Request for Additional Information
Lost Creek KM Horizon and Lost Creek East Amendment Application

RAI-1 Poorly Defined Proposed Action for the KM Amendment

Description of Deficiency

The Lost Creek ISR, LLC (LCI) proposed action for the existing licensed area (KM Amendment or herein referred to as the KMA) is defined in vague terms. For example, LCI's sole explanation of the proposed action within the existing licensed area is one sentence in the cover letter that accompanied the amendment applications. That sentence states:

> *"[t]he KM Amendment application seeks approval to recover uranium … from the KM Horizon and increase the aerial* [sic] *extent of mining in the HJ Horizon."*

Also, in response to the NRC staff's Clarifying Question 9 (ML17094A620), LCI states:

> *"[a] comparison of Figure 2.1-1 from the original Technical Report versus Plate OP-2b from the LC East Amendment Technical Report clearly shows how the width and location of the mineralization have been refined over the years. Please note how the proposed wellfields extend further east and west while the width of the area has generally been reduced."* (ML17115A215)

The NRC staff compared Figure 2.1-1 from the original Technical Report with Plate OP-2b, and finds the following:

- The approved license application had proposed six mine units (MUs) (MU1 through MU6).
- MU1 and MU2 are approved for operations, and located along the originally proposed trend in the east-west direction; however, the completed MU1 encompasses the area originally designated as MU1 and MU2 and a portion of proposed MU4. The completed MU1 is somewhat narrower (approximately 300 feet) in the north-south direction than originally proposed. MU2 encompasses the originally proposed MU3 and MU5, and is wider (approximately 1000 feet) in both the north and south directions than the original proposed mine units.
- The KMA includes five mine units in the HJ Horizon within the licensed area. It greatly expands the east-west trend (3000 feet to the east and 2000 feet to the west) and extends the north-south width 1000 feet in the western extension.

Redefining the mine units' nomenclature, and mischaracterization that the width of the proposed wellfield areas have been "generally" reduced, have led to some confusion with respect to changes in the areal extent of wellfields in the HJ Horizon.

The NRC staff has verified that the extent of MU2 is consistent with the approved license application, despite its increase in width. The footprint for MU2 is generally within the originally proposed trend and staff affords licensees some degree of expansion based on subsequent delineation drilling. However, the proposed amendment greatly expands the footprint for the proposed wellfield in both the eastern and western extents.

Based on the results of this review, the NRC staff considers that the proposed action in effect establishes a new mine unit (MU4) that expands the areal extent to the west and expands MU5 (formerly MU6) to the east.

Basis for RAI

NUREG-1569 Acceptance Criterion 1.3(1) states:
"The application summary of proposed activities includes descriptions of the following items that are sufficient to provide a basic understanding of the proposed activities and the likely consequences of any health, safety, and environmental impact. … (d) Ore-body locations and estimated U_3O_8 content."

Request for Additional Information

Please confirm the NRC staff's understanding of the scope of the proposed action or provide an alternative explanation that addresses the concerns identified in this RAI.

RAI-2 Ambiguities and Uncertainties in the Conceptual Hydrologic Model for the K Shale and the Analyses of the Supporting Data

Description of Deficiency

As discussed below, the descriptions of the K Shale conflict with data presented in the KMA and the Lost Creek East Expansion Amendment (LCEEA)[1]. Analyses of supporting data, in particular the pumping tests conducted in 2013, are unconventional and contain errors. The accuracy of the analyses requires further explanation.

Thickness and Continuity of the Three Confining Units

Lost Creek Shale

In the approved license application, the thickness of the Lost Creek Shale (LCS), which is the upper confining unit for the HJ Horizon, is stated to be between five and 45 feet and laterally continuous over the existing licensed area (pages 2.7-11; 27-26). The isopach map for the LCS

[1] For NRC purposes the KMA and LCEEA are one amendment but in discussions, they may be treated separately. For example, a topic may be adequately discussed in the KMA, which concerns the existing licensed area, but may not be adequate for the LCEEA, which concerns the Lost Creek East expansion area.

in the approved license application was consistent with the narrative, but the extent of the mapping was limited to the area of the proposed wellfields. In the KMA, the thickness of the LCS is five to 45 feet and laterally continuous in the existing licensed area (page 10). However, the KMA did not include isopach mapping for the LCS within the existing licensed area. Therefore, the thickness of the LCS in the area of the proposed expansion is not documented.

In the LCEEA, thickness of the LCS is also reportedly five to 40 feet, and continuous throughout the proposed expansion area (page D5-7). However, the isopach mapping is inconsistent with the narrative, with several locations reportedly having thicknesses less than five feet (Plate D5-3a). Additionally, the report states that the LCS outcrops in the northern portion of the Lost Creek East expansion area without any demarcation of that observance.

Sage Brush Shale

In the approved license application, the thickness of the Sage Brush Shale (SBS), which is the lower confining unit for the HJ Horizon and the proposed upper confining unit for the KM Horizon, was between five and 75 feet and laterally continuous over the existing licensed area (pages 2.7-11; 2.7-27). The isopach map for the LCS in the approved license application was consistent with the narrative but the extent of the mapping was limited to the area of the proposed wellfields and not the entire licensed area. In the KMA, the thickness of the LCS is reportedly two to 50 feet and “virtually” laterally continuous in the existing permit area (page 10), or as reported elsewhere in the application, five to 75 feet (page 31). The KMA includes isopach mapping for the LCS (Plate 2.6-3a) within the existing licensed area, but depicts a minimum thickness of one foot at several locations including within the MU1 footprint and within the proposed Lost Creek East expansion area, which is inconsistent with the narrative. The mine unit wellfield data packages for MU1 and MU2 did not address the minimum thickness of the SBS.

In the LCEEA, the thickness of the SBS is two to 30 feet and “virtually” continuous throughout the proposed expansion area (page D5-8; 13) or five to 25 feet (page 34). The isopach mapping is consistent with the narrative (Plate D6.3c).

K Shale

There is no discussion of the K Shale, which is the proposed underlying confining unit for the KM Horizon, included in the approved application, as operations at that time were limited to the HJ Horizon. However, the approved application noted that mineralization did occur in the upper KM (UKM) and that it was underlain by a unit referred to as the No Name Shale (page 2.7-27).

The KMA reports a thickness of the K Shale from two to 40 feet and occurs throughout the licensed area but may be “sporatically absent locally” (page 11). On Figure 2.6-2, the regional continuity of the K Shale is described as unconfirmed. In the KMA, the report states that the K Shale is not found everywhere in the licensed area (page 11). The KMA states that “there are breaks in the continuity of the K Shale and pump test have shown it to be a leaky aquitard”

(page 12 and 13). Also, the KMA states "stratigraphic evaluations have shown it to be absent in small localities" and "when the K shale is less defined or contains more fine sand, there is measurable hydraulic connectivity" with the underlying units. Finally, the KMA states that the "K Shale is regionally extensive but not fully contiguous, therefore it is not considered a confining unit" (page 30) The K Shale Isopach Map has several locations listed with a 1-foot thickness, which is counter to the narrative, and is found throughout the licensed area (Plate 2.6-3b).

The LCEEA reports thickness of the K Shale from two to 30 feet, throughout the proposed area, and generally exhibits continuity and adequate confinement, but may locally be absent or represented by multiple overlapping shales. On Figure D5-2, the description for the K Shale is "…mudstone and claystone, commonly silty and/or sandy. May be absent or represented by multiple overlapping shales." The LCEEA discusses the K shale, as well as other shales, in historical context and states that the "…units may show continuity over large areas but regional continuity has not been demonstrated" (page 14) The K Shale isopach map in the LCEEA shows several locations reportedly with 1-foot thickness, which differs from the narrative, and suggests that the K Shale is found throughout the proposed Lost Creek East expansion area (Plate D5-3e).

