UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 14, 2021

Mr. Brad R. Bingham
Closure Manager
Grants Reclamation Project
Homestake Mining Company of California
P.O. Box 98/Highway 605
Grants, NM 87020

SUBJECT: HOMESTAKE MINING COMPANY OF CALIFORNIA, U.S. NUCLEAR REGULATORY COMMISSION REQUEST FOR ADDITIONAL INFORMATION, REVISED REQUEST FOR AMENDMENT TO CHANGE THE BACKGROUND MONITORING LOCATION FOR RADON AND AMBIENT GAMMA RADIATION, LICENSE NO. SUA-1471, DOCKET 040-08903

Dear Mr. Bingham:

By letter dated December 18, 2020, the Homestake Mining Company of California (HMC or licensee) submitted to the U.S. Nuclear Regulatory Commission (NRC) a license amendment request (LAR) for review and approval (Agencywide Documents Access and Management System [ADAMS] package Accession No. ML20356A287). Specifically, the revised LAR proposes a change in license condition 10 to eliminate specification of background monitoring station HMC-16 and replace it with stations HMC-1OFF and HMC-6OFF as approved locations for routine monitoring of ambient background radon and gamma radiation levels at the Grants Reclamation Project. The NRC accepted the submission for review in letter dated February 22, 2021 (ADAMS Accession No. ML21053A325).

The NRC staff has initiated its detailed technical review and has identified information needed to be able to complete the review. The information needed to continue the NRC staff review is described in the enclosed request for additional information (RAI). Responses to the enclosed RAI should be provided within 30 days from the date of this letter. If HMC is unable to meet this response date, notify the NRC staff, within two weeks of receipt of this letter, of your new submittal date. If the RAI response does not provide sufficient information, the NRC staff will notify the licensee if the information provided is not acceptable.

In accordance with Title 10 of the *Code of Federal Regulations* 2.390 of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's ADAMS. ADAMS is accessible from the NRC Web site at https://www.nrc.gov/reading-rm/adams.html.

If you have any questions regarding this matter, please contact me at 301-415-7777, or via e-mail at Ron.Linton@nrc.gov.

Sincerely,

Signed by Linton, Ron
on 09/14/21

Ron C. Linton, Project Manager
Uranium Recovery and Materials
Decommissioning Branch
Division of Decommissioning, Uranium Recovery,
and Waste Programs
Office of Nuclear Material Safety
and Safeguards

Docket No.: 040-08903
License No.: SUA-1471

Enclosure:
Request for Additional Information

SUBJECT: HOMESTAKE MINING COMPANY OF CALIFORNIA, U.S. NUCLEAR REGULATORY COMMISSION REQUEST FOR ADDITIONAL INFORMATION, REVISED REQUEST FOR AMENDMENT TO CHANGE THE BACKGROUND MONITORING LOCATION FOR RADON AND AMBIENT GAMMA RADIATION, LICENSE NO. SUA-1471, DOCKET 040-08903. DATE: September 14, 2021.

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ADAMS Accession No.: ML21237A454
Concurrence Case: 20210825-50013 *concur via e-Concurrence

OFFICE	NMSS/DUWP/URMDB	NRR/DEX/EXHB	NMSS/DUWP/URMDB
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U.S. Nuclear Regulatory Commission Request for Additional Information Homestake Mining Company of California, Revised Request for Amendment to Change the Background Monitoring Location for Radon and Ambient Gamma Radiation, Grants Reclamation Project Materials License SUA-1471

Request for Additional Information (RAI) -1

Provide a justification for confining the alluvial plain to the San Mateo Creek (SMC) alluvial plain as indicated in Figure 7 of Attachment 1 to the Homestake Mining Company of California (HMC or licensee) December 2020 submittal (HMC, 2020a).

Discussion

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed geological (HMC, 2012) and hydrogeological (Hoffman, 2001) descriptions of the general area of the Grants Reclamation Project (GRP). Figure 1 below shows the extent of the alluvial deposits in the SMC basin as well as the SMC, Lobo Creek, and Rio San Jose surface water drainages. The report by Hoffman (2001) describes the San Mateo alluvial system as following "…the San Mateo alluvium and drainage system and extends from the northeast of the site to the south and west."

Figure 2 (below) shows the alluvial plain as defined by HMC and used in its evaluation of proposed background radon monitoring stations.

Using data from the United States Geological Survey (USGS, 2021a), the NRC staff evaluated the geology and topography in the vicinity of the GRP using Google Earth Pro. The green outline area in Figure 3 below represents the NRC staff's interpretation of a broader alluvial plain based on reported alluvium deposits (yellow shaded area) in the vicinity of the GRP. For comparison purposes, the maximum elevation around the perimeter is approximately 2,023 meters (m) (6,637 ft) to coincide with HMC's proposed HMC-6OFF location.

The NRC staff notes that the northeast to southwest line through the San Mateo drainage (the blue line in Figure 3) continues decreasing in elevation. The elevation change between HMC-6OFF and the current monitoring station HMC-4 is approximately 23 m (75 ft) [21m (69 ft) for HMC-1OFF]. HMC-6OFF is approximately 6.5 kilometers (km) [4 miles (mi)] from HMC-4. HMC-1OFF is approximately 5 km (3.1 mi) from HMC-4. As indicated in Figure 3, the elevation begins to flatten out around HMC-4 and decreases approximately another 8 m (26 ft) between HMC-4 and the southwestern end of the blue line in Figure 3.

According to HMC's conceptual site model (CSM) (HMC, 2020a):

> "Outdoor radon concentrations are highest under stable atmospheric conditions with little wind (typically in the early morning hours). In valley locations, high radon concentrations also correlate with inversion conditions that commonly occur in the SMC. Migration of radon from nearby upland source areas is driven primarily by topography and gravitational forces that cause cooler, denser air masses to flow downgradient and to pool in low-lying areas."

If this is the case, then the effects of topography and inversion conditions on radon concentrations will not be limited to HMC's depiction of the alluvial plain. The migration of radon will continue south and west of the GRP in the broader area representative of HMC-4 and HMC-5.

Basis

This information is needed to determine compliance with the following requirements:

- Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, Appendix A, Criterion 7 – this regulation requires an operational monitoring program be conducted to measure or evaluate compliance with applicable standards.

- 10 CFR 20.1302(a) – this regulation requires surveys of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys for compliance purposes and for evaluating the concentrations and potential radiological hazards of residual radioactivity detected.

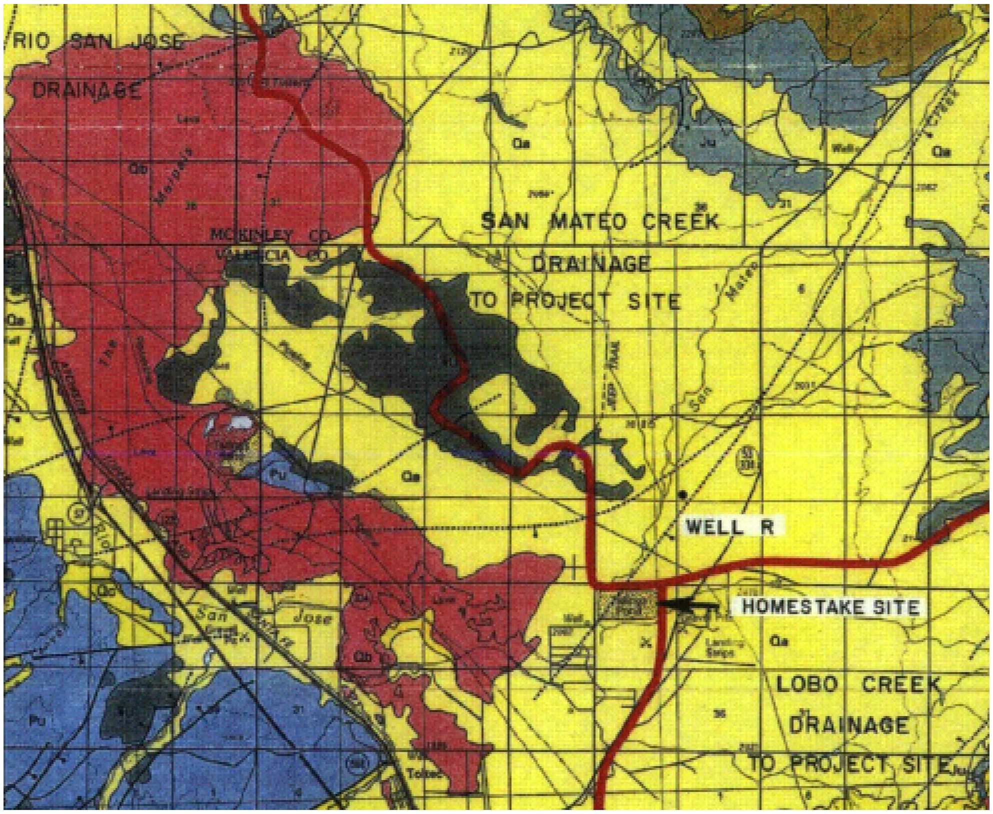

Figure 1. Surface water drainages in the vicinity of the GRP (from Figure 3.1-1 in HMC, 2012)

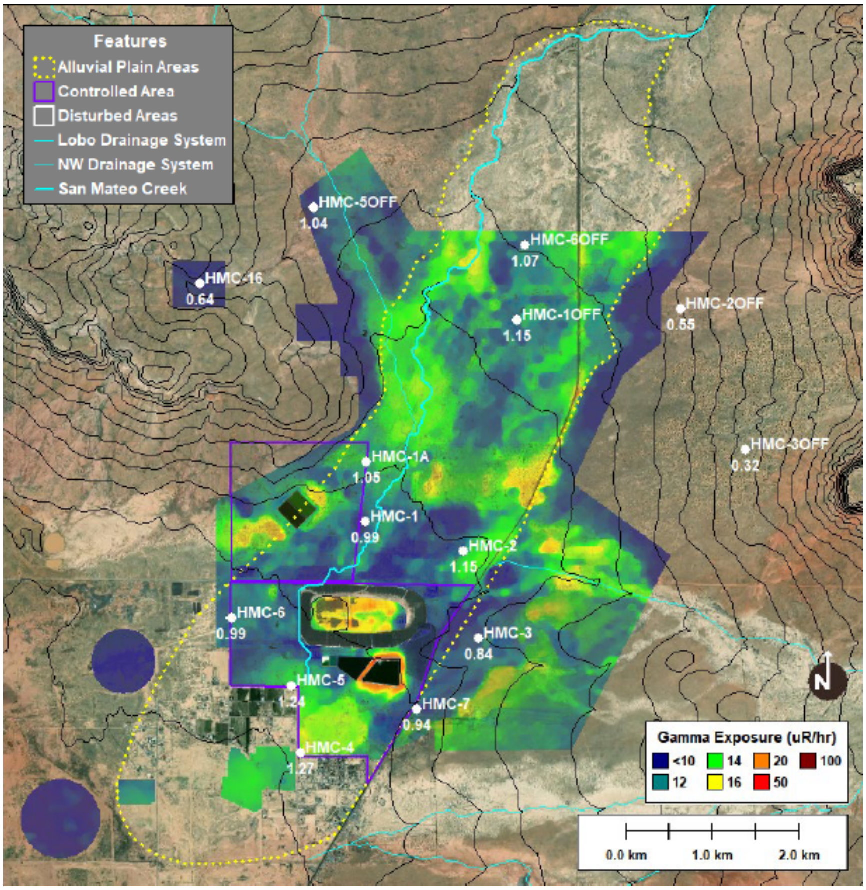

Figure 2. Alluvial plain in the vicinity of the GRP with environmental monitoring stations as described by HMC (from Figure 8 of Attachment 1 to HMC, 2020a)

