HOMESTAKE

Grants Reclamation Project

Homestake Mining Company of California

David W. Pierce
Closure Manager

March 31, 2020

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Mr. Ron Linton, Project Manager
Project Manager, Materials Decommissioning Branch
Decommissioning, Uranium Recovery & Waste Programs
Office of Nuclear Materials Safety and Safeguards
U.S. Nuclear Regulatory Commission
MS T-5A10, 11545 Rockville Pike
Rockville, MD 20852

RE: Revised HMC response to NRC's "Request for Additional Information – Compliance of Homestake Grants, New Mexico Site with 10 CFR 20.1301 and 10 CFR 20.1302." Docket No. 040-08903, License No. SUA-1471

Dear Mr. Linton:

Homestake Mining Company of California (HMC) has prepared this revised response to a Request for Additional Information (RAI) from the Nuclear Regulatory Commission (NRC) concerning "Compliance of the Homestake Grants, New Mexico Site with 10 CFR 20.1301 and 10 CFR 20.1302" [letter dated July 31, 2018 (ML18159A366)]. HMC initially responded by letter dated August 20, 2018 (ML18240A143), but the response was not accepted for detailed review by NRC [letter dated August 30, 2019 (ML19239A165)]. The attached RAI responses have been revised to modify the proposed approach for annual calculation of public dose from radon, and to address NRC comments provided in the original RAI as well as comments regarding HMC's original RAI responses as provided in the NRC's August 30, 2019 decision letter.

Should you have any questions or comments regarding these revised RAI responses, please contact me at dpierce@homestakeminingcoca.com or (505) 290-2187.

Sincerely,

David W. Pierce

David Pierce
Closure Manager
Homestake Mining Company, Grants, New Mexico

cc: R. Linton, NRC, Rockville, Maryland (electronic copy)
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M. McCarthy, Barrick, Salt Lake City, Utah (electronic copy)
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G. George, Davis Wright Tremain, San Francisco, California (electronic copy)
R. Whicker, ERG, Albuquerque, New Mexico (electronic copy)

Preface

The following presents HMC's revised responses to requests for information (RAIs) from NRC concerning "Compliance of the Homestake Grants, New Mexico Site with 10 CFR 20.1301 and 10 CFR 20.1302" [USNRC, 2018 (ML18159A366) and 2019 (ML19239A165)]. RAIs from NRC are shown in italics, followed by HMC's response.

RAI #1 (from July 31, 2018 NRC Letter)

The NRC staff requests that HMC no longer report comparisons of measured concentrations in air at perimeter monitoring stations to effluent concentration values from 10 CFR Part 20 Appendix B, Table 2 and use the dose method consistent with 10 CFR 20.1301 and 10 CFR 20.1302.

HMC Response

HMC has identified that since the RAI-related commitment by HMC in the January 19, 2016 response submittal to "no longer report comparisons of measured radon concentrations in air at perimeter monitoring stations to ECs in Appendix B, Table 2 of 10 CFR 20" (ML16033A407), the table of semiannual radon values provided in Semiannual Environmental Monitoring Reports (routinely provided in Attachment 2) had inadvertently continued to include a column with fractional comparisons to 10 CFR 20 Appendix B Effluent Concentrations (ECs) for radon without decay products present. In response to RAI #1, the template table used to compile radon monitoring data for semiannual reporting has been revised to eliminate the subject table column and associated footnote. This corrective action will prevent any comparisons of this nature in future Semiannual Environmental Monitoring Reports as required under 10 CFR 40.65 (referred to herein as "40.65 Reports").

RAI #2 (from July 31, 2018 NRC Letter)

The NRC staff requests that HMC commit to computing the dose limit where the dose conversion factor is based on the air radon concentration of 10 CFR Part 20 Appendix B, Table 2, with daughters and appropriate equilibrium ratios or provide justification as to why radon concentration without daughters is acceptable. Additionally, it is requested that HMC provide equation(s), equilibrium ratios, occupancy factors, and any other factors it considers appropriate to the NRC staff to demonstrate compliance with the public dose limits and provide any justifications for any changes for future submittals of environmental monitoring reports. These parameters, along with calculated radon release rates from the tailings, can be used in the MILDOS program to compute radiation doses to members of the public.