Neither the KMA nor LCEEA includes an isopach map of the LCS.

Geologic Cross-Sections

The geologic cross-sections in the LCEEA exhibit the following breaks in a confining unit:

E1-E2	LCS
B1-B2	K Shale
A5-A6	K Shale
A6-A7	K Shale

In addition, no shale is depicted in both geologic cross-sections (Figures 2-2 and 2-3) included in Volume 4 of the LCEEA.

Supporting Data

In support of the conceptual model that the designated confining units will sufficiently minimize the unwanted migration of lixiviant, the report states that the confining characteristic of the units "have been demonstrated through pumping tests." However, several errors and omissions were noted by the NRC staff in the reported analysis of the pumping test data. The accuracy of these analyses requires further explanation. The following errors were identified in the report:

a) Barometric Efficiency

In Volume 4 of the LCEEA, Section 5.2 discusses barometric corrections applied to the 2013 pumping tests. Appendix C presents calculations for aquifer barometric efficiency, which

appear to incorrectly assign the formation barometric efficiency to the coefficient of determination (i.e., R^2), rather than the slope of that line (see page 109 of 576 of Volume 4). The error is compounded because the graph incorrectly assigns the barometric pressure to the ordinate rather than the abscissa. Water level corrections using the barometric efficiency values, including drawdown calculations, are not accurate. Also, Volume 4 of the LCEEA does not include figures depicting the uncorrected and corrected water levels.

Similar errors were noted in the barometric efficiency calculations in Volume 5 of the LCEEA. In addition, for several wells (e.g., MB11 and M-KM5A), the actual barometric efficiency appears to exceed a value of one.

The attachments to the KMA stated that the difference between barometric efficiency corrected and uncorrected drawdown was less than one percent and provided a figure depicting one example. While it may be true that the correction of one percent is for one example, it is difficult to make a generalized statement for all wells, especially if the uncorrected drawdown is quite low.

b) Depth, Depth to Water, and Water Level Above Pressure Transducer

In Volume 4 of the LCEEA, Appendix D provides, in table form, the pressure transducer data measuring the water fluctuations in the observation and pumping wells during various pumping tests. The column in the table listing the water levels has a heading “Depth (feet).” However, based on the graphs also provided in Appendix D, the data in the table may be “water level above pressure transducer” rather than “depth” (i.e., depth to water). The application does not include information on the elevation of the pressure transducer or measured depth to water during the test, such that groundwater elevation can be determined.

c) Pumping Test at Well M-KM7

i) Daily Fluctuations at Wells LC27M, M-HJ4 and M-KM8

For this pumping test, daily fluctuations can be observed in the water levels at wells LC27M, M-HJ4 and M-KM8. The LCEEA does not address these fluctuations. Staff notes that BLM livestock watering well 4775 is located in close proximity to well M-KM8. It was not clear from the description whether this well was operating during the test and if it influenced the daily fluctuations during operation of this well. If so, the approved application states that BLM’s well 4775 is shallower than sands targeted for production and the fluctuations do not support this statement. If not, please provide an explanation for the daily fluctuations observed in water levels at these wells.

ii) Drawdown at Well M-FG2

Table 6-2 of the application states that no drawdown was observed in the water levels at well M-FG2, based on barometric corrected values. The hydrograph for this well in Appendix D (page 214 of 576 of Volume 4)[2] suggests a possible relation to the pumping. However, it is not reported if the data are corrected or uncorrected with the barometric efficiency and whether the improper barometric efficiency factor may have influenced this determination.

iii) Drawdown at Well LC27M

In Volume 4 of the LCEEA, a vertical to horizontal anisotropy ratio is used in several curve fitting plots (e.g. center test well LC27M, south cluster wells M-HJ1 and M-HJ2A). The report does not discuss these ratios. Please provide a rationale for using these anisotropy ratios, and an explanation of the drawdown at this well in comparison to other observation wells.

iv) Drawdown at Well M-KM8

Table 6-2 reports a drawdown of 2.48 feet at observation well M-KM8 (KM Horizon) for the M-KM7 pumping test. Review of the observation well M-KM8 water level data in Appendix D (page 230 of 576 of Volume 4) indicates that the water level at this location continues to decrease for several days after pumping at the test well (M-KM7) ceased. The report should provide an explanation for this behavior.

v) Drawdown at Well M-N3

The water levels at well M-N3 were only measured sporadically during the pumping test. The hydrograph in Appendix D (page 245 of 576 of Volume 4) includes a data point one year and four months after completion of the pumping test without an explanation of the data. The report should provide an explanation of the data.

d) Pumping Test at Well M-HJ4

i) No Well in HJ Horizon Near Pumping Well

For this pumping test, the closest well to the pumping well in the HJ Horizon is approximately 4,000 feet. Consequently, the hydraulic properties calculated from this test are based on water levels at the pumping well and at an observation well with little to no drawdown. Please provide the rationale for not including a well closer to the pumping well during this test.

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[2] For references to a page “of 576 of Volume 4” refers to the pdf page numbering in file with ADAMS Accession No. ML1707A367. Otherwise, the reference is the specific page, table, figure, etc. of the document.

i) Drawdown at Well M-HJ5

Table 6-2 reports a drawdown of 0.81 feet at observation well M-HJ5 (HJ Horizon) for the M-HJ4 test. Review of the observation well M-HJ5 water level data in Appendix D (page 280 of 576 of Volume 4) indicates that the water level at this location decreases for several days after pumping at the test well (M-HJ4) ceased. The report should provide an explanation of the data.

ii) Delayed Response at Wells M-FG2 and MB-09

A footnote in Table 6-2 indicates that the maximum drawdowns at wells M-FG2 and MB-09 were recorded 114 hours after pumping cessation.[3] The report should provide an explanation of the data.

iii) Erratic Behavior at Well MB-09

The hydrograph in Appendix D (page 284 of 576 of Volume 4) presents the measured water levels for observation well MB-09 during the central cluster HJ Horizon test. Well MB-09 water levels show an approximate 1-foot increase, followed by an abrupt decrease after approximately 100 hours of pumping. The report should provide an explanation of this erratic behavior.

iv) Curve Fitting at Well MB-09

Table 6-2 indicates that the drawdown at observation well MB-09 (central cluster HJ Horizon test) is 0.57 feet. However, the curve fitting plot for this data suggests the drawdown exceeds 1.2 feet (page 458 of 576 of Volume 4). The report should provide an explanation of this discrepancy.

e) Pumping Test at Well M-KM4A

i) Drawdown at the Pumping Well

Table 6-2 indicates that the drawdown at pumping well M-KM4A is 26.33 feet. However, the post pumping water level recovery (page 307 of 576 of Volume 4) suggests the occurrence of a much larger drawdown. The report should provide an explanation for this phenomenon.

[3] LCI used the term “post pump shut-in”.

ii) Change in Pumping Rate

Table 7-1 indicates that there was an increase in the pumping rate in pumping well M-KM4A during the test. Table 7-1 does not present a transmissivity value for the pumping well, but transmissivity values are presented for observation wells M-KM5A and M-KM6. Please describe how the increase in pumping rate was accounted for in calculating the transmissivity for these observation wells.

iii) Justification for an Analysis by the Hantush Method

Table 7-1 indicates that the recovery data at pumping well M-HJ1 (south test cluster) was analyzed with the Theis method, but the curve fitting plot (page 501 of 576 of Volume 4) indicates that the Hantush method was used. Please resolve this discrepancy and describe why the Hantush method was used along, with the underlying assumptions of that method and how the assumptions were met.

f) Attachment D6-5, Volume 5, 2016 Pumping Tests

In Volume 5 of the LCEEA, the results from the pumping test conducted at well M-KM9 (KM Horizon North Cluster) are presented in Table 6-2. A maximum drawdown of 0.69 feet at observation well M-L6 (L Horizon) and 1.21 feet at observation well M-L7 (L Horizon) are reported. For both wells, review of the data in Appendix E suggests the maximum drawdown was observed approximately one day after cessation of the pumping test. However, the report did not provide the rationale for attributing the drawdown to the pumping test. Similarly, the maximum drawdown at well M-L6 (L Horizon) was observed several hours after completion of the pumping test at M-L7. The report should provide an explanation of the data.

