in the license for natural uranium is 36.0 pCi/L. For natural uranium contamination, rather than being "confined to the northern edge of the tailings pile," the 36 pCi/L contours (based on highest natural uranium values) presented in the 2003, 2004, 2009, 2012, and 2013 Groundwater Monitoring Reports are seen to: (1) enclose an area encompassing the northern portion of the tailings impoundment and extending beyond it to the east and west; (2) enclose a separate area centered around monitoring well TMW-89 located several hundred meters north of the tailings impoundment; and (3) demarcate the eastern limits of a third area, located west of the tailings impoundment and encompassing the location of the catchment basin, the western limits of which are undefined.

Because the 36.0 pCi/L contour is unbounded on the west, the extent of natural uranium groundwater contamination in relation to the western limit of the bonded area needs to be determined. As acknowledged in the 2013 Annual CAP Review and Groundwater Monitoring Report, the volume of fluid (and thus the mass of contaminants) leaked from the Catchment Basin on the west side of the facility is unknown. Staff notes that monitoring wells TMW-10, TMW-72 and TMW-73, all within 70 meters for the western edge of the bonded area, have consistently exceeded the GPS since they were first sampled in 2006 or 2007 by factors of as much as 169 (TMW-73), 83 (TMW-10), and 38 (TMW-72).

Staff also makes the following observations with regard to natural uranium values reported for POC wells for the period from 2004 to 2013:

- Values have consistently exceeded the GPS in well TMW-16 by as much as a factor of 10.

*Manganese*

Staff has made several determinations with regard to manganese concentrations measured in both POC and catchment basin pump-back (CBPB) wells. The manganese GPS stipulated in the license for both of these sets of wells is 0.2 mg/L. Staff observations for manganese values reported for POC wells between 2004 and 2013 are as follows:

- Values have consistently exceeded the GPS in well TMW-18. Values in TMW-18 since 2004 have generally ranged from 1.04 to 1.54 mg/L, with out-of-range values of 4.72 and 12.9 mg/L reported for 1/10/2005 and 1/14/2008, respectively;
- Values for TMW-16 have frequently exceeded the GPS.

Staff observations for manganese values reported for CBPB wells between 2004 and 2013 are as follows:

- Values in TMW-99 have consistently exceeded the GPS by up to a factor of 4;
- Values in TMW-112 have frequently exceeded the GPS by as much as a factor of 3.5;
- Since 2011, values in TMW-100 have frequently exceeded the GPS;
- Spikes in reported values significantly in exceedance of the GPS are noted in wells TMW-113 (0.47 mg/L) and TMW-115 (0.32 mg/L) on 7/7/2013 and 10/20/2009, respectively.

*Iron*

Staff has also made determinations with regard to iron concentrations measured in both POC and CBPB wells. The iron GPS stipulated in the license for both of these sets of wells is 0.6 mg/L. Staff observations for iron values reported for POC wells between 2004 and 2013 are as follows:

- Values in well TMW-18 have consistently exceeded the GPS by as much as a factor of 15.

Staff observations for iron values reported for CBPB wells between 2004 and 2013 are as follows:

- Values in TMW-99 have consistently exceeded the GPS by up to a factor of 19;
- Values in TMW-112 have frequently exceeded the GPS by as much as a factor of 17, although exhibiting a broad range of fluctuations.

**RAI:**
The licensee should resolve or justify the discrepancies between the information in the application and that in the Annual CAP Review and Groundwater Monitoring Reports with regard to:

- The current extent of the combined radium-226/228 plume;
- The current extent of the natural uranium plume;
- On-going exceedances of the manganese GPS;
- On-going exceedances of the iron GPS.

**2) License Position or Statement**

In Section 2.1 of the Technical Review (TR), the application quotes from the 2013 Annual CAP Review and Groundwater Monitoring Report and cites a 2009 report by Telesto Solutions, Inc. entitled “Final Ground Plume Interpretation” as stating that:

> *The water level contours and flow directions on Figure 6 clearly show that the ground water pumping wells are providing complete containment of any water that could be impacted by the Tailings Impoundment, or facilities in the Catchment Basin area. Flow within the Battle Spring Aquifer converges towards the pumping centers and there is no potential for off-site excursion of potentially impacted ground water or wells that show elevated concentrations of U-Nat or Ra 226-228.*

**Basis:**
As noted in RAI-1, the NRC staff has determined that the overall area enclosed by the 5.8 pCi/L combined radium 226/228 contour in 2013 is larger and extends farther east than in previous years, for the first time reaching background monitoring well TMW-5. This observation does not reconcile with the assertion that well pumping has achieved complete containment of contaminated groundwater.