NRC Comments on initial HMC response to RAI #2 (from August 30, 2019 NRC response letter).

HMC has not adequately demonstrated a method for compliance with 10 CFR 20.1301. As discussed with HMC staff, this proposed methodology is not consistent with any of the options recommended in the Interim Staff Guidance, DUWP-ISG-013, used for demonstrating compliance with 10 CFR 20.1301. More importantly, HMC did not provide justification why its proposed alternate methodology would insure that the maximum public dose from its operations would be within the regulatory limits.

HMC Response

HMC does not use a dose conversion factor based on 10 CFR 20 Appendix B effluent concentration limits for radon-222 (Rn-222) without daughters (progeny) present for calculation of public dose from radon. Public radon dose is currently (and historically) calculated based on the measured net (above background) radon concentration, an assumed radon progeny/gas equilibrium ratio of 0.2, and a radon dose conversion factor derived from 10 CFR 20 Appendix B (Table 2) with progeny present. The parameters and calculation are detailed in a public dose Attachment to second half semiannual 40.65 reports. Comparisons of measured Rn-222 concentration data at boundary monitoring locations with radon effluent concentration limits from Appendix B of 10 CFR 20 (without progeny) were previously routinely included in Attachment 2 of all semiannual 40.65 Reports, but at NRC's request this historical reporting convention has been eliminated.

RAI #2 states that MILDOS modeling can be used to "compute radiation doses to members of the public". However, NRC has determined that HMC's respectively proposed approach was inconsistent with NRC's Interim Staff Guidance (ISG) "*Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301*" (USNRC, 2014 and 2019). This "ISG Radon Guidance" indicates that if modeling is to be used to demonstrate compliance with 10 CFR 20.1301 public dose limits, measurements to "confirm or compare" with modeling results are also expected. Accordingly, HMC proposes continuation the current/historic method for determination of public radon dose and comparison with 10 CFR 20.1301 public dose limits (i.e. Option 1 as specified in 10 CFR 20.1302), but with modified parameter assumptions as described below.

The current/historic method for estimating public radon dose is based on measurement of the net (above background) radon concentration at monitoring stations in close proximity to the nearest public residence (station HMC-4 or HMC-5, whichever has the highest net concentration). Moving forward, consistency with the ISG Radon Guidance is fundamentally dependent on moving the approved background radon monitoring station from HMC-16 to a representative location along the floor of the San Mateo Creek (SMC) valley in which the Site is situated. The average background radon concentration at HMC-16 is typically about 50-60% lower than average background radon concentrations that occur naturally along the floor of the SMC valley (ERG, 2020). The underlying geology and geomorphic setting at HMC-16 result in a significantly lower-level radiological background environment versus background conditions along the floor of the SMC valley. Consequently, subtraction of the annual average background radon concentration at HMC-16 from the measured average at station HMC-4 or HMC-5 (in accordance with license conditions and the ISG Radon Guidance) results in a systemic high bias in calculated public doses from effluent radon.

In addition to a fundamental inconsistency with the ISG Radon Guidance, defining background radon conditions at HMC-16 results in calculated net effluent radon levels that are not comparable to corresponding results modeled with MILDOS at the same locations based on measured radon flux emissions from the tailings piles[1]. If net effluent radon levels for public dose estimation continue to be based on subtraction of HMC-16 data, and more conservative occupancy and radon equilibrium parameters as cited in the ISG Radon Guidance are assumed, HMC is at risk of routinely exceeding 10 CFR 20.1301 public dose limits due to due to a non-representative background radon monitoring location. This highlights the importance of selection of a new background location in an area that meets the criteria cited in the ISG Radon Guidance (USNRC, 2019a):

- "*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*."
- "*…determining appropriate background location(s) is complicated by spatially and*

[1] Note that radon emissions from all other sources at the Site (e.g. evaporation ponds, RO plant, etc.) are negligible relative to emissions from the tailings piles (see HMC response to RAI #3 for technical details).

temporally varying concentrations; impact of varying geology on the natural emissions of radon from soil into air; effects of topography on wind patterns, especially on patterns of low speed winds (e.g., down valley drainage)…".