The report states the six pumping tests conducted during 2016 "…indicate that the K Shale, or its equivalent, is a functional aquitard in the areas tested. The K-Shale should function even better during production when the pumping stress is offset by injection." The report does not define what is meant by "the K Shale equivalent" or the term "better," The NRC staff observes that the pumping rates used for the KM pumping tests were low, resulting in a small drawdown in the KM Horizon (i.e., lower than the proposed pumping rates in the June 2016 Plan without explanation). This, in turn, would lead to small drawdown in the L Horizon, making the results of these tests inconclusive. It is recognized that the pumping rates and the duration of tests conducted in the L Horizon were sufficient. However, the separation between the KM and L wells includes several shale stringers in addition to the K Shale. Therefore, it is unclear if the results are based on a "K Shale Equivalent" consisting of multiple shale stringers. Please provide an explanation for the noted deficiencies.

g) KMA, 2009 Pumping Tests

The pumping tests conducted in 2009 within the KM horizon at wells KPW-2 and KPW-1A (within the proposed location of MU3) show communication between the KM and L horizons and other unexplained phenomenon. For example, during the pumping test at KPW-1A, well UKMP-101, which is located 1515 feet from the pumping well, had 5.1 feet of drawdown whereas well KMP-1 which is located much farther at 3219 feet had a greater drawdown of 9.4 feet. In addition, for that test, well KMU-2, which is located in the underlying aquifer had a drawdown 20.8 feet, which exceeded the drawdown by four times at a well screened in the pumping aquifer (KM Horizon) at essentially a similar distance. Finally, for that test, both wells in the underlying aquifer (KMU-1 and KMU-2) reportedly had similar drawdowns of 21 feet but well KMU-1 is located only 89 feet from the pumping well whereas well KMU-2 is located 1515 feet from the pumping well. The communication suggests a lack of any confining unit and other abnormalities which should be addressed in the report including specific management or enhanced monitoring of this site-specific condition. The communication suggests a lack of any confining unit and the specific management or monitoring of this site-specific condition should be provided in the report. The report should provide an explanation of the data.

Summary

In the initial application for the existing licensed area, it was stated that the confining units to the HJ Horizon had a minimum thickness of five feet. In the current application, the minimum thickness of two of the three confining units may be five feet, two feet, one foot or absent. Also, no updated information is provided on the third confining unit (K Shale: Note that the K shale would not have been discussed in the original application because operations in the KM Horizon was not being sought.)

The analyses of pumping test data that support a conceptual model, with the ability of the confining units to contain the lixiviant, included analytical errors, insufficient analyses, and contradictory information to the proposed conceptual model.

<u>Basis for RAI</u>

NUREG-1569 Section 2.7.2 provides guidance on the following areas of review:

> *At a minimum, the reviewer should evaluate whether the applicant has developed an acceptable conceptual model of the site hydrology and whether the conceptual model is adequately supported by the data presented in the site characterization. To this end, the reviewer should: … 3) Evaluate the site hydrogeologic conceptual model for ground-water flow in potentially affected aquifers. Review available data from well logs and hydrologic tests and measurements to obtain confidence that sufficient data have been collected and that the data support the applicant's hydrologic conceptual model for ground-*

water flow within and around the permit boundary. The applicant's interpretation of ground-water hydraulic gradients (used to infer flow direction), horizontal hydraulic conductivity, and the thickness, areal extent, and vertical hydraulic conductivity of confining formations should be evaluated. Examine pumping tests, analyses, and/or other measurement techniques used to determine the hydrologic properties of the local aquifers and aquitards that affect or may be affected by the proposed in situ leach activities. Also examine pumping tests that are used to investigate vertical confinement or hydraulic isolation between the ore production zone and upper and lower aquifers."

Request for Additional Information

Please provide a uniform, conceptual model for the confining units that is consistent with supporting data and address the information requests noted in the "Description of Deficiency" section above. Furthermore, the information submitted suggests areas that may require a greater density of wells than one well per four acres (see RAI 4). Please provide a justification for maintaining the minimum well density, especially for the L Horizon.

RAI-3 Lack of Detail on Historic Drillholes

Description of Deficiency

In Section 2.6.2.4 of the KMA, the report states that prior to acquisition by UR-Energy, 1,064 exploration holes were drilled within the currently defined Lost Creek East expansion area, exploration by UR-Energy was limited to 16 test holes, and since acquisition, UR-Energy has conducted 179 delineation holes plus installation of 28 wells.

In Section D2 of the LCEEA, the report repeats the same text, but does not report the 179 delineation holes. The report did not include a summary table of the historic drill holes for either the existing licensed area or the Lost Creek East expansion area.

Basis for RAI

NUREG -1569 Acceptance Criterion 2.7.3(3) states " [a]ll significant borehole data should be included in an appendix."

NUREG -1569 Acceptance Criterion 3.1.2 states " [t]he reviewer should pay particular attention to the techniques employed to prevent hydraulic communication between the overlying or underlying aquifers through well boreholes."

Request for Additional Information

Please provide a table listing the status of all drillholes and wells within the existing licensed area and the Lost Creek East expansion area.

RAI-4 Lack of Detail on the Excursion Monitoring Program\Vertical Containment

Description of Deficiency

The KMA and LCEEA amendments contain the following statements with respect to the excursion monitoring program and vertical containment:

- "The model indicated that an excursion into the L Horizon can be successfully recovered using engineering controls. Finally, the model indicated that underlying monitor wells in the L Horizon should be focused on areas where the K shale is the thinnest." (KMA page 20)

- "The K Shale underlies the KM Horizon, but it is not considered a true, regionally ·extensive confining unit. However, based on testing results to date, it has been demonstrated that the minor communication, between the production zones and the underlying L Horizons, can be managed through operational practices, detailed monitoring, and engineering operations.

  Future "Mine Unit" scale pump tests results, combined with site specific geologic and hydrologic data, will be utilized to determine the appropriate operations monitoring scheme for each planned Mine Unit." (KMA page 20)

- "In general, the KM Horizon will be mined prior to the overlying HJ Horizon. In such cases, the water quality of the restored KM Horizon will be determined and will serve as the monitored underlying aquifer during recovery of HJ Horizon mineral.

  If the KM Horizon is mined prior to the overlying HJ Horizon, restoration of the KM Horizon may or may not be finalized prior to mining the HJ. If the KM is not restored, then the aquifer underlying the KM will be monitored for excursions until such time the KM is restored at which point the KM Horizon will serve as the monitored underlying aquifer for the HJ. If the KM Horizon is restored prior to mining the HJ Horizon, the restored baseline water quality of the KM Horizon will be determined and the KM Horizon will serve as the monitored underlying aquifer.

  The specific method for determining baseline and the monitoring plan will be outlined in each respective Mine Unit application.