In Section 2.8 of the TR, it is also stated (citing from the "Final Ground Plume Interpretation" report) that:

> *Another mechanism that may delay the introduction of chemical mass into ground water is the perched waterbody that historically existed north, east and west of the tailings impoundment. Having been fed by tailings leakage, the perched water contained high concentrations of regulated chemicals. After the tailings leak was mitigated, the perched water body would have drained slowly downward towards the water table. Even though saturated conditions in the historical perched water zone are largely gone, slow unsaturated flow to water table is probably ongoing and this can introduce chemicals to ground water at the water table. In addition, typical heterogeneity in the geologic system likely leads to non-uniform vertical drainage that causes more chemicals to enter the ground water at some locations compared to others. The result is chemical hotspots that do not correspond to expected lateral transport originating at or below the tailings. This mechanism likely operated in the vicinity of the Tailings Impoundment, within the area outlined by the historical maximum extent of the perched water body (see Figure 1). (Now included in Appendix 16 of this document).*

Given that a perched waterbody would not be influenced by the existing pumpback wells, the movement of contaminated groundwater in the perched horizon should be assessed in relation to its potential to account for the expansion of the combined radium 226/228 plume within the main aquifer.

The licensee states in the 2013 Annual CAP Review and Groundwater Monitoring Report that:

> *All perched wells around the tailings impoundment were essentially dry as of the fall of 1989 and have not been pumped since that time*.

This appears to be a reiteration of the statement made in the August 1995 "Addendum to the Revised Environmental Report Geologic Cross Sections and Aquifer Information" (ML080590245) which states that:

> *As of September 1989 available fluid present in the perched aquifer had been pumped out and returned to the tailings impoundment. Therefore, the perched aquifer is no longer saturated*.

NRC staff would like to determine if the reported current lack of water in the perched wells is based on an inference from this statement or actual, current well observations. Staff notes that because the perched wells are located northeast and north of the tailings impoundment, the extent to which a perched water body may have been or be present elsewhere is uncertain in any case.

**RAI:**
The licensee should provide NRC with an assessment of the potential for contaminated groundwater migration within the perched horizon to contribute to expansion of the combined radium 226/228 plume within the main aquifer.

**3) License Position or Statement**

No water quality data is presented in Appendix 8 of the TR for the North Camp Well.

**Basis:**
The North Camp well was identified in the 1994 Revised Environmental Report (ML081010327) as a water supply well along with PWW-1, PWW-2 and Drake-1, for which data is presented in Appendix 10 of the TR. Staff notes that the North Camp Well (within 5 miles of the facility) is shown on the "Well Map – Fall 2013" included in Appendix 10 of the TR.

**RAI:**
The licensee should provide water quality data for the North Camp well or justify why it is not provided.

**4) License Position or Statement**

The public doses are reported in the 10 CFR 40.65 semiannual effluent monitoring reports. The licensee provided, in the application, a summary of the public doses (See pages 62 and 63) since the last license renewal in 2004.

**Basis:**
NRC staff reviewed the semi-annual effluent monitoring reports since 2004 and cannot determine the basis for the 440 mrem/yr per pCi/L dose conversion factor cited in each semi-annual effluent monitoring report. According to 10 CFR 20 Appendix B, Table 2, the dose conversion factor for Rn-222 is 500 mrem/yr per pCi/L based on the 1.0 E-10 uCi/ml limit value. The dose conversion factor is important in converting the air radon concentration into a dose to a member of the public. The licensee needs to provide a technical justification for using 440 mrem/yr per pCi/L and not using 500 mrem/yr per pCi/L.

**RAI:**
NRC staff cannot determine from the license renewal application the impact of radiation dose on the member of the public and whether the licensee is in compliance with 10 CFR 20 Subpart D. The licensee shall provide a justification for the use of the dose conversion factor of 440 mrem/yr per pCi/L as used in the 10 CFR 40.65 semi-annual effluent reporting requirement.

**5) License Position or Statement**

The licensee stated that, based on semiannual effluent monitoring reports since the previous renewal application in 2004, that the public doses do not exceed normal doses from natural background sources of radioactivity. In calculation #9 on page 63 of the application, the licensee states that the radon concentrations measured at the upwind air monitoring stations

during the two (2) quarters for a given semiannual period are averaged, corrected for the site equilibrium factor and converted to a background radon dose for the facility.

**Basis:**
According to 10 CFR 40.65, it states that:

> *On the basis of such reports and any additional information the Commission may from time to time require the licensee to take such action as the Commission deems appropriate.*

NRC staff cannot determined from the information provided by the licensee how all four quarters of radon results are incorporated into the annual radon dose.