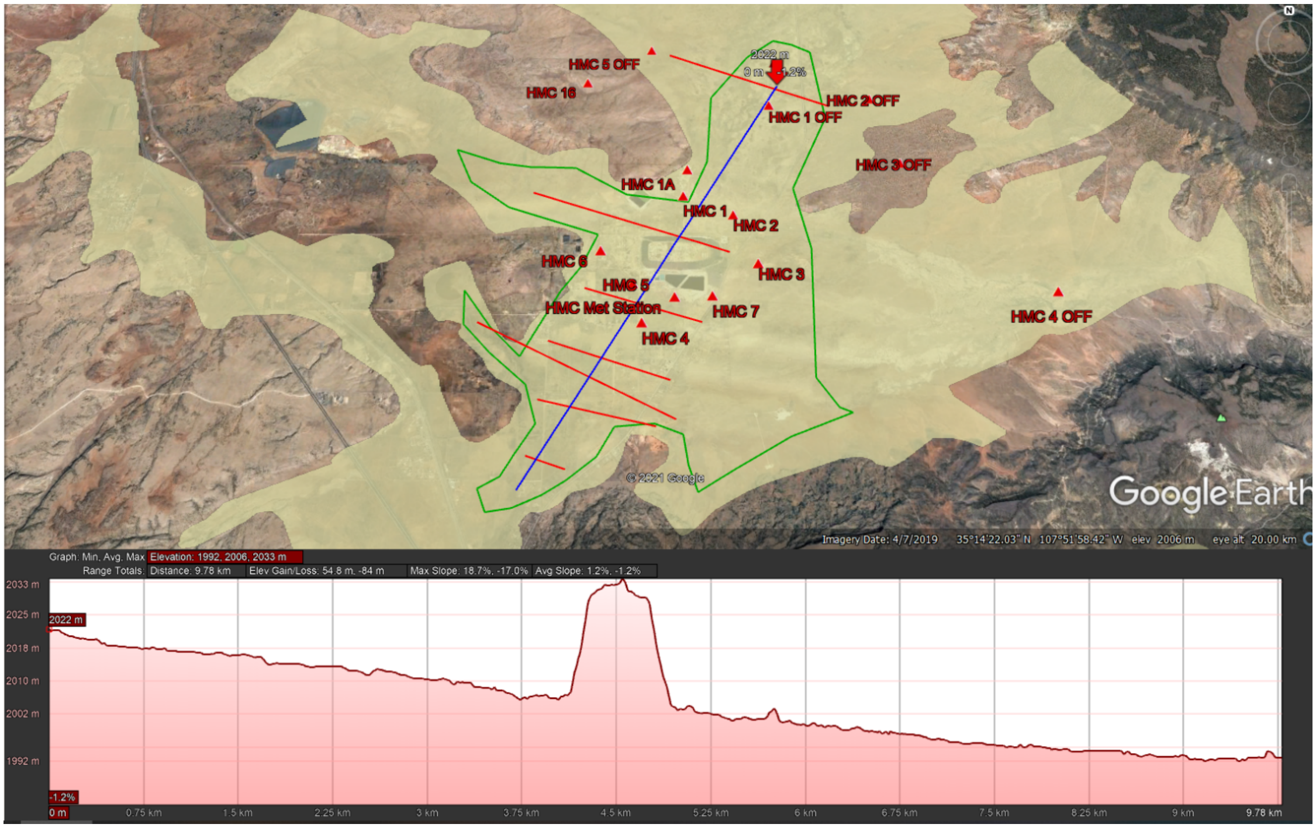

Figure 3. NRC staff's representation of the alluvial plain with maximum elevation of 2,023 m (green outline), northeast to southwest elevation (blue line and bottom elevation profile), and east-west "flat" areas (i.e., relatively small elevation changes) (red lines).

<u>RAI-2</u>

Provide justification for considering proposed locations HMC-1OFF and HMC-6OFF as representative of the locations of monitoring stations HMC-4 and HMC-5. This justification should address the issues discussed in the following Discussion section.

<u>Discussion</u>

NRC staff guidance for determining appropriate radon monitoring locations can be found in Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301 (the Interim Staff Guidance [ISG]) (NRC, 2018a):

> …NRC staff reviewers should be aware of the complexities of determining an appropriate background outdoor radon concentration that is representative of the receptor (or other monitoring) locations. A background location typically would need to be close to the monitoring locations, with geology similar to the site geology, so that the background

location is representative of the monitoring location. But the background location should also be far enough from the facility that the radon concentration is not significantly affected by radon releases from the facility. If onsite meteorological (Met) data are available, the data can be used to help determine if background locations are unimpacted or minimally impacted by site operations.

There may be conditions in which applicants or licensees may want to consider using more monitoring locations or a longer preoperational monitoring period than recommended (i.e., monitor for longer than four quarters) to provide a better understanding of the background radon concentrations and spatial and temporal variability around the proposed facility location. Such conditions include:

- the location is known to have elevated radon concentrations;
- the location has significant topographic features such as valleys, mountains, buttes, or varying elevations;
- there are significant existing sources of radon nearby; for example, old mine shafts, outcroppings of uranium-bearing minerals, or other uranium recovery facilities; or
- preliminary preoperational monitoring data or other existing data indicate substantial spatial variability in radon concentrations.

The NRC staff notes that all of these conditions exist at the GRP site.

The ISG also includes the following guidance:

> "NRC staff should compare results of monitoring at background locations to other locations. NRC reviewers should evaluate cases in which radon concentrations measured at the background location are consistently higher than concentrations at or around (especially downwind from) the facility. This situation may be an indication of a background location that is influenced by other radon sources or in other ways is not representative of the true background radon concentrations for the facility."

The NRC staff evaluated the proposed locations HMC-1OFF and HMC-6OFF consistent with this guidance. For all practical purposes, HMC-1OFF and HMC-6OFF have essentially the same attributes when reviewed in accordance with this guidance and the NRC staff has not found any significant distinctions between these two proposed locations.

Elevation

As previously discussed, the elevation difference between HMC-6OFF and HMC-4 is approximately 23 m (75 ft). The NRC staff notes that this is the same elevation difference between HMC-16 (the current background radon monitoring station) and the proposed location HMC-1OFF. Figure 8 of HMC's report (Attachment 2 to HMC, 2020a, the Rood report) indicates that the cutoff for being considered the San Mateo alluvial plain floor is 2,027 m (6,650 ft) (i.e., HMC-5OFF). Monitoring stations with elevations greater than this are considered above the San Mateo alluvial plain floor.

While the locations of HMC-1OFF and HMC-6OFF may be considered low-lying areas with respect to nearby upland radon sources, it is not clear to the NRC staff that HMC-1OFF and HMC-6OFF are representative of current radon monitoring areas HMC-4 and HMC-5. According to the Rood report (Attachment 2 of HMC, 2020a), even minor elevation differences on the order of 7 m (23 ft) can impact radon levels (see discussion on HMC-3, bottom of p.15).

Proximity to upland slopes

As indicated in Figure 3, HMC-1OFF and HMC-6OFF are generally closer to the upland areas of the San Mateo alluvial plain than HMC-4 and HMC-5. According to HMC (2020a), this area is a source of radon contributing to higher radon concentrations on the alluvial plain floor. However, the NRC staff considered the greater alluvial plain area in the vicinity of HMC-4 and HMC-5 (i.e., a greater area over which the pooled radon can dissipate), and that HMC-4 and HMC-5 are located further from these upland sources (see Figure 3). Taking into account the lower elevation of HMC-4 and HMC-5 relative to HMC-1OFF and HMC-6OFF, as discussed above, it is not clear to the NRC staff that HMC-1OFF and HMC-6OFF are representative of these current monitoring locations.

In addition, the NRC staff evaluated Figure 5 and notes that HMC-1OFF and HMC-6OFF are modeled as higher predicted radon concentrations relative to HMC-4 and HMC-5. The NRC staff recognizes that the main purpose of the figure was to demonstrate differences between radon concentrations on the upland slopes and the floor of the alluvial plain. However, any proposed background stations that are modeled as having higher background radon concentrations than the point(s) of compliance for public dose assessment (i.e., HMC-4 and HMC-5) should be cause for reexamining the CSM and evaluating any changes to the CSM, or additional data collection needs, or both.

HMC recognized the importance of this type of normalized data analysis in its response to a previous NRC staff Request for Additional Information (RAI) (see HMC response to RAI No. #2b in HMC, 2014). Furthermore, the modeling results in Figure 5 incorporate some, but not all, of the factors influencing radon concentrations at HMC-1OFF as discussed by HMC (see HMC response to RAI No. #9b in Attachment 3 to HMC, 2020a). For example, Figure 5 does not include an estimated effect of known localized radon sources that could potentially increase the differences between HMC-1OFF and other monitoring stations.

Proximity to localized radon sources

Previous studies noted the potential for local uranium outcroppings to measurably impact ambient radon concentration levels (Environmental Protection Agency [EPA], 1976; Buhl, 1985). Using information from the Mineral Resource Data System (USGS, 2021b) for Cibola County, New Mexico (NM), the NRC staff used Google Earth Pro to evaluate nearby legacy uranium mines. These legacy mines are shown in Figure 4. The specific area of interest also has the 2018 wind rose collected from HMC's Met station overlain on the legacy mines closest to HMC-1OFF and HMC-6OFF. This area appears to generally coincide with one of the near surface uranium mineralizations identified by Buhl, et al. (1985) near the La Jara mesa in Figure 3.1 of their report.

From Figure 4, HMC-1OFF appears to be downgradient from the two sectors (the purple lines in the figure) representing the largest percentage of drainage flow conditions as identified by HMC (i.e., more stable wind conditions). Adding the third highest sector (the orange line in the figure) also encompasses HMC-6OFF. It does not appear to the NRC staff that these sources were specifically evaluated previously by other authors or currently by HMC.