  See Section 3.2.7.4 of the original Lost Creek Technical Report for additional detail." (LCEEA page OP-20)

- "The lower production zone aquifer (KM Horizon) is bounded by a laterally extensive upper confining unit, but a lower laterally extensive confining unit is absent. However,

based on testing results to date, it is anticipated that the minor communication between the production zones and the overlying and underlying horizons can be managed through operational practices, detailed monitoring, and engineering operations." (LCEEA page 36)

- "The L Horizon groundwater flow direction and gradient are not consistent with the regional conceptual regime, and is likely due to insufficient data (only three data points), and the presence of numerous faults (Figure 1-2). It is anticipated that with the completion of additional L Horizon monitoring wells, the flow direction and gradient will align with the regional regime." (LCEEA page 6, Hydrologic Tests – L Horizon)

The above statements do not provide the NRC staff with sufficient information to make a reasonable determination finding that the licensee will be able to adequately confine the regulated materials to locations and purposes authorized in the license (see 10 CFR 40.41(c)), or that the proposed monitoring program is adequate based on the proposed density of wells.

A similar rationale for management or operational controls was made in the application for the existing licensed area. For example, the approved application stated:

> "*[b]ased on testing results to date, it is anticipated that any minor communication between the HJ Horizon and the overlying and underlying sands can be managed through operational practices, detailed monitoring, and engineering operations.*" (page 2.7-18)

Furthermore, the original application stated:

> "*[o]verlying and underlying wells will be installed at a density of about one well for each four acres of mine unit area. The actual density will be based on the aquifer characteristics of the mineralized zone and the overlying or underlying aquifer; and specific locations may be targeted depending on the thickness and continuity of the shale separating the mineralized zone from the overlying or underlying aquifer. If conditions are encountered at a prospective mine unit, such that vertical confining layers are very thin or absent, then the local stratigraphy will be evaluated and the mine unit operations and monitoring will be adjusted for the situation. These adjustments may include placement of the overlying or underlying monitor wells in different stratigraphic horizons within the mine unit, rather than in the separate overlying or underlying aquifer. Other adjustments could include additional operational controls, such as localized higher production rates, to help ensure none of the mining fluids migrate from the mineralized zone.*" (Page 3-7)

However, based on past operational history, these commitments for operational management have not been implemented consistently in the existing licensed area. For example, the wellfield data packages for MU1 and MU2 did not report any analysis of the placement of wells

relative to areas that the confining units thinned. In the KMA, instead of a minimum of five feet, the thickness of the confining units decreased to one foot or is non-existent, yet there is no discussion of this in either wellfield package.

Of greater concern is the number of vertical excursions, number of failed mechanical integrity testing (MIT) on wells that had passed their original MIT, and other information that suggests a higher propensity for a vertical excursion due to site conditions. However, the KMA and LCEEA applications did not provide an analysis of this history. Three wells had been on excursion status at least once since operations began in October 2013 (two wells (MU-104 and MU-109) in the underlying aquifer and one well (MO-108) in the overlying aquifer). The excursion status for both wells in the underlying aquifer was due to over-pressurization. While the licensee performed appropriate corrective actions following the excursion status, the NRC staff does not consider these actions as “managed through operational practices”. During the pumping test for the wellfield data package conducted prior to operations, both wells had the largest observed drawdown of any KM observation well, (except well MU-108, which lost its integrity and ultimately had its casing replaced). The excursion status for the third well, MO-108, is attributed to the failed integrity of the casing of two nearby injection wells, rather than migration fluid through the confining unit.

The NRC staff notes that this facility has had higher than normal MIT failures. For example, for the last two quarter reports (2016 fourth quarter and 2017 first quarter) LCI reported two failed MIT of 45 wells tested (4.9%) whereas Nichols Ranch reported five failed MIT of 147 wells tested (3.4%) and Ross reported one failed MIT of 229 wells test (0.4%). Historically, LCI failure rates have exceeded 3 percent and during 2015, LCI failure rate reached 8.0 percent. The higher failure rates may be due, in part, to difficulties in completing a well due to site conditions.

Another example is the leakage through borehole LC254. This borehole is not part of the historic drillholes as it was completed and assumed to be abandoned using the current and appropriate abandonment procedures by the applicant after 2008. The leakage through this abandoned borehole, and the possible inadequacy of the abandonment by grout, was not addressed in the amendment applications.

<u>Basis for RAI</u>

NUREG -1569 Areas of Review 2.7.1(3): “A description of site hydrogeology, including … (iii) estimated thickness and lateral extent of aquitards, and other information relative to the control and prevention of excursions”

NUREG -1569 Acceptance Criterion 3.1.3(3): “The number, location, and screened intervals of excursion monitoring wells are described in sufficient detail, follow industry standard practice, and are adequate to ensure prompt detection of horizontal and vertical excursions, taking into account site specific parameters such as local geology and hydrology. Acceptance criteria for methods and calculations used to determine the placement of horizontal and vertical excursion monitoring wells are presented in Section 5.7.8.3 of this standard review plan”.

NUREG -1569 Acceptance Criterion 5.7.8.3(3): "The applicant establishes criteria for determining monitor well locations. … NUREG/CR–6733 (NRC, 2001, Section 4.3.3) established that significant risks for vertical excursions may exist if monitor wells are randomly located, given the typical criteria for spacing of vertical excursion monitor wells at licensed *in situ* leach facilities {e.g., one well per 1.6 ha [4 acres] for overlying aquifers; one well per 3.2 ha [8 acres] for underlying aquifers}. Thus, location of vertical excursion monitor wells within the well field should be such that the likelihood of detecting a vertical excursion is maximized. The appropriate number of these monitor wells may vary from site to site. … In well fields where the production zone confining layers are particularly thin, or of questionable continuity, a greater number of monitor wells is appropriate. In general, when the direction of ground-water flow in an upper or lower aquifer is well known, the applicant should consider locating these wells on the hydraulically down gradient side of a well field, in areas where production zone confining layers may be thin or incompetent, and in areas where injection pressure may be highest (i.e., closer to injection wells than to production wells)".

NUREG -1569 Acceptance Criterion 5.7.8.3(5): "[t]he applicant defines operational approaches for the monitoring program."

Request for Additional Information

Please provide specific information on changes to the excursion and baseline monitoring programs in areas where the HJ and KM wellfields overlap and the confining unit may not be adequate. The information should include methods to obtain a wellfield baseline, and other standards and application of those standards in areas where the production units directly overly one another, and in areas where a production unit overlies/underlies only the spacing between perimeter well and production unit of the other wellfield. Similarly, the information should detail restoration operations in areas that overlap.

Also, in areas where the confining unit may be insufficient, please provide detailed information on the management of the operations of the production units in that area or commitments for enhanced monitoring.

RAI-5 Unconfined/Low Confining Pressure for HJ Horizon

Description of Deficiency

Based on the reported bedding and geologic cross sections, the LCEEA demonstrates that the production horizons, specifically the HJ Horizon, are found at increasingly shallow depths in the northern area of the Lost Creek East expansion area. In fact, the report states that the HJ Horizon is unconfined on the east side of the Lost Creek East expansion area (D6.5.2; page 34) and its saturated thickness was insufficient to sustain a long-term pumping test at the northern cluster (page 6 of Volume 4). However, the application does not depict where the HJ Horizon becomes "unconfined' (or not fully saturated) or discuss the impacts of the unconfined or limited

saturated conditions on operations (e.g., ability to maintain and inward gradient, solubility of oxygen in the lixiviant, lack of an overlying aquifer, etc.)

Basis for RAI

The applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life and property (10 CFR 40.32(c)).

The licensee shall confine his possession and use of source and byproduct material to the locations and purposes authorized in the license (10 CFR 40.41(c)).

Request for Additional Information

Please provide information on areas where the HJ Horizon is not fully saturated, and modifications to operations where the lower existing hydraulic pressures may require modifications to the ISR operations.

RAI-6 Lack of Detail on Cross Sections

Description of Deficiency

The geologic cross sections in the LCEEA (Plates D5-2a through D5-2j) lack the projection of the potentiometric surfaces for the horizons of interest.

The geologic cross sections in LCEEA Technical Report Volume 4 (Figures 2.2 and 2.3) lack any scale bars or potentiometric surfaces.