**RAI:**
The licensee needs to provide justification as to why only two (2) quarters for a given semiannual period are averaged and why not the four quarters over an entire year to report an annual Total Effective Dose Equivalent (TEDE) from radon.

**6) License Position or Statement**

The licensee stated that, based on semiannual effluent monitoring reports since the previous renewal application in 2004, that the public doses do not exceed normal doses from natural background sources of radioactivity. In calculation #5 on page 63 of the application, the licensee states that an equilibrium factor is applied to the upwind radon concentrations to derive a background radon dose and to the average semiannual radon concentration in the Security Trailer to derive a radon dose to the nearest resident. An equilibrium factor table is provided in each semiannual 40.65 report.

**Basis:**
According to 10 CFR 20.1301, it states that the TEDE to an individual members of the public from the licensed operation should not exceed 0.1rem (1 mSv) in a year. The year as defined by 10 CFR 20.1003 means the period of time beginning in January used to determine compliance with the provisions of this part. NRC staff reviewed previous semiannual effluent monitoring reports and noted that the licensee computes an ongoing average of the equilibrium ratio. This ongoing average of the equilibrium ratio extends back to 01/01/1993. NRC staff has determined that the use of an ongoing average of the equilibrium ratio does not comport to 10 CFR 20.

**RAI:**
NRC staff has determined that the radon dose computed by the licensee using an equilibrium factor that represents the average equilibrium factors computed over a period ranging from 1993 to 2014 does not meet the definition for a year. The licensee needs to provide a technical basis for using an average equilibrium factor to compute the radon dose and how this comports to the definition of a year defined by 10 CFR 20 or compute an equilibrium ratio for the reporting year.

**7) License Position or Statement**

The licensee stated that, based on semiannual effluent monitoring reports since the previous renewal application in 2004, that the public doses do not exceed normal doses from natural background sources of radioactivity. In Calculation Parameters No. 3, it states that radon decay product exposures in working levels are measured semiannually in the Security Trailer using a calibrated Buck Basic 12, Bendix BDX-44, MSA or Sensidyne GilAir II air pump and filter and the filter is read by the modified Kusnestz Method.

**Basis:**
According to 10 CFR 40.65, it states that on the basis of such reports and any additional information the Commission may from time to time require the licensee to take such action as the Commission deems appropriate. NRC staff is seeking additional information to validate the radon decay exposure method and how this is representative with the RadTrak detectors placed in the kitchen and bedroom and changed quarterly.

**RAI:**
The licensee needs to justify the frequency for making a single measurement each semi-annual period and demonstrate that this radon progeny concentration is representative of the radon progeny in air over the entire six-month period. The licensee needs to explain how long the air is sampled, what type of air filter is used for collection, flow rate during air sampling, duration of time before counting, how long is the sample counted, type of counting equipment, and any correction factors used to compute the final radon decay product exposure or value. The explanation should include the overall uncertainties, and the lower limit of detection for the counting equipment.

**8) License Position or Statement**

According to the Technical Report (Kennecott, 2014), Kennecott measures (the total) Rn-222 concentrations at receptor location 4A (downward) and the Security Trailer using Track-Etch radon detectors and report these results in the semi-annual effluent report every six months.

**Basis:**
NRC staff has several objectives for the RAI. First, NRC staff wants to identify the Rn-222 concentration (and radon dose) contributed from the facility at the receptor locations 4A (downward) and the Security Trailer. Second, compare the calculated Rn-222 concentration with the measured Rn-222 concentration at these receptor point. And third, calculate the Rn-222 concentration at the hypothetical receptor location at the maximum projected concentration based on the wind rose and the Rn-222 inventory form the tailing impoundment. NRC staff would like to know if there is a hypothetical receptor location at a maximum concentration based on wind rose and actual Rn-222 inventory form the tailings impoundment.

**RAI:**

- Using the annual Rn-222 inventory (source team) from the tailings impoundment as reported in the semi-annual effluent report for 2014, calculate the annual average Rn-222 concentration at the receptor point 4A and the receptor point Security Trailer.
- Compare and report the calculated annual average Rn-222 concentrations at each receptor point to the annual average Rn-222 concentrations at each receptor point as reported in 2014 semi-annual effluent report.
- Using the annual Rn-222 inventory (source term) from the tailings impoundment as reported in the semi-annual effluent report 2014, calculate the annual average Rn-222 concentration at a hypothetical maximum concentration receptor point (based on meteorological wind rose) using the tailings impoundment as the point of release.