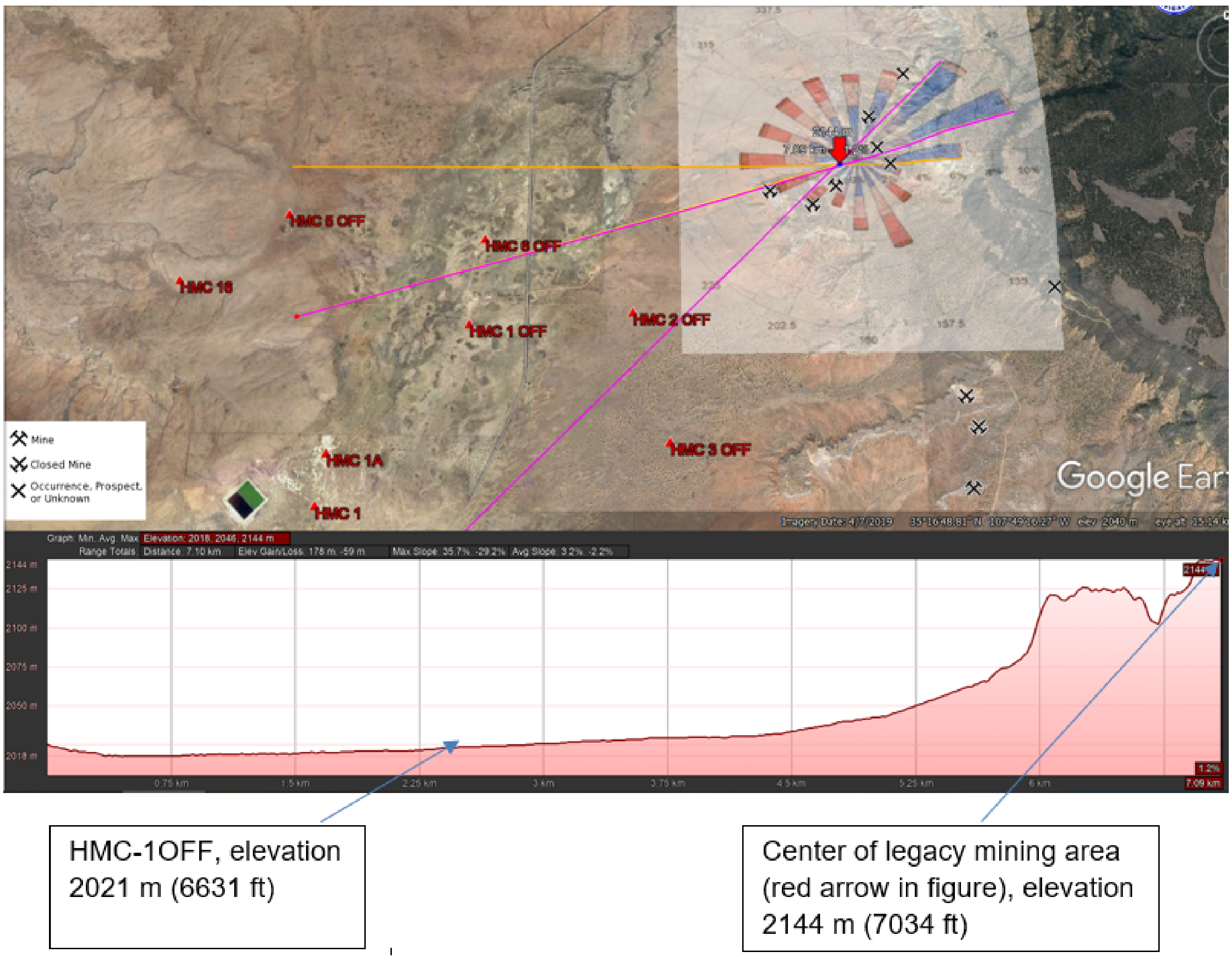

Figure 4. Legacy uranium mines in the vicinity of the GRP.

The NRC staff notes that Momeni and Carson (American Meteorological Society [AMS], 1982) used physical (not virtually modeled) smoke tracers to represent drainage flow for sources located on a mesa. What they observed at sunset was that the smoke drifted downward, following the canyon wall, and then eventually filling the canyon. Radon concentrations at two stations observed, both located within a canyon and at different heights, showed peaks around sunset (i.e., when temperature was dropping). Although these two stations were relatively close to an active mill tailings impoundment, it does offer empirical data to demonstrate, generally, the behavior of radon sources at elevation and that radon tends to stay near the ground.

The NRC staff is not aware of available data to determine if there is any effect from these uranium sources on HMC-1OFF or HMC-6OFF. However, it is highly unlikely that there would be any impact at HMC-4 and HMC-5 due to the additional distance from these sources.

Soil type

In describing sources of ambient radon concentrations, HMC stated (HMC, 2020a), "While higher radon emissions from relatively small, more discrete sources, such as outcropping mineralized bedrock and historic uranium mining disturbances in nearby upland areas, may contribute to pooling across the SMC wash, this contribution is likely dwarfed by emissions from ubiquitous background sources in upland areas, and more importantly, from the alluvial fill in the bottom of the wash." In describing the alluvial plain deposits (see Figure 2), HMC noted (HMC, 2020a) "Averaging 50-100 feet deep in the lower SMC basin, alluvial plain deposits exhibit different radiological characteristics versus adjacent upland areas (Sections 3.5 - 3.9), and ambient radon concentrations at any given location can also be influenced locally by Ra-226 concentrations in underlying or nearby soils due to radioactive decay, emanation of radon gas, and exhalation of radon gas from the soil surface."

The NRC staff notes that the permeability of different soil types will affect the ability of radon to move from the soil into the air (USGS, 1992, 1993). Although HMC recognizes this is true, as noted above, it did not provide an evaluation of the site other than discussing the alluvial plain in general.

The NRC staff utilized the online Web Soil Survey (U.S. Department of Agriculture [USDA], 2021) to visualize the soil types in the vicinity of the GRP. As Figures 6 and 7 show, there is basically one soil type in the relevant are north of the large tailings pile (LTP) (Type 257) where the proposed HMC-1OFF and HMC-6OFF are located. South of the LTP, including HMC-4 and HMC-5, there are a variety of different soil types. These soil types may be very similar in their ability to impact the exhalation of radon gas from the soil surface; however, considering the importance of local soils in HMC's stated CSM, and the fact that the proposed background locations reside in soil types different from the locations of public dose compliance (i.e., HMC-4 and HMC-5), HMC should analyze any differences and potential impacts to the CSM.

Radon from the Lobo Canyon Drainage and other directions

The NRC staff (see RAI No. #9c in Attachment 3 to HMC, 2020a) and the EPA (see Comment No. #3 in Attachment 3 to HMC, 2020a) both provided observations questioning the representativeness of HMC-1OFF to the locations of public dose compliance (i.e., HMC-4 and HMC-5). HMC did not fully address the concerns expressed in these observations.

For example, HMC did not specifically address why it was not necessary to represent drainage from the Lobo Canyon and potential impacts from other areas East-Southeast (ESE) clockwise through the West-Northwest (WNW) direction. The NRC staff notes that HMC previously rejected HMC-5OFF because it was "unlikely to see radon contribution from Lobo Creek" (HMC, 2013a). Figure 13 of the Rood report (Attachment 2 of HMC, 2020a) indicates that neither HMC-1OFF nor HMC-6OFF will see any contribution of radon from the Lobo Creek drainage either.

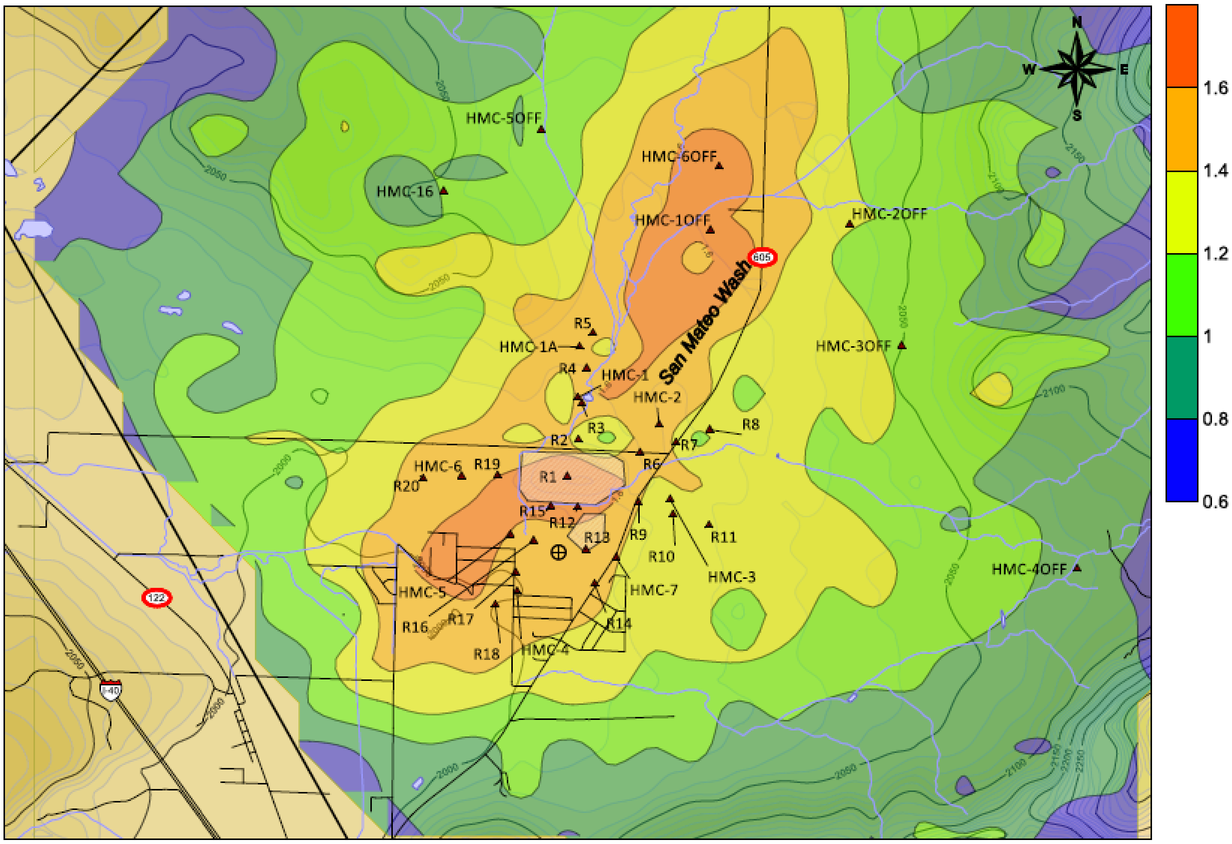

Figure 5. Predicted concentration normalized to HMC-16 for the case of enhanced radon flux in San Mateo Wash and based on 2017 Met data (from Figure 15 in Attachment 2 to HMC, 2020a)

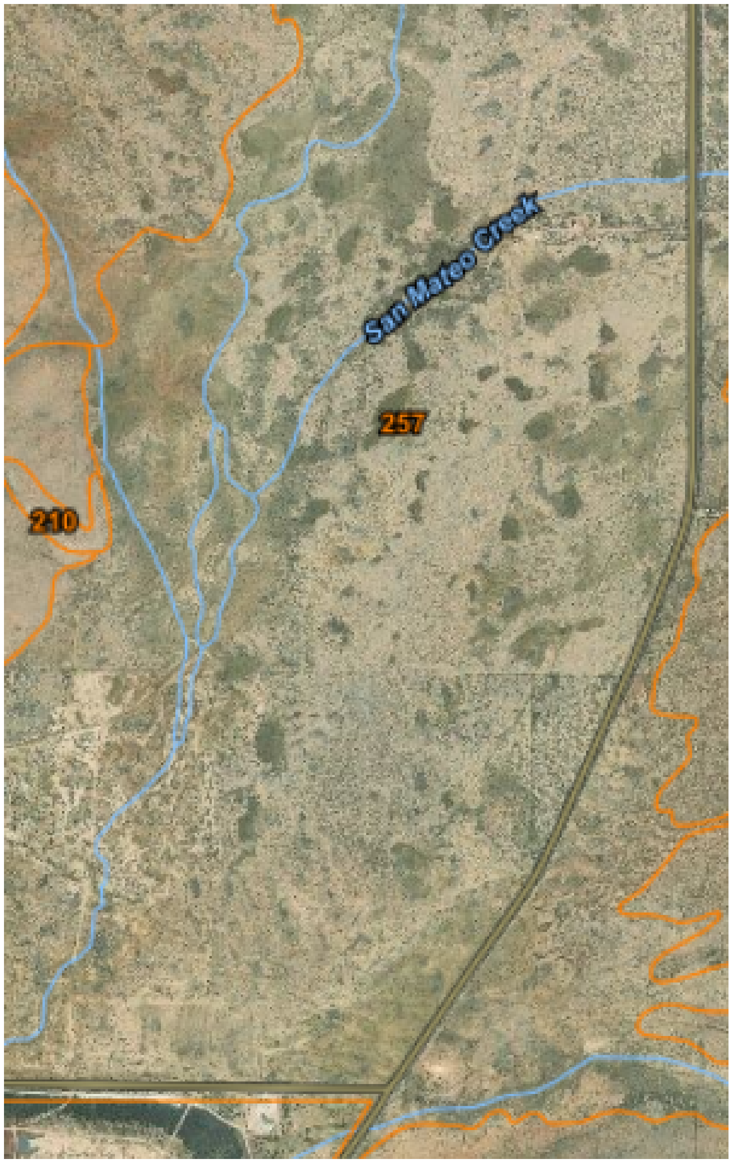

Figure 6. Soil type north of the GRP LTP (USDA, 2021)