Basis for RAI

NUREG-1569 Acceptance Criterion 2.6.3(2) states that all maps and cross sections are at sufficient scale and resolution to show clearly the intended geologic information. Maps show the locations of all site explorations such as borings, trenches, seismic lines, piezometer readings, and geologic cross sections.

Request for Additional Information

Please revise the cross-sections with the appropriate potentiometric surface projections and scale bars.

RAI-7 Discrepancies in the Proposed Schedule(s)

Description of Deficiency

The LCEEA includes a schedule for development, production and restoration of the current and proposed mine units (wellfields) on Figure OP-4a, an anticipated schedule for bond increases associated with the mine unit developments on Figure RP-3, and a schedule for developing input parameters to the MILDOS-AREA code in Attachment D10-2. The proposed schedules are inconsistent. Also, the schedules extend beyond the expiration of August 31, 2012, for the existing license.

Basis for RAI

NUREG-1569 Acceptance Criterion 1.3(1) states: "[t]he application summary of proposed activities includes descriptions of the following items that are sufficient to provide a basic understanding of the proposed activities and the likely consequences of any health, safety, and environmental impact. … (g) Estimated schedules for construction, startup, and duration of operations".

Request for Additional Information

Please provide a single schedule for the project.

RAI-8 Insufficient Detail on the Cumulative[4] Drawdown Analysis

Description of Deficiency

a) Table OP-3

The LCEEA included a summary of aquifer characteristics for the drawdown calculations for the life of each mine unit. In response to staff's clarification issues, Table OP-3 was revised by the applicant to correct the information staff identified during its acceptance review. Staff has identified the following additional deficiencies during its detailed technical review:

i) Lack of Revision to the Calculated Drawdown in the Revised Table

While LCI corrected the aquifer properties in the revised table for MU5, MU7, MU10, and MU9, the calculated drawdown remained unchanged for two of those mine units (MU5 and MU10). If the properties were changed, the calculated drawdown should reflect those changes.

[4] Staff is using the term "cumulative" as was used in the report for discussing the "cumulative" impacts of the proposed action. Staff is not using the term "cumulative" in context of the meaning under the National Environmental Policy Act.

ii) Production/Restoration Life of the Mine Units

The table lists the life of the various mine units from 6.7 to 16 years. This life is inconsistent with each of the proposed schedules.

iii) Average Net Consumptive Use

The table lists the net consumptive use between 15.7 and 45 gallons per minute, but it provides no supporting documentation on the method used to calculate those values.

b) Analytical Method to Establish Cumulative Drawdown

In Section OP 3.6.3.3 of the LCEEA, the report states that the consumptive use of groundwater is expected to be minimal, with the vast majority of groundwater used in the ISR production and restoration being treated and re-injected. To quantify the cumulative drawdown, the report includes an analytical solution to a single well modeling a mine unit at its centroid, and reports the calculated drawdown for each mine unit at a radial distance of two and three miles. Based on information contained in the application, additional information is needed on the assumptions and use of the results for the stated purposes.

i. Assumptions of Homogeneous and Infinite Aquifer

The report includes a summary of the basic assumptions for using the analytical solution. The report further states that: (1) the analysis is conservative because of the assumption of no recharge to aquifer; and (2) the calculations neglect the impact by the known fault systems which limit groundwater flow, thus restraining the radial spread of the drawdown.

A) For confined systems with effective confining units, as reported for the site, recharge would be negligible. The NRC staff does not consider induced infiltration by drawdown (leaky aquifer) as recharge, because it is inconsistent with another assumption of Theis (bounded by aquicludes).

B) The faults are not consistent with homogeneous and isotropic aquifer. Also, if the faults limit the drawdown, then the source of water must be the surrounding aquifer or from storage in the area bounded by the faults. This would lead to excessive drawdown at the mine unit.

C) According to information contained in the LCEEA, the HJ Horizon is not fully saturated and outcrops along the eastern areas of Lost Creek East expansion

area are due to bedding orientation. Therefore, the assumption of an infinite aquifer is invalid.

ii) Timing and Superposition

The report states that "[t]he cumulative drawdown effect of multiple mine units operating simultaneously can be determined by summing the individually computed drawdown at a common point in time and distance." However, the report did not provide any examples (e.g., BLM wells), or address that the method described does not account for the staggered operations of the mine units or any residual drawdown.

iii) Nearby Receptors

The report concludes that the potential impacts to groundwater quantity outside of the existing licensed area, due to the proposed consumptive use, is small, but it does not provide any supporting analysis. The report discusses potential impacts to surface water elevation in the nearby Kennecott Sweetwater Mill, but it provides only a conclusory sentence on the "loss of use" to wells outside of the existing licensed area.

Iv) Maximum Drawdown within a Mine Unit due to Mutual Interference

The report did not address the maximum drawdown within the individual mine units during operation or from mutual interference by the surrounding mine units.

c) Cumulative Drawdown from LCI's Water Supply Wells

The report provides a discussion of the mutual interference of drawdown from the two water supply wells completed in the N Horizon and calculates a "maximum" interference drawdown of 23.2 feet mid-way between the two wells. While the drawdown mid-way between the water supply wells is 23.2 feet, it is neither a maximum interference drawdown (the mutual drawdown increases going toward each well) nor a minimum (because the wells are operating at differing pumping rates).

<u>Basis for RAI</u>

NUREG-1569 Acceptance Criterion 3.1.3(5) states: "[t]he description of the *in situ* leaching process includes the following information and demonstrations: … (f) An analysis of the effects that *in situ* leach operations are likely to have on surrounding water users has been provided."

NUREG-1569 Acceptance Criterion 7.1.3(4) states: "[t]he applicant has provided an adequate evaluation of the environmental resources that are vulnerable to the incremented effects from

the cumulative impacts of the proposed action and other past, present, and reasonably foreseeable action."

Request for Additional Information

Please provide an acceptable cumulative drawdown analysis to address the above deficiencies.

RAI-9 Vertical Hydraulic Gradient Calculations

Description of Deficiency

In Volume 5, Table 2-1 lists information used to calculate the vertical gradient. In one column with the heading "Difference in Water level Elev. (ft)," the reported value is the difference in depth to water measurement, rather than the difference in potentiometric elevation.

Basis for RAI

NUREG-1569 Section 2.7.3 "*Acceptance Criteria"* states: "[t]he characterization of the site hydrology is acceptable if it meets the following criteria: … (3) The applicant has described the local and regional hydraulic gradient and hydrostratigraphy."

Request for Additional Information

Please explain the significance of the difference in measured depth to water and its use in determining the vertical gradient.

RAI-10 BLM Well 4451

Description of Deficiency

According to the KMA, the Wyoming State Engineer's Office records indicate that BLM well 4451 has a well depth of 900 feet and static water level of 104 feet, with an unrecorded screened interval. This well is reportedly screened below the target zones based on the depth. The KMA states that in October 2013, the well was "E-logged" and, based on that investigation, it was determined that the well had 240 feet of casing and the hole caved in below the casing depth (page 23). Also, at the time of the investigation, the depth to the static water level was 148 feet. The KMA did not discuss the implication of the 2013 findings on the water quality measurements since 2009 or the potential impacts from the ISR operations on the well yield if the open hole is limited to shallow depths.

Basis for RAI

NUREG-1569 Acceptance Criterion 2.2.3(1) states: ”[i]nformation is presented in detail sufficient to understand the surrounding land and water uses, such that the likely consequences imposed by *in situ* leach operations can be adequately assessed.”

Request for Additional Information

Please provide an analysis of BLM well 4451 (quality and quantity) in light of results of the 2013 testing.