Based on the above criteria and related Site circumstances, HMC recently commissioned a study to re-evaluate the previously proposed change in the background radon/gamma monitoring station from location HMC-16 to offsite radon station HMC-1OFF (HMC, 2013 and 2016), situated upgradient of the Site near the approximate center of the floor of the SMC valley. This study included evaluation of additional historic and recent radon data generated from routine monitoring, relevant data generated by a special investigation requested by NRC concerning occupational radiation exposures at the Site (ERG, 2019), and new gamma radiation survey data collected in offsite background areas both within and beyond the floor of the SMC valley. The Report for this study (ERG, 2020) is provided as the technical basis for a license amendment request (LAR) to move the background radon/gamma monitoring station from HMC-16 to HMC-1OFF (HMC, 2020). The LAR and supporting Report are submitted concurrently with this revised response to RAIs on compliance with public dose limits because these issues are closely interrelated.

In specific response to RAI #2 comments from NRC, and in accordance with Section 4.3 of the ISG Radon Guidance (USNRC, 2019a), HMC proposes to calculate public dose from radon based on the net differential between annual average measured radon gas at air station HMC-4 or HMC-5 (whichever value is greater), and the measured annual average radon concentration at background monitoring station HMC-1OFF. Section 4.3 of the ISG Radon Guidance implies that this differential is an acceptable 'measure' of net effluent radon levels at site boundaries and/or location(s) representative of public receptor exposure scenarios.

Based on comparison of MILDOS-predicted effluent radon levels at monitoring station HMC-5 versus long-term measured differences in average radon levels between monitoring locations HMC-5 and HMC-1OFF, the long-term average differential appears to provide a reasonably accurate measure of combined impact of effluent radon releases from all Site facilities (tailings piles, water treatment and evaporation systems). However, public dose from radon is estimated/reported annually based on only four quarters of data, and respectively 'measured' net effluent radon levels may not be consistent with net differences based on longer-term averages. In any given year, temporal and spatial variability in local background levels, along with analytical uncertainty associated with alpha track-etch detectors, may have a significant impact on the calculated annual average effluent radon concentration at locations of interest with respect to potential public exposures.

Evaluation of existing radon data and previous modeling efforts has raised questions as to whether this simplified conceptual 'measure' of net effluent radon, as defined in the ISG Radon Guidance, is a valid assumption for the Site. Accordingly, HMC has initiated a special study (beginning 1st quarter 2020) to evaluate ambient radon gas levels as a function of distance and direction from the approximate centroid of the LTP. Alpha track-etch detectors are posted on 500-meter increments along radial transects extending up to 2 km in the various directions and locations of boundary environmental monitoring stations (see Figure 1 below). The objective of the study is to characterize the spatial extent of measurable effluent radon emissions from the tailings piles, information that can be evaluated with current/historic boundary monitoring data and MILDOS modeling results to better inform the most effective and accurate method(s) for estimation of public dose on an annualized basis. This special study is consistent with recommendations and objectives found in Section 4.7 of the ISG Radon Guidance (NRC, 2019a), and results may eventually lead to the identification of a more accurate and reliable method for determining public dose from effluent radon emissions.