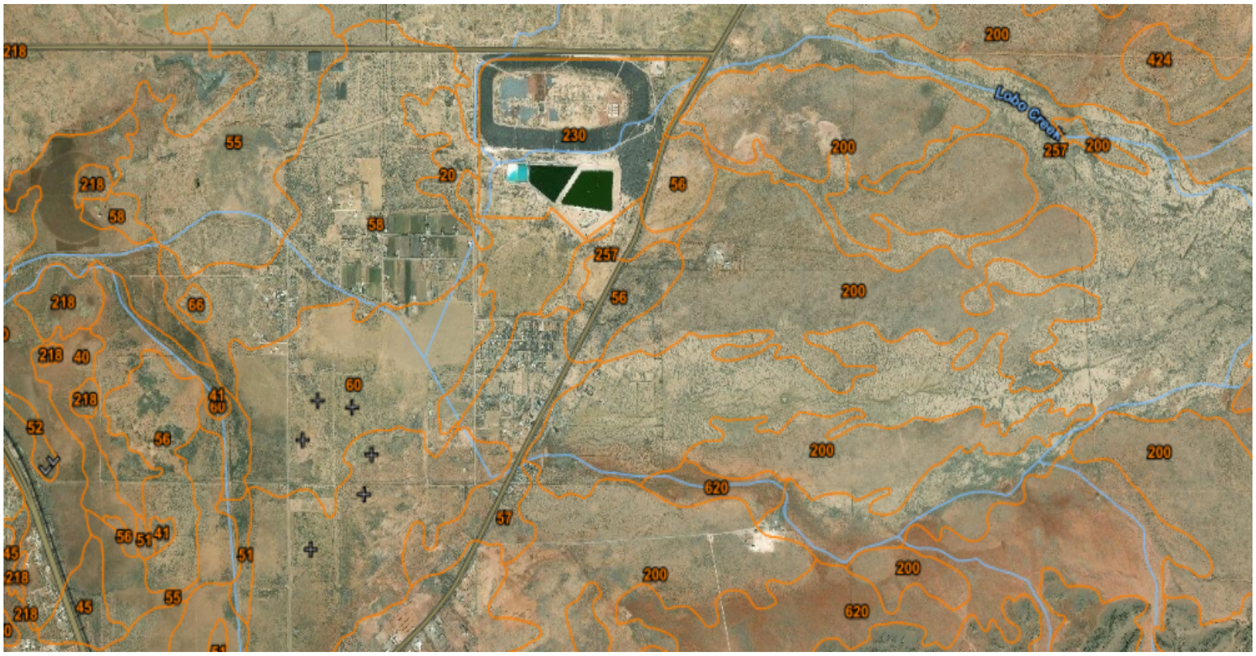

Figure 7. Soil types south of the GRP LTP (USDA, 2021)

Furthermore, the EPA noted that HMC-1OFF and HMC-6OFF are “likely nearer to sources and in the direction of drainage plumes, which may explain why the values are higher than monitors near the Homestake facility.” This observation is consistent with the NRC staff’s observation above under “Proximity to localized radon sources”. In its response, HMC discussed monitoring station HMC-16, but did not address the EPA’s concerns which are shared by the NRC staff.

Known elevated radon concentrations

The NRC staff previously described (Request for Supplemental Information-2 [RSI-2] in NRC, 2020) the study performed by Buhl, et al. (1985), including the use of background station 201 that was reported by HMC (HMC, 2013a) to be close to its proposed location of HMC-1OFF. In this study, 10 background locations, including station 201, were chosen to represent the natural radon environment prior to uranium development in the Grants Mineral Belt area.

When the authors statistically evaluated the background stations, they determined that station 201 (near the current HMC-1OFF) was “consistently elevated above other stations”. The authors did not attempt to definitively determine why station 201 was consistently elevated. However, taking the previous observations into account (proximity to upland slopes, etc.), HMC has not made a clear case for selecting HMC-1OFF, or HMC-6OFF, or both as representative of the locations of public dose compliance (i.e., HMC-4 and HMC-5).

Basis

This information is needed to determine compliance with the following requirements:

- 10 CFR Part 40, Appendix A, Criterion 7 – this regulation requires an operational monitoring program be conducted to measure or evaluate compliance with applicable standards.

- 10 CFR 20.1302(a) – this regulation requires surveys of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys for compliance purposes and for evaluating the concentrations and potential radiological hazards of residual radioactivity detected.

RAI-3

Provide additional information, including monitoring results, to substantiate the effects of prior remediation in the vicinity of the GRP site on ambient radon concentrations (if determined to be necessary, see discussion).

Discussion

In response to NRC RSI No. #5, HMC postulated (HMC, 2020a) that prior soil remediation at the GRP in the vicinity of the LTP both reduced radon concentration to the north of the LTP on the one hand, and left residual contamination near HMC-4 and HMC-5 that are the cause of increased radon concentration at these locations, based on estimated gamma exposure levels, on the other hand.

The NRC staff evaluated the history of the 1977 tailings release, and the subsequent cleanup of this spill and windblown contamination (HMC, 2020b, 2013b; Environmental Restoration Group [ERG], 1995; United Nuclear-Homestake Partners [UNHP], 1978; NM, 1977a, 1977b).

Regarding the area north of the LTP, HMC stated (HMC, 2020a) "Radon monitoring data collected in these same areas since removal of soil contamination in the mid-1990's indicate that radon concentrations have decreased to levels slightly lower on average than those observed at upgradient background station HMC-1OFF (Section 3.7, Figures 5 and 8)." and "Although placement of cover materials to stabilize and isolate the tailings from the environment in the 1990's may also have contributed to subsequent reductions in ambient radon levels in these areas, this factor alone does not explain reductions in radon concentrations to levels lower than those observed at upgradient background station HMC-1OFF. The data suggest that large-scale removal of windblown soil contamination beyond the tailings piles, including possible removal of underlying alluvial materials with naturally elevated Ra-226 levels and associated radon emissions, had a significant influence on the observed reductions in local radon levels."

Regarding gamma radiation, HMC stated (Section 3.7 of Attachment 1 to HMC, 2020a): "In areas adjacent to the tailings piles, reductions in terrestrial gamma radiation resulting from large-scale windblown soil cleanup conducted between 1993-1995 (HMC, 1995) are reflected in the gamma survey data (Figure 7), suggesting these areas have remained compliant with NRC-approved soil release criteria under the existing Decommissioning and Reclamation Plan for the past 25 years, and significant migration of radiologically elevated soils over this period is not apparent."

The NRC staff notes that HMC does not offer any quantifiable data, other than a kriged exposure rate map (Figure 7 of Attachment 1 to HMC, 2020a), to substantiate these claims. Figure 2.2-4 of the Decommissioning and Reclamation Plan Update (HMC, 2013b) shows the extent of the windblown soil contamination. The alluvium in this general area (e.g., the area north of the LTP, and in the vicinity of Thunderbird Lane) is approximately 75 ft thick (see Cross Sections A-A' and C-C' in HMC, 2018). The soil used to replace the contaminated areas came from borrow areas shown in Figure 3-2 in the Completion Report (ERG, 1995).

According to HMC (HMC, 2020a), up to two ft of soil was removed from contaminated areas. Soil removed from the borrow areas for replacement soil originated from the uppermost five ft of soil (HMC, 2013b) from these areas. Considering the soil types at the GRP, described above, it is not clear to the NRC staff that this exchange of similar soil types would appreciably lower background gamma or radon levels. In addition, after completion of the remediation of this area, the licensee stated (HMC, 2020b): "In 2019, Homestake conducted a gamma survey of a portion of the San Mateo alluvial flood plain upgradient of the Homestake Facility. The average of the upgradient gamma data was calculated to be 14,337 counts per minute (cpm) (ERG 2019). The 52 500 foot by 500 feet grid blocks scanned during the windblown remediation recorded an average gamma reading of 16,629 cpm. Although the average gamma confirmation data is higher, the confirmation sampling methodology was biased high."

The NRC staff notes that the 500 by 500 ft grid blocks are shown on Figure 6-3 of the Completion Report (ERG, 1995). Using this figure, the NRC staff calculated the average gamma levels for only those grid blocks north of the LTP. There were 33 survey grids (those in grid blocks "D" and "E" in Figure 6-3 of ERG, 1995) with an average gamma reading of 16,962 cpm, slightly higher than the overall average. The current assessment appears to conflict with the 2019 statement above, and the NRC staff's calculations, which are based on measurement data.

Because the NRC staff is not aware of data that demonstrates decreased radon concentrations or gamma radiation levels, compared to conditions prior to events requiring remediation near the LTP, the NRC staff does not consider the proposed effects reasonable. However, if HMC would like to pursue making a demonstration consistent with what it proposed (HMC, 2020a), HMC should submit an analysis of surface and subsurface radium soil concentrations from the remediated area north of the LTP from the earliest available data collected prior to the detection of windblown contamination and compare to current measured (not estimated) soil concentrations. This submittal should include all raw data for the NRC staff's independent analysis.

If HMC is submitting data to make this demonstration, it should also prepare an analysis comparing previous radon concentrations measured at HMC-1OFF and closer stations. This analysis should take into account different radon measurement techniques, including the licensee's own data (HMC, 2020a) showing decreased radon concentrations after switching vendors. The purpose of this analysis is to substantiate HMC's claim that prior remediation lowered the ambient background radon concentrations to a degree not explained by placement of a cover on the LTP. This submittal should include all raw data for the NRC staff's independent analysis.

Referring to land areas near HMC-5 and HMC-4, HMC stated: "It is visually apparent that this area was partially cleaned up during the windblown soil cleanup (HMC, 1995). Site records indicate that a portion of this area was impacted in 1977 by an unplanned release of tailings through a breach in the south berm of the LTP (HMC, 2013b; UNHP, 1978)." (Section 3.7 of Attachment 1 to HMC, 2020a) and "Slightly elevated radon levels southwest of the STP near air monitoring stations HMC-4 and HMC-5 also appear spatially associated with adjacent soil impacts on HMC property (Figure 11)." (Section 3.8 of Attachment 1 to HMC, 2020a).

The NRC staff reviewed Figure 11 of HMC's recent submittal (Attachment 1 to HMC, 2020a) and the extent of the tailings spill (UNHP, 1978; NM, 1977a, 1977b) and can't conclude that there is visual proof that cleanup efforts left material that is currently impacting the area near HMC-5 and HMC-4. According to official records (UNHP, 1978; NM, 1977a, 1977b), the extent of the tailings spill did not travel as far south as HMC-4. From NRC staff's interpretation of Figure 11 (Attachment 1 to HMC, 2020a), gamma exposure increases from the LTP to the southwest toward HMC-4. However, as described below, the higher contaminated material from the spill was deposited more to the north (i.e., closer to the tailings pond) and the less contaminated material was deposited further to the southwest.

In addition, the NRC staff reviewed other documented gamma scans in this general area (Figure 10 of HMC, 2019; Image 14 of EPA, 2013) and did not distinguish gamma levels in the vicinity of HMC-5 and HMC-4 from general variations in background, other than the top of the LTP and the small tailings pile which were readily evident.

The NRC staff notes that the extent of the tailings spill indicate that the outer area of the spill contained the lower concentrations of contamination compared to the other two areas (Location "A" in UNHP, 1978). Even so, this less contaminated area does not appear to be within 600 m of the HMC-4 monitoring station. This is the distance determined by HMC to be the maximum distance from the LTP to be influenced by radon from that source. If HMC is proposing that HMC-4 is currently being influenced from a fully remediated section of land, it should reevaluate potential effects from the LTP on HMC-4.