RAI-11 Background Radiological Characteristics

Description of Deficiency

Section D10 provides baseline information on direct gamma, air particulate and radon measurements collected as part of the preoperational monitoring program. The information presented in the application needs clarification, as multiple data gaps were identified in the preoperational monitoring program for the LCEEA.

Basis for Request

10 CFR Part 40, Appendix A, Criterion 7, requires: “At least one full year prior to any major site construction, a preoperational monitoring program must be conducted to provide complete baseline data on a milling site and its environs. Throughout the construction and operating phases of the mill, an operational monitoring program must be conducted to measure or evaluate compliance with applicable standards and regulations; to evaluate performance of control systems and procedures; to evaluate environmental impacts of operation; and to detect potential long-term effects.”

NUREG-1569, Acceptance Criterion 2.9.3(1) states: “Monitoring programs to establish background radiological characteristics, including sampling frequency, sampling methods, and sampling location and density are established in accordance with pre-operational monitoring guidance provided in Regulatory Guide 4.14, Revision 1, Section 1.1 (NRC, 1980).” RG 4.14 provides guidance on preoperational environmental monitoring at uranium mills.

Request for Additional Information

Please address the following items regarding the preoperational environmental monitoring program for the LCEEA:

a) Air (Particulate and Radon) Sampling Station Locations

Regulatory Guide 4.14 recommends air particulate and radon sampling at three locations at or near the site boundaries, one location at or near the nearest residence, and one control location remote from the site for preoperational monitoring. Factors to consider in determining sampling locations include: (a) average meteorological conditions (wind speed, wind direction, atmospheric stability); (b) prevailing wind direction; (c) site boundaries nearest to mill; (d) direction of nearest occupiable structure; and (e) location of estimated maximum concentrations of radioactive materials.

Sections D-4 and D-10 and Figure D4-6 of the report contain information on the direct gamma, air particulate, and radon measurements acquired during the preoperational monitoring period at one sampling station (HV-6/PR-13). This station was installed at the eastern boundary of the Lost Creek East expansion area to obtain preoperational and operational monitoring data from the eastern site boundary. Based on meteorological data contained in LCI's report, "Meteorology, Climatology, and Air Quality Data Report for the Lost Creek Uranium In-Situ Recovery Project Modifications," (ML16095A088) air sampling station HV-6 appears to be located favorably for measuring emissions from the CPP. Table D10-2 provides high volume air sampling results for the fourth quarter of 2012 through the first quarter of 2014 for the HV-6 air sampling station. The minimum detectable concentrations are provided for each of the radionuclides, except for natural uranium.

Please provide the minimum detectable concentration for the measurements of natural uranium in high-volume air samples listed in Table D10-2, or an explanation of why it is not available.

b) Direct Radiation Measurements Using Gamma Scans

Regulatory Guide 4.14 recommends that gamma radiation measurements should be made with passive integrating devices, pressurized ion chambers, or properly calibrated portable survey instruments. Direct gamma radiation measurements of radium-226 concentrations in soils at Lost Creek East expansion area are summarized in Attachment D10-1, "Baseline Radiological Survey Report; Lost Creek East in-Situ Uranium Mine, Sweetwater County, Wyoming (September 2013)." This report does not correlate sodium-iodide detection system measurements with other radionuclides in surface or subsurface soils, such as natural uranium, thorium-230 and lead-210.

Characterization of background gamma radiation in the Lost Creek East expansion area consisted of two components. The first component was measurement of direct radiation with passive integrating devices. In support of the original application for the existing licensed area, thermoluminescent dosimeters (TLDs) were installed at 12 locations in and around the area, based on MILDOS-AREA analyses. For the LCEEA, the location of optically stimulated luminescence dosimeters (OSLs), air monitoring stations, and radon track etch detectors appears to be based on the existing licensed area, rather than the Lost Creek East

expansion area, and there is no correlation to MILDOS-AREA analyses for their placement. The second component was the use of portable radiation detectors mounted on utility-terrain vehicles, as described in Attachment D10-1. This report summarizes and analyzes radiation measurements collected within the Lost Creek East expansion area one year earlier by Tetra-Tech, Inc.

Please provide justification for the placement of OSL, air monitoring and radon track etch detectors for the characterization of the Lost Creek East expansion area.

c) Surface Soil Samples

Regulatory Guide 4.14 provides guidance on the preoperational and operational aspects of effluent and environmental monitoring at uranium mills. NUREG-1569, Acceptance Criterion 2.9.3(2), states: "Soil sampling is conducted at both a 5-cm [2-inch] depth as described in Regulatory Guide 4.14, Section 1.1.4 (NRC, 1980) and 15 cm [6 in] for background decommissioning data." All surface soil samples should be analyzed for radium-226, and ten percent of the surface soil samples should be analyzed for natural uranium, thorium-230 and lead-210.

Section 2.9.1 of the original Lost Creek Technical Report describes soil sampling conducted in support of the preoperational monitoring program for the original Lost Creek license application. Information on soil sampling at 5-cm or 15-cm depths within the Lost Creek East expansion area is not included in the LCEEA.

Also, as noted above, the September 2013 Tetra-Tech, Inc. does not contain information on correlations between direct gamma measurements using sodium-iodide detectors with natural uranium, thorium-230 or lead-210 in surface or subsurface soils.

Please provide justification for not performing soil samples at 5-cm or 15-cm depths, or indicate where this can be found in the LCEEA.

d) Subsurface Soil Samples

Regulatory Guide 4.14 provides guidance on the preoperational and operational aspects of effluent and environmental monitoring at uranium mills. It recommends collection of five subsurface soil samples to a depth of one meter, and that all subsurface soil samples should be analyzed for radium-226, and one set of subsurface soil samples should be analyzed for natural uranium, thorium-230 and lead-210.

Although subsurface soils samples were assayed as part of the original Lost Creek application, there is no information on subsurface soil sampling within the Lost Creek East expansion area. As noted above on direct gamma measurements, the September 2013 Tetra-Tech, Inc. report does not contain information on correlations between the sodium-

iodide detection system measurements with other radionuclides in subsurface soil, such as natural uranium, thorium-230 and lead-210.

Please provide justification for not performing subsurface soil samples, or indicate where this can be found in the LCEEA.

e) Sediment Sampling

Regulatory Guide 4.14 recommends sediment sampling at two locations in each surface water location (e.g., streams, rivers, drainages) crossing the site boundary, and any offsite areas that that may be subject to direct runoff from potentially contaminated areas. Section 1.1.2 of Regulatory Guide 4.14 states, “Any stream beds that are dry part of the year should be sampled when water is flowing. Samples should be collected at the site boundary or at a location immediately downstream of the area of potential influence.” Section 1.1.4 of this regulatory guide states, “One set of sediment samples should be collected from the same surface water locations as described in Section 1.1.2.”

For the application in support of the existing licensed area, sediment samples were collected at the upstream and downstream permit boundaries and at the Crooked Well Reservoir, which is a small on-site impoundment of East Battle Draw that traps sediment when there is flow in the drainage. Composite samples of 10 to 20 subsamples were collected along a transect to a depth of eight cm (three in), and then analyzed for natural uranium, radium-226, thorium-230 and lead-210. The NRC staff concluded that the collection and analysis of sediments for the existing licensed area were consistent with Regulatory Guide 4.14.

The sediment sampling locations associated with the existing licensed area site boundary do not correlate with site boundaries of the Lost Creek East expansion area.

The LCEEA does not address sediment sampling downstream of stock ponds located in the Lost Creek East expansion area that are used by the Bureau of Land Management.

Also, there appears to be a contradictory statement regarding the need for sediment sampling in the Lost Creek East expansion area. The last sentence on page D10-1, Section D10, of the LCEEA states, “Because there is no perennial surface water in the Permit Area, sediment sampling was not conducted.” Sediment sampling is not limited to perennial surface water, according to Regulatory Guide 4.14. Sediment samples should be collected from stream beds that are dry part of the year when water is flowing. As noted above, sediment sampling was conducted for the original Lost Creek site area, and Section 2.7.1.1 of the LCEEA, “Drainage Characteristics,” indicates that drainages in Lost Creek East expansion area are ephemeral and flow during spring snowmelt.