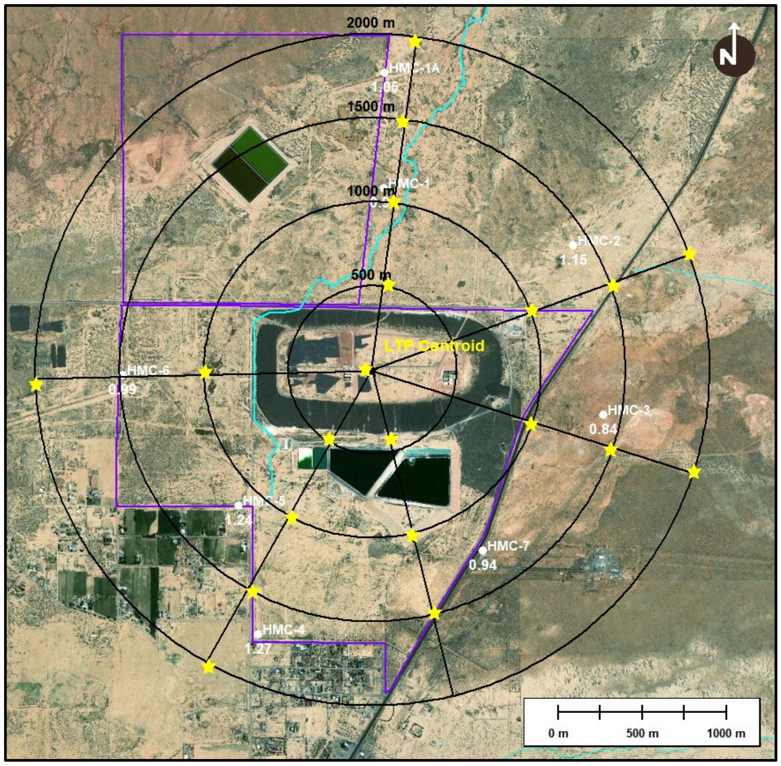


Figure 1: Radon versus distance study monitoring design.

In addition to use of a more representative background radon monitoring location at station HMC-1OFF, HMC proposes use of more conservative assumptions for occupancy factor and radon equilibrium ratio based on generic values cited in the ISG Radon Guidance (USNRC, 2019a). The technical and regulatory bases for selection of the radon equilibrium ratio and occupancy factor to be used in calculating public radon dose are described below. If the LAR is approved by NRC, background radon/gamma monitoring at station HMC-16 will be discontinued and replaced with respective monitoring at station HMC-1OFF.

Radon Equilibrium Ratio

The ISG Radon Guidance (USNRC, 2019a) was reviewed for recommendations on selection of an appropriate equilibrium ratio to use in the dose calculation approach (as described above) to demonstrate compliance with 10 CFR 20.1301. The ISG Radon Guidance provides the following relevant information:

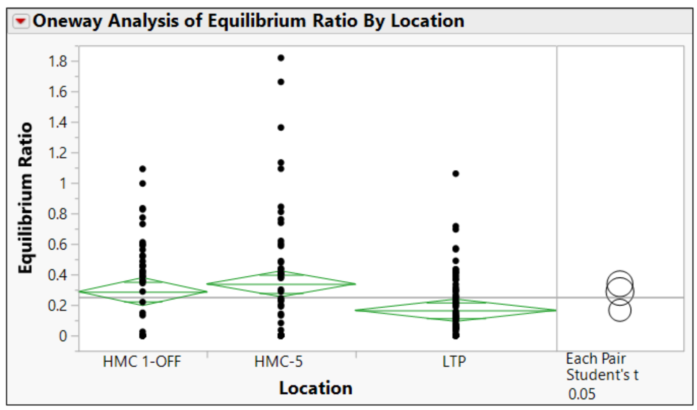
- The most simplistic and conservative approach to determining the equilibrium ratio is to assume that radon progeny are present at 100% equilibrium with radon gas (i.e. an equilibrium ratio of unity). However, the licensee does not need to assume 100% equilibrium.
- If direct and/or representative measurements of radon progeny are not practicable, conservative assumptions regarding the radon progeny/gas equilibrium ratio as noted below can be used in conjunction with measured long-term average radon gas concentrations to estimate public radon dose.
- Indoor exposures: It is generally acceptable to NRC staff to assume an equilibrium ratio of 0.5.
- Outdoor exposures: It is generally acceptable to NRC staff to assume an equilibrium ratio of 0.7.
- Combined Indoor/Outdoor residential exposures: Assuming the majority of time is spent indoors under

a residential scenario at locations relatively close to the facility, it is generally acceptable to NRC staff to assume an equilibrium ratio of 0.5.