Regarding the cleanup of contaminated areas in the vicinity of HMC-4 and HMC-5, the NRC staff notes that the licensee employed the same type of remediation techniques (i.e., soil removal and recover) and cleanup values (HMC, 2013b; ERG, 1995). The NRC staff requires additional data to confirm HMC's suggested residual impacts from remediation.

Because the NRC staff is not aware of data that demonstrates increased radon concentrations or gamma radiation levels, compared to conditions prior to events requiring remediation near the LTP, the NRC staff does not consider the proposed effects reasonable. However, if HMC would like to pursue making a demonstration consistent with what it proposed (HMC, 2020a), HMC should submit an analysis of surface and subsurface radium soil concentrations from the remediated area in the vicinity of HMC-4 and HMC-5 (see, for example, UNHP, 1978) from the earliest available data collected prior to the 1977 release of tailings and prior to the detection of windblown contamination and compare to current measured (not estimated) soil concentrations. This comparison should take into account previous efforts by the licensee to distinguish background radium and uranium soil concentration values from windblown contamination concentration values based on equilibrium values (HMC, 1988). This submittal should include all raw data for the NRC staff's independent analysis.

<u>Basis</u>

This information is needed to determine compliance with the following requirements:

- 10 CFR Part 40, Appendix A, Criterion 7 – this regulation requires an operational monitoring program be conducted to measure or evaluate compliance with applicable standards.
- 10 CFR 20.1302(a) – this regulation requires surveys of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.
- 10 CFR 20.1501(a) – this regulation requires surveys for compliance purposes and for evaluating the concentrations and potential radiological hazards of residual radioactivity detected.

RAI-4

RAI-4a

Provide an analysis of the proposed change in location for measuring background gamma radiation. The analysis should provide a rationale why the preferred location(s) are representative of the current monitoring stations HMC-4 and HMC-5.

RAI-4b

Specify how the results of measured background gamma radiation will be used in the determination of the dose to a member of the public (e.g., using the lower of the two values, etc.).

<u>Discussion</u>

HMC's December 2020 submittal requested a change in location for measuring background gamma radiation in addition to background radon. However, the submittal was focused on an analysis of the radon monitoring stations and did not address gamma radiation.

Basis

This information is needed to determine compliance with the following requirements:

- 10 CFR Part 40, Appendix A, Criterion 7 – this regulation requires an operational monitoring program be conducted to measure or evaluate compliance with applicable standards.

- 10 CFR 20.1302(a) – this regulation requires surveys of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys for compliance purposes and for evaluating the concentrations and potential radiological hazards of residual radioactivity detected.

RAI-5

Given the issues identified by the NRC staff below with the design of the regression analysis, discuss how the regression results can be applied generally to estimate background radon concentrations.

Discussion

Figure 17 of the Rood report (Attachment 2 of HMC, 2020a) depicted the results of a regression analysis of a short-term data set from Table 8 of the same report. The short-term data set was derived from the first three calendar quarters of 2020. The NRC staff notes that it is common for outdoor radon concentrations to exhibit seasonal variations. See, for example, the NRC staff's discussion of seasonal radon concentrations at the Anaconda mill in the July 1, 2020, RSI (NRC, 2020). In addition, compliance with public dose limits are evaluated on a calendar-year basis. An analysis of three quarters of data does not appear sufficient for determining a background station that will ultimately be used for regulatory compliance purposes.

More importantly, however, is the design of the statistical analysis itself. A key statistical concept is that of a random sample of *n* points or observations (NRC, 2011, 2000; EPA, 2009). In this case, the *n* observations are the eight HMC monitoring stations and the 20, R1 through R20, monitoring stations in Table 8. If HMC wanted to estimate the background radon concentration from the entire relevant population of radon monitoring locations (some predefined area representative of HMC-4 and HMC-5, for example), then it should have randomly sampled monitoring locations from this population, performed radon monitoring at these locations, and then performed statistical analyses with the resulting data. Although the NRC staff is providing comments on the design of the statistical analysis used, it is not taking a position and did not perform an assessment of the adequacy of the proposed methodology to derive a background radon concentration.

As designed, the statistical analysis uses the sample locations in Table 8, which are all biased. For example, the HMC monitoring stations are used because they are current monitoring stations. The R stations are used because they are all a specified distance radially from the center of the LTP. Therefore, the data set is unlikely to exhibit statistical independence. In addition, because the sampling locations were all biased, it does not appear that the results of a regression on these data can be applied to HMC-1OFF or HMC-6OFF, which locations are biased as well, as these monitoring locations were not part of the biased sampling population. The approach proposed by HMC is overly simplistic as using the methodology applied here, all one has to do is choose any site, in any location, regardless of direction, distance, or elevation, that matches the numerical results of the biased regression and that would be considered an appropriate background monitoring location. This does not seem reasonable to the NRC staff. Moreover, this approach is not consistent with HMC's proposed CSM because the CSM requires consideration of these factors.

Basis

This information is needed to determine compliance with the following requirements:

- 10 CFR Part 40, Appendix A, Criterion 7 – this regulation requires an operational monitoring program be conducted to measure or evaluate compliance with applicable standards.

- 10 CFR 20.1302(a) – this regulation requires surveys of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys for compliance purposes and for evaluating the concentrations and potential radiological hazards of residual radioactivity detected.

RAI-6

Consistent with the ISG (refer to RAI-2), provide a year by year annual assessment of radon concentrations comparing the results from HMC-1OFF and HMC-6OFF to other HMC monitoring stations (i.e., HMC-1 through HMC-7) for each full year HMC-1OFF has been monitored, or direct NRC staff where to find this information.

Discussion

HMC provided long-term (2009-2019) and short-term (three quarters in 2020) measured radon concentrations for the long-term radon monitors surrounding the tailings piles [Table 4 of the Rood report (Attachment 2 of HMC, 2020a)]. This data is acceptable for very general comparisons. However, neither of these values is useful for determining regulatory compliance as public dose assessments are performed on an annual basis (with a start date in January). Long-term averages can obscure important annual differences between the background monitoring station and the station used to assess public dose. Short-term averages do not fully incorporate seasonal differences at a specific station or temporal differences between stations.

Basis

This information is needed to determine compliance with the following requirements:

- 10 CFR Part 40, Appendix A, Criterion 7 – this regulation requires an operational monitoring program be conducted to measure or evaluate compliance with applicable standards.

- 10 CFR 20.1302(a) – this regulation requires surveys of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys for compliance purposes and for evaluating the concentrations and potential radiological hazards of residual radioactivity detected.

RAI-7

Provide an analysis of the 2017-2019 wind data, which was used in the CALPUFF[1] modeling, demonstrating that it is representative of long-term conditions at the GRP site.

Discussion

Because HMC proposed a new environmental monitoring station, which is typically performed during the siting of a new facility, the NRC staff determined that it was appropriate to apply the guidance from NUREG-1569 (NRC, 2003). Specifically, Acceptance Criterion 2.5.3(3) of NUREG-1569 states that the characterization of the site meteorology is acceptable if the Met data used for assessing impacts are substantiated as being representative of expected long-term conditions at and near the site. Additional guidance on assessing whether short-term Met data is representative of long-term conditions is provided in the fourth paragraph of Regulatory Position C.1 of Regulatory Guide (RG) 3.63, “Onsite Meteorological Measurement Program for Uranium Recovery Facilities – Data Acquisition and Reporting,” (NRC,1988) which states:

> “The minimum amount of meteorological data needed for a siting evaluation is considered to be that amount of data gathered on a continuous basis for a consecutive 12-month period that is representative of long-term (e.g., 30 years) meteorological conditions in the site vicinity. To determine whether the period during which the onsite data was collected is representational, compare a concurrent period of meteorological data from a National Weather Service (NWS) station with the long-term meteorological data from that NWS station. The NWS station selected for this comparison should, if possible, be in a similar geographical and topographical location and be reasonably close (preferably within 50 miles [80 kilometers]) to the site. In some sections of the country, the spacing between NWS stations may necessitate the selection of an NWS station more than 50 miles away. The reduced data and supportive documentation should be retained and should be available for review for the period of facility operation.”

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[1] CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying Met conditions on pollution transport, transformation and removal.

RG 3.63 does not include guidance on acceptable methods, either qualitative or quantitative, for comparing concurrent and long-term Met data from a nearby NWS station. However, the NRC staff has found acceptable alternative methods for demonstrating the long-term representativeness of Met data (NRC, 2018b, 2017, 2015). The three-year collection period proposed by HMC in its response to RSI No. #1 (Attachment 3 to HMC, 2020a) is not consistent with either RG 3.63 or the NRC staff's alternative methods.

Basis

This information is needed to determine compliance with the following requirements:

- 10 CFR Part 40, Appendix A, Criterion 7 – this regulation requires an operational monitoring program be conducted to measure or evaluate compliance with applicable standards.

- 10 CFR 20.1302(a) – this regulation requires surveys of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys for compliance purposes and for evaluating the concentrations and potential radiological hazards of residual radioactivity detected.

RAI-8

Background

Additional general information is needed to support the NRC staff's review regarding the Met measurement data and summaries based on the onsite monitoring program at the GRP site. These data were one of the inputs to the CALPUFF dispersion modeling analyses to support the proposed relocation of the background radon monitoring location(s) said to be representative of the GRP site as discussed throughout the December 2020 (current License Amendment Request [LAR]) (HMC, 2020a).

Pursuant to a July 1, 2020, RSI (NRC, 2020), the licensee provided responses to NRC RAI issued in 2016 (NRC, 2016) related to the quality of the onsite Met monitoring program and related atmospheric dispersion modeling intended to support a 2013 LAR. HMC's responses are provided in Attachment 3 of the current LAR.

In part, the current LAR is based on more recent onsite Met data covering the 2017 through 2019 period of record (POR), some data summaries (e.g., wind roses, data recovery statistics), and quality assurance (QA) documentation of performance audits of the onsite Met instrumentation. While the documentation for the current LAR appears to be more comprehensive than that provided to support the 2013 LAR, the NRC staff needs additional information for their evaluation of the current LAR.

RAI-8a

Provide the ASCII-character files for each year of sequential hourly onsite Met data (i.e., 2017, 2018, and 2019) including any information regarding formatting of those files, time stamping (e.g., hour beginning or hour ending) of the hour-averaged data, units of measure by parameter, etc.

RAI-8b

Provide calendar quarterly or Met season wind roses (as discussed below) similar to Figure 3 of Attachment 2 of the current LAR for at least the 3-year composite POR from 2017 to 2019. Such wind roses may also be provided for these individual years. Whatever set(s) of wind roses are provided, also indicate the respective percent frequency of calm conditions based on the starting thresholds for the HMC wind instrumentation which is not specified in Figure 3 of Attachment 2.

RAI-8c

To the extent that it is still necessary to support the CSM for the GRP site, provide calendar quarterly or Met season day/night wind roses indicating the daytime and nighttime hours for the respective seasons as well as the percent frequency of calm conditions as indicated in RAI-8b. If presented, the discussions of day/night wind conditions should not be limited to supporting the occurrence of nighttime drainage flow but should also be discussed in the context of the annual standard and corresponding background (i.e., accounting for all hours).

Discussion Regarding RAIs 8a to 8c

The NRC staff evaluated the frequencies of inversion conditions over the year as referenced to the 1974 New Mexico Environmental Institute (NMEI, 1974) study cited by HMC in describing the CSM for the GRP site. Frequencies of occurrence appear to be based on limited sampling days as opposed to daily monitoring per Table 4-6 of the NMEI 1974 report (i.e., based on sampling of about 10 percent of the days during fall and winter and about 26 percent of the days during spring and summer of the 1972 and 1973 POR). Sampling did not appear to occur during April of that period. Further, that table doesn't appear to indicate the time of onset and duration of inversion conditions as the text indicates. Nevertheless, temperature inversion frequency is estimated to have been about 60 percent on an annual basis and was said to likely have been even greater but due to weather conditions over the sampling period.