In addition, Tables D6.1-2 and D6.1-3 provide the results of storm water and snow melt sampling at Lost Creek East expansion area boundaries. Therefore, sediment sampling

should be conducted at these locations, in accordance with Regulatory Guide 4.14 recommendations.

Please provide additional information on sediment sampling of ephemeral streams, storm water and snow melt for the Lost Creek East expansion area. The information should address analyses for natural uranium, radium-226, thorium-230 and lead-210, and a summary or comparison of sediment sampling performed for the original Lost Creek licensed and the Lost Creek East expansion area boundaries.

Please provide information or a justification for not conducting sediment sampling downstream of stock ponds located in the Lost Creek East expansion area that are used by the Bureau of Land Management.

f) Surface Water Sampling

Regulatory Guide 4.14 recommends surface water sampling at site locations that can include large permanent onsite water impoundments, such as a pond or lake, offsite impoundments that could be subject to direct surface drainage from potentially contaminated areas, surface waters, or drainage systems crossing the site boundary, and surface waters that could be subject to drainage from potentially contaminated areas. Surface water samples are collected as a grab sample on a monthly and quarterly basis for water impoundments and drainage systems, respectively, and analyzed for suspended and dissolved natural uranium, radium-226, thorium-230, lead-210 and polonium-210 at specific intervals.

In the letter dated April 18, 2017 (ML17115A194), it is stated that attempts to collect surface water samples from drainages were met with limited success due to the lack of precipitation. According to information contained in Section D6, insufficient water was available to conduct a complete analysis, which has been problematic since surface water sampling commenced in 2007. Contributing factors are reported to include poor precipitation, sandy soils, and high evaporation rates, which collectively result in minimal runoff and a lack of sufficient surface water for sampled collection and analysis.

Results of surface water sampling is presented in Tables D6.1-2 and D6.1-3. Table D6.1-2 provides historic water quality results for the west/east Battle Spring Draw, and Table D6.1-3 provides the results of storm water and snow melt sampling at the Lost Creek East expansion area boundaries. The radionuclides analyzed include natural uranium, radium-226, and thorium-230, but not lead-210. Lead -210 is one of the radionuclides recommended for analysis in Regulatory Guide 4.14. In Tables D6.1-2 and D6.1-3, the radionuclides analyzed in surface water samples include natural uranium, radium-226, and thorium-230, but not lead-210.

Please provide additional information on surface water sampling of ephemeral streams, discharges from stock ponds, and storm water and snow melt for the Lost Creek East expansion area.

Please provide the rationale for not including lead-210 in surface water sample analyses.

g) Vegetation, Food, and Fish Sampling

Regulatory Guide 4.14 recommends the collection of three vegetation samples, three food samples of each type (crops, livestock, etc) within three kilometers of the site, and fish samples from each body of water. The samples should be analyzed for natural uranium, radium-226, thorium-230 and lead-210.

Vegetation and food samples were collected and analyzed as part of the original Lost Creek preoperational monitoring program. Information on sampling sediments, vegetation and food is available in Sections 2,9 of the Technical Report for the original license application. Also, Section 2.2.1 of the 2011 Lost Creek Technical Report states that the only agricultural production within the existing licensed area, or within 3.2 km (two mi) of the existing licensed area, is related to grazing. Three grazing allotments were reported to provide forage for cattle, horses, and sheep. The NRC staff considered the vegetation baseline sampling acceptable for the existing licensed area, and concluded it was not necessary to obtain fish and crop samples, based on justifications provided by LCI. The NRC staff also accepted justifications for not collecting crops or sampling for large or small game animals in the existing licensed area. The collection and analysis of preoperational beef samples were found to be consistent with the food sampling recommended in Regulatory Guide 4.14.

In the letter dated April 18, 2017 (ML17115A194), it is stated that there are no fish in the area to sample. However, there is no information provided in that letter, or the LCEEA, that explains why vegetation of food sampling was not conducted for the LCEEA, as was performed for the original Lost Creek preoperational monitoring program, or are representative of the proposed Lost Creek East expansion area.

Please provide additional information on the collection of vegetation and food samples within the Lost Creek East expansion area, or provide sufficient justification that the preoperational monitoring program for the existing licensed area meets the recommendations of Regulatory Guide 4.14 and NUREG-1569 Acceptance Criterion 2.9.3(1).

h) Groundwater Sampling – Nearby Wells

Regulatory Guide 4.14 recommends collecting samples from wells located within two kilometers of the disposal area and could be used for potable water, livestock watering or crop irrigation. (Staff has interpreted this requirement for ISR facilities as two kilometers of the license area (for background) and two kilometers of a wellfield (during operations).) The

samples should be analyzed quarterly as grab samples for dissolved and suspended natural uranium, thorium-230, radium-226, polonium-210 and lead-210. .

In the letter dated April 18, 2017 (ML17115A205), it is stated that the background chemical analysis of water from regional BLM stock wells was provided in the original Lost Creek application. In the LCEEA, the report provides tables summarizing groundwater rights within 0.5 miles and three miles and figures depicting the locations of the rights. However, the report does not present information on groundwater rights within two kilometers of the licensed area. Based on the NRC staff's review of Figure D6.3-2, groundwater rights referred to as Osborne #1 (Symbol 2 on the figure) may be located within two kilometers of the Lost Creek East extension area.

Please provide rationale for not sampling or commitment to sample the well associated with this groundwater use.

RAI-12 Meteorological Tower Representativeness

Description of Deficiency

The Lost Creek East expansion area is located to the east of the existing licensed area and the Lost Creek meteorological tower location. The LCEEA does not address the acceptability of the Lost Creek meteorological station for the Lost Creek East expansion area. The rationale for using the Lost Creek meteorological tower for the Lost Creek East expansion area should be explained. The LCEEA should have included an affirmative statement that that the existing meteorological tower location at the Lost Creek site is representative of the adjacent Lost Creek expansion area.

Basis for Request

Meteorological data are used for the selection of environmental monitoring locations, assessing the impact of operations on the environment, and determining radiological dose assessments as required in 10 CFR Part 20. The meteorological tower that was used for collecting meteorological data in support of the existing licensed area is located in the western area of the Lost Creek site, and collected baseline monitoring data for the existing licensed area. The applicant proposes using this meteorological station for the adjacent Lost Creek East expansion area.

Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery facilities-Data Acquisition and Reporting," states: "The location of the meteorological instruments should represent as closely as possible the long-term meteorological characteristics of the area for which the measurements are being made." It also states, "At most facilities, the instruments could all be sited at one location. At some sites, instruments may need to be sited at more than one location if the meteorological conditions are not similar throughout the site vicinity."

Similarly, Regulatory Guide 1.23, “Meteorological Monitoring Programs for Nuclear Power Plants,” states: “To the extent practical, meteorological measurements should be made in locations that can provide data representative of the atmospheric conditions into which material will be released and transported…Factors to be considered in selecting the appropriate measurement locations and installation of the instruments include the prevailing wind direction, topography, and location of manmade and vegetation obstructions.”

Request for Additional Information

Please submit an affirmative statement with the rationale for the existing meteorological tower at the Lost Creek site being representative of the adjacent Lost Creek East expansion area, taking into account meteorological conditions, prevailing wind direction, land characteristics, and other factors.