- Equilibrium factor by measurement: Direct, site-specific measurements of radon gas and radon progeny EEC can be made at the location of interest (e.g. nearest public residence) to allow calculation of the equilibrium ratio. Due to temporal and spatial variability in radon gas and progeny levels, paired measurements of radon gas and radon progeny levels at each location should be made at the same time. This method may be conservative as such measurements will reflect the equilibrium ratio for radon from all sources (including background), not just facility-related radon.

In the "Basis for Request" provided by NRC for RAI #4, the NRC cites a calculated equilibrium ratio of 0.34 at air monitoring station HMC-5 based on MILDOS modeling input data provided previously by HMC. At NRC's request, HMC recently conducted a special study concerning occupational exposures at the Site, part of which included direct measurements of radon equilibrium ratio parameters at key locations, including the LTP, HMC-5 and HMC-1OFF. Respective measurements included short-term grab sampling for radon gas (with a Durridge RAD7 instrument) and measurement of radon progeny based on air grab sampling and analysis of sample filters using the modified Kusnetz method. These paired measurements, co-located in time and space, were scheduled twice per day (morning and afternoon) three days per week over an investigation period of approximately 4 months. Details of the methods and sampling design were provided in an associated Study Plan (ERG, 2017). Statistical comparisons of resulting equilibrium ratios by location as provided in the final Report (ERG, 2019) are reproduced as shown in Figure 2.

Aside from NRC questions regarding the quality of radon gas measurement data with the RAD7 instrument (USNRC, 2019b)[2], the distribution of calculated equilibrium ratio results reveals a mean value of 0.34 at HMC-5, coincidentally matching the value calculated by NRC for this same location (see NRC's Basis for RAI #4). As might be expected, measured equilibrium ratios on top of the LTP are statistically lower than other locations as radon emissions from the LTP are "fresh", consisting only of radon gas when first released from the soil surface.



Parametric Comparisons by T-test

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
HMC-5	LTP	0.1731004	0.0566086	0.061427	0.2847739	0.0026*
HMC 1-OFF	LTP	0.1222980	0.0591087	0.005692	0.2389036	0.0399*
HMC-5	HMC 1-OFF	0.0508024	0.0630712	-0.073620	0.1752250	0.4216

Nonparametric Comparisons by Wilcoxon Method

q*	Alpha
1.95996	0.05

Level	- Level	Score Mean Difference	Std Err Dif	Z	p-Value
HMC-5	HMC 1-OFF	-0.5301	5.871764	-0.09028	0.9281
LTP	HMC-5	-8.0985	6.727344	-1.20382	0.2287
LTP	HMC 1-OFF	-10.1140	6.632661	-1.52487	0.1273

Figure 2: Statistical comparisons of measured radon equilibrium ratios at locations relevant to evaluation of effluent radon properties and environmental behavior.

[2] NRC noted in its review of the Study Report that during the monitoring period, outdoor temperatures in the area fell below the 32° F minimum operating temperature range specified for the RAD7 instrument. However, these instruments were housed in small enclosures with electrical heat blankets inside, there was no evidence of pump diaphragm malfunction (the main concern during freezing temperatures), and spatial/temporal trends reflected in the data are consistent with expectations based on HMC's conceptual site model for radon behavior in the vicinity of the Site (ERG, 2020). HMC believes that the RAD7 radon gas data are of suitable quality for characterization of relative differences in equilibrium ratios between locations.

Because measured equilibrium ratios vary considerably (temporally and spatially) and the Study period was limited (about 4 months), and since there is uncertainty in both direct measurement and modeling of equilibrium ratios, HMC proposes to use conservative generic values specified in the ISG Radon Guidance as generally acceptable to NRC staff (USNRC, 2019a). The nearest member of the public represents a residential scenario with combined indoor/outdoor exposures, and a radon equilibrium ratio of 0.5 will be used for future calculation of public dose from radon gas/progeny. Results will be reported annually in 2nd half semiannual 40.65 reports.