In that report, vertical lapse rates appear to have been extrapolated from measured temperature differences between the Mesa station (8,290 ft Mean Sea Level [MSL]) and either the Canyon (7,315 ft MSL) or Flats (7,175 ft MSL) stations. Those stations appear to be located northeast and east of GRP site. Elevations at the perimeter radon samplers near the LTP of the GRP site are lower, ranging from about 6,560 to about 6,610 ft MSL.

While the cited information from the NMEI 1974 report may be a useful indicator, the setup of temperature inversions over the course of a year might also have been reasonably estimated from the seasonal frequencies of low wind speed conditions at the GRP site. The current LAR does not appear to include seasonal wind rose summaries (as called for in Paragraph 3 of Regulatory Position 1 in RG 3.63).

The NRC staff recognizes that the Met data has been summarized on a calendar-year basis that doesn't readily lend itself to the Met seasons (i.e., December-February, March-May, June-August, September-November). So, alternatively, two sets of seasonal wind roses based on the period Dec 2017 to Nov 2018 and Dec 2018 to Nov 2019 would be acceptable. These summaries would allow for some indication of year-to-year variations that may be present and would appear to be somewhat consistent with the seasons reported in Table 4-6 of the NMEI 1974 report.

The NRC staff further notes that the current LAR does not include day/night wind roses as was the case for the 2013 LAR submittal despite the quality issues described in the RAIs for that submittal (NRC, 2016). The applicable standard is on an annual basis and discussions of day/night wind conditions should have been in the context of all hours comprising the annual standard and representative background conditions.

Basis

This information is needed to support the determination of compliance with the following radiological requirements and related Met monitoring guidance:

- 10 CFR 20.1301(a) – this regulation establishes, in part, that the total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of dose contributions from background radiation.

- 10 CFR 20.1302(a) – this regulation requires surveys, as appropriate, of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys including, but not limited to, those necessary for compliance purposes and for determining the magnitude and extent of radiation levels.

- U.S. NRC, Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301, Agencywide Documents Access and Management System (ADAMS) Accession No. ML15051A002.

- RG 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities – Data Acquisition and Reporting," Washington, DC: NRC, Office of Nuclear Regulatory Research, March 1988, ADAMS Accession No. ML003739874.

- U.S. EPA, "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements," March 2008.

RAI-9

Background

Additional technical information is needed to support the NRC staff's review regarding HMC's onsite Met monitoring program at the GRP site. This information relates to the quality, validity, and reasonability of the onsite Met data and is primarily based on the staff's review of the performance audit reports in Attachment 3B of the current LAR. The onsite Met data were one of the inputs to the CALPUFF dispersion model. Those dispersion analyses were performed to support, in part, the proposed relocation of the background radon monitoring location(s) said to be representative of the GRP site as discussed throughout the current LAR.

Attachment 3B of the current LAR consists of six performance audit reports conducted semi-annually in May and November of each year covering the 2017 to 2019 POR. In addition to several questions regarding the quality assurance / quality control (QA/QC) provisions of the monitoring program, instrument-related questions are also given below focusing on the onsite wind speed and wind direction measurements input to CALPUFF.

RAI-9a

Confirm whether, at any time for the HMC Met monitoring program, a QA/QC program plan was issued and implemented or if the routine Met data checks indicated in the response to RAI No. 4 (Item h) in Attachment 3 of the current LAR were the only other QA/QC-related items implemented, besides the performance audits, on a routine basis. If a QA/QC program plan was issued, provide a copy or reference to it.

RAI-9b

Clarify any QA-related discussions in the current LAR by addressing the limitations of the QA/QC checks being performed.

RAI-9c

Clarify Table 3-2 of the performance audit reports to indicate which table from the EPA QA Handbook for Met monitoring, cited below, is the basis for the acceptance tolerances listed therein and used by Meteorological Solutions, Inc. (MSI) during the performance audits. Annotate any differences from the referenced EPA guidance accordingly.

Discussion Regarding RAIs 9a to 9c

Pursuant to a July 1, 2020, RSI (NRC, 2020), HMC provided responses to NRC RAI issued in 2016 (NRC, 2016) related to the quality of the onsite Met monitoring program and related atmospheric dispersion modeling (using the EPA's AERMOD [AMS/EPA Regulatory Model] program) intended to support a 2013 LAR. HMC's responses are provided in Attachment 3 of the current LAR. In part, the current LAR replaces the 2009 onsite Met data used in the 2013 LAR with onsite Met measurements from a longer POR (i.e., 2017 through 2019) and uses a different and more sophisticated EPA dispersion modeling code (i.e., CALPUFF).

Based on Figure 3.1 and Section 3.1 of Attachment 3B to the current LAR, the onsite Met monitoring system is mounted on four-sided, open-lattice tower with ladder to climb. Some type of equipment box or shelter (e.g., housing a data logger, communications equipment) appears to be placed on the southern side of a platform several feet below the top of the tower. A combined wind speed and wind direction instrument (i.e., RM Young Model 05305-AQ system) is boom-mounted at 10 m above ground level (AGL). This is a mechanical device, similar to an aerovane (i.e., propellor and vane combined), but with more sensitive threshold starting speeds (i.e., less than 0.5 meters per second [m/sec]) for each sensor.

Other measurements at the tower include ambient temperature at 9.5 m AGL. There is no provision for measurement of the change of temperature with height (delta-T), the typical indicator of atmospheric stability used in NRC Met monitoring and dispersion modeling guidance. The CALPUFF model estimates stability conditions and plume diffusion using other indicators based on both onsite and offsite Met data, observations, and land use characteristics. The onsite Met monitoring program also includes measurements of precipitation at 0.6 m AGL, relative humidity (RH) at 9.5 m AGL, solar radiation at 9.0 m AGL, and site barometric pressure at 8.5 m AGL.

Section 1.0 of the six performance audit reports in Attachment 3B of the current LAR states that the "[m]eteorological instrument performance audits at Barrick / Homestakes' meteorological monitoring station was [sic] conducted in accordance with" the guidelines in the "Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements", March 2008. The NRC staff acknowledges that this is a recognized U.S. EPA Met monitoring guidance document.

Section 2.7.1 of the EPA QA Handbook cited above states, with respect to wind measurement system audits, that a "performance audit is the determination of instrument system accuracy made with an independently selected method and by a person who is independent of the operating organization." Although not a primary focus of this review, that concept would apply to other Met variables as well.

HMC's response to RAI No. 2 (Item a) in Attachment 3 of the current LAR indicates that in 2009 "the Met station operations vendor for HMC" was "Meteorological Solutions, Inc.", a division of Trinity Consultants (Trinity). MSI conducted the performance audits documented in Attachment 3B and presumably continued to provide those operational services during the interim leading up to HMC's use of the 2017 to 2019 POR in the current LAR.

Based on the EPA guidance cited by HMC, the NRC staff is trying to understand if, from a QA standpoint, routine operation and maintenance of the onsite Met monitoring system consists only of semi-annual performance audits conducted by MSI and data review and verification checks performed by Trinity or if the onsite monitoring program undergoes periodic independent audits of system operation and QA plan implementation. It appears from the information available, including the response to RAI No. 4 (Item f) in Attachment 3 of the current LAR, that the former is the case. However, it is not clear if the MSI staff involved in the performance audits are considered to be "independent of the operating organization." It appears that no independent audits of system operation and QA plan implementation, if one exists, have taken place.

Also, the EPA QA Handbook cited above includes several tables that list audit acceptance criteria. Some are mostly similar to Table 3-2 of the six performance audit reports in Attachment 3B of the current LAR.

RAI-9d(1)

Confirm: (1) the boom length for the wind instruments mounted on the HMC Met tower; and (2) whether or not potential interference effects from the tower itself, an antenna near the wind instrument boom on an adjacent tower leg, and/or the equipment box or shelter on the tower platform below the wind instrument boom were evaluated and the results of those evaluations.

RAI-9d(2)

If any interference from these potential immediate obstructions to air flow was or are identified, address any effects on the resulting wind speed and/or wind direction data and, if necessary, revise the CALPUFF dispersion analyses and conclusions drawn from the results accordingly.

Discussion Regarding RAIs 9d(1) and 9d(2)

The response to RAI No. 1 (Item f) in Attachment 3 to the current LAR states that "the HMC tower is located at a distance at least 10 times the height of nearby obstructions in accordance with meteorological siting recommendations from the EPA." However, that response appears to be with respect to the large and small tailings piles and "any other potential obstructions to air flow". The HMC Met tower configuration, as shown in Figure 3.1 of the performance audit reports in Attachment 3B to the current LAR, was not readily available at the time RAI No. 1, referenced above, was originally issued. More local obstructions to airflow may also have an influence on Met measurements.

RAI-9e

Explain why identical performance audit responses by the wind speed sensors and recorded by the data acquisition system (DAS), as discussed below, were identical to each of the audit input values considering that DAS responses for other Met parameters were often slightly different, as is typical, from their corresponding audit input values.

Discussion Regarding RAI 9e

In general, monthly data recoveries of 100 percent are initially suspect from a QA standpoint without additional justification. Table 1 for the 2017 to 2019 POR, as part of the response to RAI No. 4 (Item d) in Attachment 3 to the current LAR, shows annual data recoveries of 100 percent for most parameters. However, the NRC staff notes that the system configuration does not include redundant sensors and that data substitution was not employed for the HMC Met monitoring program (see the responses to RAI No.4, Items a and e, respectively) in Attachment 3. Further, no routine maintenance activities appear to have been performed other than those identified during the performance audits as indicated in the response to RAI No. 4 (Items h and g, respectively) or as a result of the routine Met data verification checks also indicated in the response to RAI No. 4 (Item h) in Attachment 3.

Further, as summarized in the response to RAI No. 4 (Item g) in Attachment 3 and as detailed in the performance audit reports in Attachment 3B of the current LAR, the wind speed sensor bearings were indicated as being replaced during the performance audits of May 24, 2017, May 22, 2018, November 14, 2018, and November 20, 2019. Often times, experience shows that increased bearing wear can result in lower recorded wind speed measurements or even stalled sensors. However, in these four cases, including the initial “as-found” and after bearing replacement “as-left” performance checks, it is not clear to the NRC staff why the sensor responses as recorded by the DAS were identical to every audit input value for all audit checks. This observation is also true for the “as-found” performance audits of November 28, 2017, and May 16, 2019.

RAI-9f(1)

Confirm that the process indicated below was followed for Met data validation, at least during the 2017 through 2019 POR used in the current LAR.

RAI-9f(2)

Clarify the current LAR to either reference the QA/QC program plan for Met monitoring on this project or summarize the full Met data validation process.

RAI-9f(3)

Regardless of the QA/QC process followed for validating the onsite Met data, update the current LAR by providing the performance audit reports that cover the periods from January 1 to May 24, 2017, and from November 20 to December 31, 2019, to help establish the validity of those Met data. The first and last performance audits documented in the current LAR occurred on May 24, 2017, and November 20, 2019, respectively.

Discussion Regarding RAIs 9f(1) to 9f(3)

It appears that for all variables measured by the HMC onsite Met monitoring program, the “as-found” results for a given semi-annual performance audit, whether the particular equipment was serviced or not, bracket the Met measurements made since the preceding semi-annual performance audit. Further, it appears that these audit results, along with the periodic Met data reviews, are used to establish data validity.