RAI-13 MILDOS-AREA Calculations

Description of Deficiency

An updated MILDOS calculation that considers production from both the original Lost Creek site and the Lost Creek East expansion area wellfields is provided in Attachment D10-2 of the Technical Report, entitled “Revised Estimated Radiation Doses to Members of the Public from the Lost Creek Project including the Eastern Expansion, Sweetwater County, Wyoming; May 2014.” Radiation doses were estimated using the MILDOS-AREA code, version 3.1 (2012). The information presented in the application needs clarification.

Basis for Request

NUREG-1569 Acceptance Criterion 7.3.1.2.3(4) states: “The conceptual model used for calculating the source term and individual exposures (and/or concentrations of radionuclides) from airborne effluents at the facility boundary is representative of conditions described at the site as reviewed in Section 2.0 of this standard review plan. The conceptual model is consistent with the methodologies described in Regulatory Guide 3.51, Sections 1–3, “Calculational Models for Estimating Radiation Doses to Man From Airborne Radioactive Materials Resulting From Uranium Mill Operations” (NRC, 1982). The conceptual model for the MILDOS-AREA code is one acceptable method for performing these exposure calculations”

NUREG-1569, Acceptance Criterion 7.3.1.2.3(5) states: “The parameters used to estimate the source term, environmental concentrations, and exposures are applicable to conditions at the site as reviewed in Section 2.0 of this standard review plan. Guidance on source term calculations is available in Regulatory Guide 3.59, Sections 1–3, “Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations” (NRC, 1987). Additionally, an example source term calculation specifically applicable to *in situ* leach facilities is described in Appendix D.”

Request for Additional Information

a) The original Lost Creek application identified the nearest resident as being located in Baroil, Wyoming, and formed the basis for installing a passive air sampling station (URPA-1) at that location. For the Lost Creek East expansion area, the nearest resident could include a person that resides nearby to monitor an inactive facility, such as Kennecott Uranium Company's Sweetwater Mill, since there is the potential for the person to receive an exposure, as a member of the public, when not being monitored occupationally under the facility's radiation protection program. The NRC staff noted that the prevailing wind direction from the Lost Creek site toward the Sweetwater Mill occurs diurnally and seasonally, as illustrated in Figure 16 and 17 of the document entitled, "Meteorology, Climatology, and Air Quality Data Report for the Lost Creek Uranium In-Situ Recovery Project Modifications" (ML16095A088). According to Section D1 of the LCEEA, the distance to the Sweetwater Mill from the Lost Creek site is less than 10 kilometers, which is the distance for evaluating air monitoring at residences or occupiable structures (see Regulatory Guide 4.14 Section 2.1.2). The applicant needs to address the potential dose to this member of the public or provide the rationale why such an evaluation is not required.

   Table 8 of the May 2014 MILDOS-AREA assessment lists four groups that represent members of the public (package delivery, tour group, reagent truck driver, and camper). The highest estimated annual doses were for the camper and reagent truck driver. Subsequent to this assessment, in a letter dated January 16, 2015 (ML15029A423), it is stated that either the package delivery driver or on-site contractor are the individuals likely to receive the highest public dose.

   Please provide information on whether operations in the Lost Creek East expansion area would change the existing assessment of the individual likely to receive the highest public dose, including: (a) a package delivery driver; (b) an on-site contractor; (c) a camper; (d) a reagent truck driver; and (e) a person residing at Kennecott Uranium Company's Sweetwater Mill. Meteorological conditions, such as prevailing wind direction, direction from the Lost Creek East expansion area, and other factors should be considered, including meteorological data collected from a previously operating meteorological tower located in the vicinity.

b) Meteorological data summarized in Table 1 of Appendix D10-2 differs from the 8-year on-site data described in Figure 10 of the document entitled, "Meteorology, Climatology, and Air Quality Data Report for the Lost Creek Uranium In-Situ Recovery Project Modifications" (ML16095A088). It appears that Table 1 of Appendix D10-2 is based on meteorological data from the Lost Soldier meteorological station, in comparison with Figure 2.2-3 of the Lost Creek Safety Evaluation Report (ML112231724).

   Please provide an updated joint frequency distribution for the Lost Creek meteorological station, along with a revised Table 1 that provides the percentage of wind from each direction.

c) Table 6 of Appendix D10-2 provides the calculated maximum annual quantities of radon-222 released each year, based on the production schedule in Figure 3 and input parameters in Tables 4 and 5. The NRC staff independently calculated maximum annual quantities of radon-222 released using the same methodology, but could not verify the values listed in Table 6.

   Please provide more information on the calculation method and assumptions used to calculate maximum annual quantities, along with a detailed description of the calculation method for the peak year.

d) The Population Distribution section of Appendix D10-2, which was prepared in May 2014, contains errors and omissions, and does not agree with information in Figure D1-6 or Table D1-2. For example, the Appendix D10-2 report states there are no towns within 30 km of the proposed site, but Table 3 of this section lists Bairoil as a town within 28 km of the site. Also, Table 3 lists the population of Jeffrey City as 110 based on 2010 census data, but the 2010 US Census data lists the population of Jeffrey City as 58, which is in agreement with data contained in Figure D1-6 and Table D1-2. In addition, Table 3 of Appendix D10-2 lists only four population groups within 80 km of the site, but additional population groups are listed in Figure Dl-6 and Table D1-2.

   Please revise the population distribution section of the report to correct errors, and in the format specified in Regulatory Guide 3.46, “Standard Format and Contents of License Application, Including Environmental Reports, for In Situ Uranium Solution Mining” (June 1982).

e) In the letter dated April 18, 2017 (ML17115A194), it is stated that the MILDOS-AREA model could be rerun prior to beginning mining at the Lost Creek East expansion area and prior to implementing any other material changes to the schedule.

   Please submit a revised MILDOS calculation, in electronic format, using an updated wellfield production and restoration schedule, preferably with the latest version of MILDOS-AREA (v4.01, September 2016).

RAI-14 Groundwater Quality for the Site Characterization

<u>Description of Deficiency</u>

In the letter dated April 18, 2017, (ML17115A205), it is stated that groundwater samples were analyzed for radionuclides, with results provided in Table D6.4-1 of the original Lost Creek East Amendment Application. Table D6.4-1 contains results of groundwater monitoring data from background monitoring wells, except for L Horizon wells, which were installed in 2016. A minimum of four quarters (ten months) of data is presented for each well listed in Table D6.4-1 for the period 12/2012 through 09/2013. Groundwater quality for three of the five L Horizon wells installed during 2016 is summarized in Table D6.4-3. The data consist of a single

sampling event for each well. Typically, background quarterly sampling for one year is included in an application.

Basis for Request

NUREG-1569 Acceptance Criterion 2.7.3(4) states: "[r]easonably comprehensive chemical and radiochemical analyses of water samples, obtained within and at locations away from the mineralized zone(s), have been made to determine pre-operational baseline conditions. Baseline water quality should be determined for the mineralized and surrounding aquifers. These data should include water quality parameters that are expected to increase in concentration as a result of *in situ* leach activities and that are of concern to the water use of the aquifer (i.e., drinking water, etc.). The applicant should show that water samples were collected by acceptable sampling procedures, such as American Society for Testing and Materials D4448 (American Society for Testing and Materials, 1992)."

Request for Additional Information

Please either confirm that additional samples will be collected from the L Horizon or provide an adequate justification for not collecting the additional sampling.

RAI-15 Missing Tables and Figures

Description of Deficiency

Volume 1 of the KMA contains an "electronic" Attachment 2.7-2, containing a pdf file entitled "Lost Creek Hydrologic Test Composite KLM Horizon 5-Spot Testing, October, 2012". However, the tables and figures that accompany this report were not included in the electronic attachment and therefore staff cannot fully evaluate the report.

Basis for Request

Section 10 CFR 40.9 states: "Information provided to the Commission by an applicant … shall be complete and accurate in all material respects.

Request for Additional Information

Please provide the tables and figure that accompany this report.