RAI-9g(1)

Confirm if a re-certification period other than one year applies to any of the audit standards used during the 2017 to 2019 POR, especially those noted below.

RAI-9g(2)

Confirm whether it is acceptable from a QC standpoint if an audit device is calibrated, in whole or in part, using standards still within their respective certification periods but the audit device itself is then used on a performance audit that is outside of the certification periods for the standards but within the newly-established one-year certification period for the audit device itself.

RAI-9g(3)

If necessary, provide an explanation in Appendix A of any audit reports to identify the applicable re-certification periods for all audit equipment and related standards.

Discussion Regarding RAIs 9g(1) to 9g(3)

Appendix A of the audit reports present audit equipment certifications. The results of these certification checks generally appear to be acceptable. Except as noted below, these checks appear to have been performed within the typical one-year certification period for calibration standards (e.g., see Appendix C of the EPA QA Handbook cited above) before being used on these performance audits.

As explained below, the NRC staff notes that the transfer standards used, in part, to calibrate the RH audit devices were all within a one-year period of their respective dates of preparation. However, in some cases, the RH performance audits occurred outside of the one-year period of the standards certification but within one year of the calibration devices certifications. For example:

1. For the May and November 2017 performance audits, NaCl, MgCl2, and LiCl salt solution standards from Vaisala appear to have been used by MSI as part of calibrating the device used to audit the onsite RH sensor. A handwritten note reading “Prepared on 4/4/16”, presumably written by MSI, appears at the top of the forms that document Vaisala’s certification of these salt solution standards. The NRC staff assumes that the transfer standards were later “prepared” by MSI from the Vaisala standards. If so, MSI’s preparation of the transfer standards was within one year of the respective dates of Vaisala’s certification of these salt solution standards. However, the “4/4/16” preparation date of the transfer standards is outside a one-year period for both performance audits but just within a one-year period of the date of their preparation when used by MSI to calibrate the RH audit devices.

2. For the May 2019 performance audit, NaCl, MgCl2, and LiCl salt solution standards from Vaisala appear to have been used by MSI as part of calibrating the device used to audit the onsite RH sensor. A handwritten note reading “Prepared on 2/22/2018 MRP”, presumably written by MSI, appears at the top of the forms that document Vaisala’s certification of these salt solution standards. The NRC staff assumes that the transfer standards were later “prepared” by MSI from the Vaisala standards. If so, MSI’s preparation of the transfer standards was within one year of the respective dates of Vaisala’s certification of these salt solution standards. However, a “2/22/2018” preparation date of the transfer standards is outside a one-year period for that audit but within a one-year period of the date of their preparation when used by MSI to calibrate the RH audit device.

Basis

This information is needed to support the determination of compliance with the following radiological requirements and related Met monitoring guidance:

- 10 CFR 20.1301(a) – this regulation establishes, in part, that the total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of dose contributions from background radiation.

- 10 CFR 20.1302(a) – this regulation requires surveys, as appropriate, of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys including, but not limited to, those necessary for compliance purposes and for determining the magnitude and extent of radiation levels.

- U.S. NRC, Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301, ADAMS Accession No. ML15051A002.

- RG 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities – Data Acquisition and Reporting," Washington, DC: NRC, Office of Nuclear Regulatory Research, March 1988, ADAMS Accession No. ML003739874.

- U.S. EPA, "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements," March 2008.

- Scire, J.S., F.R. Robe, M.E. Fernau, R.J. Yamartino, "A User's Guide for the CALMET [California Meteorological] Model," Version 5, Earth Tech, Inc., Concord, MA, January 2000.

- Scire, J.S., D.G. Strimaitis, R.J. Yamartino, "A User's Guide for the CALPUFF Dispersion Model," Version 5, Earth Tech, Inc., Concord, MA, January 2000.

RAI-10

Background

Additional technical information is needed to support the NRC staff's review regarding the offsite surface Met data and monitoring programs at the Grants-Milan Municipal Airport (KGNT), the Gallup Municipal Airport, and the Albuquerque International Airport. These data were also input to the CALPUFF dispersion modeling analyses that support the proposed relocation of the background radon monitoring location(s) said to be representative of the GRP site as discussed primarily in Attachment 2 of the current LAR (HMC, 2020a).

RAI-10a(1)

Reconcile whether the Grants-Milan Met station was designated an Automated Surface Observing System (ASOS)- or Automated Weather Observing Station (AWOS)-type station during the 2017-2019 POR used in the CALPUFF dispersion modeling analyses.

RAI-10a(2)

Confirm whether the wind instrumentation at the Grants-Milan Met station during the 2017-2019 POR were mechanical wind speed and wind direction or sonic anemometer devices. The NRC staff recognizes that an instrumentation change may not be coincident with a change in station type designation.

RAI-10a(3)

If measurements at the Grants-Milan Met station were made using a sonic anemometer, confirm whether the wind values were developed as scalar or vector averages. If the latter, also verify whether the vector values reported were developed as unit vectors or calculated using another approach.

RAI-10a(4)

Verify if the wind (and other) values in the Grants-Milan Met data set input to CALPUFF represent hourly averages, some shorter averaging interval, or discrete observations made by the system.

RAI-10a(5)

If the Grants-Milan wind speed and/or wind direction data represent vector averages, identify and, if needed, reconcile any potential effects on the transport component of the CALPUFF dispersion modeling and results between that Met station and that measured by the HMC onsite monitoring program. The onsite wind data are presumably scalar-average values.

RAI-10a(6)

Either revise or justify as to their applicability (as appropriate) any tabular and/or graphic presentations in the LAR of the CALPUFF modeling results and conclusions drawn from those results. The NRC staff recognizes that vector-averaged wind speed values may be smaller and/or wind direction values different than scalar-averaged values. So, for example, to the extent that lower wind speeds based on the Grants-Milan data contribute to any transport calculations (e.g., based on the bias variable and/or the radius of influence options in CALMET), downwind plume transport may be less and higher concentrations may be found closer to modeled source(s) compared to the dispersion patterns using larger, scalar-averaged wind speed values.

Discussion Regarding RAIs 10a(1) to 10a(6)

The NRC staff has identified a potential characteristic of the Met measurement system (specifically for wind) at the Grants-Milan Municipal Airport (KGNT) – WBAN (93057), USAF ID (723625). Wind speed and wind direction are used as inputs to the CALPUFF dispersion model. This characteristic may affect the transport and/or diffusion components of the dispersion modeling and, if so, possibly the conclusions drawn from results in various figures and tables presented in Attachment 2 or referenced in Attachment 1 of the current LAR.

Based on information provided at https://www.faa.gov/air_traffic/weather/asos/, the Met station at the Grants-Milan Municipal Airport is identified as an AWOS and designated as an AWOS III P/T system. At the same time, information provided at https://www.ncdc.noaa.gov/cdo-web/datasets/LCD/stations/WBAN:93057/detail designates this station as an ASOS. The wind measurement system is currently shown to be a sonic anemometer with a presumed 3-second sampling interval and hourly reporting and averaging frequency. The begin date and POR for this system is indicated as 030607 to the present. Information from this website also designates this as an ASOS station showing that the wind measurement system consisted of a cup anemometer with a presumed 5-second sampling interval and hourly reporting and averaging frequency. The POR for this system is indicated as 100197 to 030607. Contrary to the previous date ranges, the information notes a change from an ASOS to an AWOS station starting in September 2012.

Further, the NRC staff is aware that wind data for some of these systems that use sonic anemometry determine vector as opposed to scalar averages based on the measured data. It is not known whether vector wind direction values represent unit vector or true vector averages. Values based on mechanical wind instruments, such as cup anemometers or propellors and wind vanes, are typically reported as scalar averages. Based on the above, it appears that a sonic anemometer was used at the Grants-Milan Municipal Airport Met station during the 2017 to 2019 POR to the CALPUFF model.

RAI-10b

Address the potential issues identified under RAI-10a that may also apply to the other offsite surface Met data input to the CALPUFF dispersion model. The NRC staff did not evaluate the station designations (e.g., AWOS, ASOS), wind instrumentation types, data averaging approaches, or reporting intervals for the Gallup Municipal Airport and the Albuquerque International Airport for the 2017-2019 POR.

RAI-10c

Provide the original or revised (as appropriate) ASCII-character data files for each year of sequential hourly offsite surface Met data (i.e., 2017, 2018, and 2019) including any information regarding formatting of those files, units of measure by parameter, averaging or observation intervals, time stamping (e.g., hour beginning or hour ending) of the data, etc.

Basis

This information is needed to determine compliance with the following radiological requirements and related Met monitoring and atmospheric dispersion modeling guidance:

- 10 CFR 20.1301(a) – this regulation establishes, in part, that the total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of dose contributions from background radiation.

- 10 CFR 20.1302(a) – this regulation requires surveys, as appropriate, of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys including, but not limited to, those necessary for compliance purposes and for determining the magnitude and extent of radiation levels.

- U.S. NRC, Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301, ADAMS Accession No. ML15051A002.

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RAI-11

Background

Additional technical information is needed to support the NRC staff's review of inputs to and outputs of the CALPUFF dispersion modeling analyses, and conclusions drawn from various modeling and ambient measurement results in the current LAR (HMC, 2020a). Model inputs include data from HMC's onsite Met monitoring program at the GRP site. Outputs and conclusions include various tabular, graphic, and narrative explanations of modeling results as well as ongoing and supplemental ambient radon and radon-related measurements made at the site, in the site vicinity, and surrounding area. Those dispersion analyses and measurements were performed to support, in part, the proposed relocation of the background radon monitoring location(s) said to be representative of the GRP site as discussed throughout the current LAR.

RAI-11a

Clarify the CALPUFF model's status accordingly as summarized below and as stated in the text of LAR Attachment 2.

Discussion Regarding RAI 11a

Paragraph 1 under the heading "Atmospheric Dispersion Modeling" on Pages 3 and 4 of Attachment 2 of the current LAR states that CALPUFF "has been listed by the EPA as an approved model for assessing long-range transport of pollutants and their impacts on Federal Class I areas and for certain near-field applications." Based Volume 82, No. 10 of the *Federal Register* (FR) at Page 5196 (82 FR 5196), dated January 17, 2017, CALPUFF was removed as an Appendix A (preferred) model for the purpose of assessing National Ambient Air Quality Standards compliance and Prevention of Significant Deterioration increment consumption. However, the NRC staff understands that EPA still accepts the CALPUFF modeling system for use, along with other Lagrangian models, as a screening technique for long-range transport and recognizes its near-field applicability in evaluating meteorological and flow conditions in complex terrain settings.

RAI-11b(1)

Confirm if the calm threshold for the Grants-Milan Municipal Airport (i.e., 1.5 m/sec) was only input to the CALPUFF model for that and the other two offsite airport Met stations, or for all Met monitoring locations including the HMC site, or if the 0.5 m/sec calm threshold was specified for the HMC site.

RAI-11b(2)

If a calm threshold other than 0.5 m/sec was assigned to the wind data from the HMC site, revise or justify any tabular and/or graphic presentations of modeling results and conclusions drawn from those results.

Discussion Regarding RAIs 11b(1) and 11b(2)

Paragraph 2 under the heading "Meteorological Data" on Pages 6 and 7 of Attachment 2 of the current LAR compares characteristics of the 2017, 2018, and 2019 wind roses in Figure 3 (Page 8 of that attachment) from the KGNT and HMC's onsite Met monitoring program. In particular, the text states that "[c]alm hours for airports are defined as <3 knots (1.5 m/sec)" and that "for the HMC tower, a calm is defined by the stall speed of the anemometer (0.5 m/sec)." A primary focus of that text is a comparison of calm frequencies between the two stations on the same basis (i.e., 14.9 percent offsite versus 31.6 percent onsite) using the airport threshold wind speed for calms.

That text goes on to state, in part, that "[u]nlike steady-state models such as AERMOD…., calm winds are treated explicitly in Lagrangian puff models like CALPUFF." Further, the last paragraph in Section 2.14 of Version 5 of the CALPUFF model user's guide states that:

> "When CALPUFF is applied with detailed wind and turbulence measurements, care must be used to ensure that valid measurements are not superseded [sic] by the minimum turbulence values. The minimum speed used as the calm threshold, and the individual turbulence minima should reflect the characteristics of the wind sensors and the data collection system used."

It is not clear to the NRC staff whether the calm threshold was specified only for comparing the calm frequencies for the two Met stations. On the other hand, if the applicable calm threshold was assigned to the HMC onsite wind speed data in the dispersion modeling analyses, even at a 0.5 m/sec wind speed individual puffs or puff segments could be transported as much as 1,800 m from their previous locations in a single hour.

This is an important technical consideration since most of the dispersion modeling-related results and conclusions relevant to HMC's proposed change to a different background radon monitoring location(s) tend to be local to the HMC site. Therefore, the actual characteristics of the onsite Met data are most applicable to these dispersion analyses.

RAI-11c

Confirm whether the CALPUFF modeling results for receptors at or near the HMC site indicate a similar peak-to-minimum diurnal variation of 20 to 50 times as stated in the referenced text or the significantly lower factor of 10 night-to-day ratio as mentioned in HMC's response to EPA Comment No. 4.

Discussion Regarding RAI 11c

Section 4.3 (Background Radon Concentrations and Preoperational Monitoring) of the ISG (NRC, 2018a) addresses some of the complexities of establishing a representative location for measuring background radon levels, including the possible need for more than one measurement location, as background can be excluded from demonstrations of compliance with the annual public dose standard in 10 CFR 20.301(a).

The EPA, in its review of a technical report supporting the 2013 LAR submittal (HMC, 2013a) that proposed to relocate the current HMC background monitoring location, recognized some of these same complexities. EPA's Comment 3 (see Attachment 3 of the current LAR) states "reliance on one monitor (HMC-1OFF) that is near the maximum values monitored near the facility is inappropriate and leads to an underestimation in contribution from Homestake's process and emissions sources."

HMC's response to this comment states, in part, that the CALPUFF modeling "confirms the basic conceptual model that background radon concentrations in the SMC wash are consistently higher than on the slopes and mesas above the wash." However, the NRC staff notes that this implies without further justification, at least here, that background radon levels are similar throughout the entire SMC wash. HMC concludes its response to EPA Comment 3, reiterated elsewhere in the LAR, by stating that "background is not a static value and varies both temporally and spatially." To the NRC staff, this then appears to be an incomplete assessment by not addressing variation of background radon levels within more of the wash (i.e., for locations from about the Southeast (SE) clockwise through the WNW of the GRP site) or sufficient justification that radon levels in the SMC wash north of the site, where HMC-1OFF and HMC-6OFF are located, are representative of conditions in all sectors surrounding the site.

EPA's Comment 4 (see also Attachment 3) recommends an approach for developing average background radon levels. That approach would be based on data from the currently available offsite radon monitoring locations weighted for groups of these stations as a function of wind direction frequencies for specific ranges (i.e., in total covering the WNW clockwise through the east sectors) over a given two-year POR. It appears that these background values would then be applied for compliance purposes to the measurement data (or average of that data) from the seven radon monitoring stations at and around the entire HMC site perimeter. EPA Comment 4 also notes that "….there is no background monitor data for the SE, South, Southwest, or West of the Homestake facility therefore we propose using only the wind data that corresponds with the background monitoring data wind directions."

HMC's response to EPA Comment 4 (also in Attachment 3) disagrees with EPA's recommended approach by stating, in part, that it "considers only wind direction, not wind speed, or more importantly atmospheric stability, and vertical mixing." The response also states that the "averaging method proposed ignores the process of greater importance….nocturnal drainage flow" and that "radon concentrations peak during the early morning hours (before sunrise) and are about 10 times the concentration during daylight hours." HMC goes on to state that "[a]ccounting for all these processes can only be done through atmospheric dispersion modeling."

The NRC staff agrees with HMC's statement that modeling (in the case of this LAR, use of the CALPUFF model) can account for the effects of wind speed, wind direction, atmospheric stability, and vertical mixing, among others (e.g., terrain) on atmospheric dispersion. However, the staff also notes that because the public dose standard in 10 CFR 20.301(a) is defined on an annual basis (even if compliance is determined incrementally for that duration on a semi-annual or quarterly basis), factors other than those accounted for by such modeling and those indicated above (i.e., the effects of higher concentrations due to nocturnal drainage flow) also bear consideration as evidenced by other data and results summarized in the current LAR.

The NRC staff recognizes that the CALPUFF dispersion modeling accounts for all hours and input Met conditions. However, compliance is being determined by measurement data and not dispersion modeling. The dispersion results are being used as part of the proposed relocation of the background monitors.

Examples of other factors and technical issues that bear consideration in establishing one or more background monitoring locations representative of the HMC site include: Paragraph 3 under the heading "Conceptual Model" on Pages 2 and 3 of Attachment 2 of the current LAR refers to the 2013 report by the ERG, "Basis for Selection of a Representative Background Monitoring Location for the Homestake Uranium Mill Site" (ERG, 2013). That paragraph concludes by stating "diurnal variation is clearly shown in hourly average measurements of ambient radon concentrations taken at HMC radon monitoring stations." The text goes on to state that "[i]n the early morning hours before sunrise radon concentrations were about twenty to fifty times higher than radon concentrations in the afternoon." The basis for those statements is illustrated in Figure 4-5 of ERG (2013) for a limited period of six and five consecutive days during the summer of 2013 and the winter of 2011, respectively.

While the NRC staff recognizes that those PORs are different from the three years of Met data used for the CALPUFF modeling in the current LAR, the licensee has also demonstrated reasonable year-to-year consistency in the site Met conditions by virtue of similarity in the onsite wind roses of Figure 3 of Attachment 2.

This information is aimed at helping the NRC staff understand several things: first, the marked difference between the diurnal radon variations, as stated by HMC, and how background levels might vary by season (or otherwise) during the year, and second, what variation is seen by comparison to the CALPUFF modeling results (consistent or not with the assertion in HMC's response to RAI No. 3 (Item c) in Attachment 3 that "[t]abulation of daytime and nighttime hours is not needed in the report"), and third, any effects on the conclusions drawn from the dispersion modeling results.

RAI-11d

HMC should either: (1) provide sufficient additional justification that radon levels in the SMC wash north of the site, where HMC-1OFF and HMC-6OFF are located, are representative of all locations in the SMC wash surrounding the site on an annual basis and under all conditions, or (2) establish and maintain one or more background radon monitoring stations south of the site (i.e. within the direction sectors indicated below) and propose an approach for defining representative background conditions at the compliance points (i.e., at HMC-4 and HMC-5) on an annual average basis which may include the proposed background stations at HMC-1OFF and HMC-6OFF.

Discussion Regarding RAI 11d

The wind roses for the 2017 to 2019 POR of onsite Met data at HMC, as shown in Figure 3 of Attachment 2 of the current LAR, do not appear to indicate the frequency of calm hours for each year or the composite 3-year POR. Likewise, the NRC staff was unable to identify, in the remainder of the current LAR, those calm frequencies based on the threshold wind speeds for the onsite wind instruments (i.e., 0.5 m/sec); rather, only the percent of calm hours using the threshold speed for the Grants-Milan Municipal Airport wind instruments as noted above in Paragraph 1 of the discussion for RAIs 11b(1) and 11b(2).

Despite this limitation, the NRC staff evaluated these onsite wind roses to estimate the frequencies of wind directions from the Northwest (NW) clockwise through the ESE sectors for wind speeds less than 3.4 m/sec (7.6 miles per hour [mph]) (i.e., the lowest two wind speed classes). Although the distribution of wind speeds within this second class is not known, using the frequencies associated with this class is considered to represent a reasonably conservative assumption for drainage flow to occur without additional dilution of background radon emissions from atmospheric turbulence. This assumption addresses many of the concerns raised by HMC in their responses to EPA Comments 3 and 4. The NRC staff's focus here is on lower wind speeds that are also associated with the occurrence of more stable atmospheric and temperature inversion conditions.

The frequency of these lower wind speeds for the NW clockwise through the ESE direction sectors, which generally encompass the canyons that include and feed into the SMC wash, is estimated to be about 40 to 45 percent on an annual basis regardless of the time of day. If the percent frequency of calm winds based on the HMC wind measurement system is added and all are assumed to be associated with drainage flow within the SMC wash, the above value would increase. On balance then, drainage conditions could be conservatively estimated to occur at the HMC site about half the time from the NW clockwise through the ESE direction sectors. That also means winds of all speeds from the SE clockwise through the WNW direction sectors, and wind speeds greater than 3.4 m/sec (7.6 mph) from the NW clockwise through the ESE sectors, occur about half the time as well.

However, given the above frequency of winds from the SE clockwise through WNW sectors, Paragraph 3 of EPA Comment 4, and Paragraph 3 of RAI No. 9 (Item c) in Attachment 3 of the current LAR, the NRC staff is curious why long-term and more recent (i.e., in 2020) field measurements by HMC, discussed and presented in various tables and figures under the heading "Measured Data", did not include measurements farther south of HMC-4 and HMC-5, the stated compliance points which lie along the south and southwest of the HMC site perimeter.

Further, text under the heading "Ubiquitous Radon Sources" on Pages 24 to 26 in Attachment 2 of the current LAR describes a CALPUFF modeling analysis performed by the licensee to "simulate the distribution of radon concentrations in ambient air from background ubiquitous radon emissions in soil." HMC states, and the NRC staff understands, that "[t]he purpose of these simulation [sic] was to observe the distribution of radon concentrations in the San Mateo Wash….it was not to quantify background radon." The text also states that "[t]he model shows pockets of lower and higher concentrations in the wash indicating some spatial variability may be expected."

Figure 15 of Attachment 2 illustrates CALPUFF-predicted concentrations normalized to HMC-16 (i.e., the current background monitoring station) assuming enhanced radon flux in the SMC wash. Modeling results to the north of the HMC site, where the proposed background stations at HMC-1OFF and HMC-6OFF are located, generally appear to be higher than those to the South, West and East of the site also in the SMC wash but near the perimeter compliance points at HMC-4 and HMC-5. This is consistent with HMC's statement above regarding "spatial variability." More specifically, modeled concentrations also appear to be lower with a concentration gradient that decreases more quickly near HMC-4 (i.e., outside the main plume as modeled), the higher of the two compliance points, compared to HMC-5.

The NRC staff considers that the need to substantiate contributions to background radon levels over the entire year including wind directions south of the HMC site (i.e., generally from the SE clockwise through the WNW direction sectors), is reasonably demonstrated to still be an issue.

<u>Basis</u>

This information is needed to determine compliance with the following radiological requirements and related Met monitoring and atmospheric dispersion modeling guidance:

- 10 CFR 20.1301(a) – this regulation establishes, in part, that the total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of dose contributions from background radiation.

- 10 CFR 20.1302(a) – this regulation requires surveys, as appropriate, of radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with public dose limits.

- 10 CFR 20.1501(a) – this regulation requires surveys including, but not limited to, those necessary for compliance purposes and for determining the magnitude and extent of radiation levels.

- U.S. NRC, Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301, ADAMS Accession No. ML15051A002.

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- Scire, J.S., D.G. Strimaitis, R.J. Yamartino, “A User’s Guide for the CALPUFF Dispersion Model,” Version 5, Earth Tech, Inc., Concord, MA, January 2000.

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