<u>Occupancy Factors</u>

As indicated in the "Basis of Request" for RAI #4, and consistent with recommendations in the ISG Radon Guidance (USNRC, 2019a), HMC will conservatively assume an occupancy factor of unity (1) for calculations to determine annual dose from radon gas/progeny as part of annual demonstration of compliance with the public dose limits specified in 10 CFR 20.1301. Because of this assumption, along with the assumed radon equilibrium ratio of 0.5 for combined indoor/outdoor exposures as noted above, partitioning of exposures between indoor and outdoor occupancy is not necessary as the resulting public dose estimate would be identical to that generated for 100% outdoor occupancy and an equilibrium ratio of 0.5 (this assumption will be used to simplify public dose calculations).

REFERENCES

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Homestake Mining Company of California (HMC). 2016. Withdrawal of License Amendment Request Dated 23 September 2013; Grants Reclamation Project, Docket No. 40-8903, License No. SUA-1471. June 16, 2016. (ML 16181A073).

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U.S. Nuclear Regulatory Commission (USNRC). 2014. U.S. Nuclear Regulatory Commission (USNRC). 2014. Evaluations of uranium recovery facility surveys of radon and radon progeny in air and demonstrations of compliance with 10 CFR 20.1301. Interim Staff Guidance FSME-ISG-01. Revised Draft Report for Comment. March 2014.

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Interim Staff Guidance DUWP-ISG-01. Final Report. June 2019.

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RAI #3 (from July 31, 2018 NRC Letter)

The NRC staff requests that HMC demonstrate, preferably by measurements from the main release point of the water treatment system, and not at some distant environmental monitoring station receptor point that the radon releases are insignificant.

NRC Comments on HMC's initial response to RAI #3 (from August 30, 2019 NRC response letter).

Comment: The licensee described estimates of radon effluent quantities from the occupied spaces in the reverse osmosis (RO) building and the surface of the evaporation ponds. However, as discussed with HMC staff, there are other potential sources of radon that should also be evaluated.

Based on the licensee's descriptions (e.g., HMC, 2017[3]), the NRC staff understands the RO clarifier, which is an open-air tank outside the RO building, and which serves as a receiver of tailings water from the large tailings pile and other untreated water, is a potential unmonitored source. In addition, the use of evaporation pond sprayers is another unmonitored source that can be estimated with site-specific parameters (e.g., EPA, 2010). The licensee should account for all potential radon sources or explain why they could not be a significant source of radon in air effluent. In any case, Regulatory Guide (RG) 8.37[4] provides one method for addressing unmonitored effluents. This RG states, "The licensee should estimate the magnitude of unmonitored releases and include those estimated amounts when demonstrating compliance with dose limits and the licensee's ALARA goals." As discussed with HMC staff, HMC has not provided sufficient information for NRC staff to make a determination that HMC has established a methodology to account for all monitored and unmonitored sources of radon in air effluent.

HMC Response

Because HMC is no longer proposing MILDOS modeling for determination of public dose from radon, direct monitoring or calculation of effluent radon releases from individual source terms is technically no longer relevant to public dose estimation. HMC is proposing to continue with the historic/current method for dose estimation based on measurement of the collective net (above background) effluent radon from all licensed sources at a monitoring location representative of the nearest member of the public. In specific response to RAI #3, HMC has nevertheless developed estimates of annual radon releases from each of the identified source terms as follows:

1. Releases from the LTP and STP (based on annual flux measurements).
2. Releases from the RO water treatment building (based on indoor radon measurements and flow specifications for ventilation fans).
3. Releases from static pond water (based on Ra-226 concentrations and empirically-derived radon release factors).

[3] HMC, 2017. 2016 Annual Monitoring Report / Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200. ADAMS Accession No. ML17159A574.

[4] Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities." ADAMS Accession No. ML003739553.

4. Releases from operation of spray evaporators on the ponds [based on the method of calculation found in EPA guidance (USEPA, 2010)].
5. Releases from clarifier tanks outside of the RO plant (based on max Ra-226 concentration of influent discharge, assumed equilibrium with Rn-222, and that all Rn-222 is released to atmosphere).

Releases from Tailings Piles

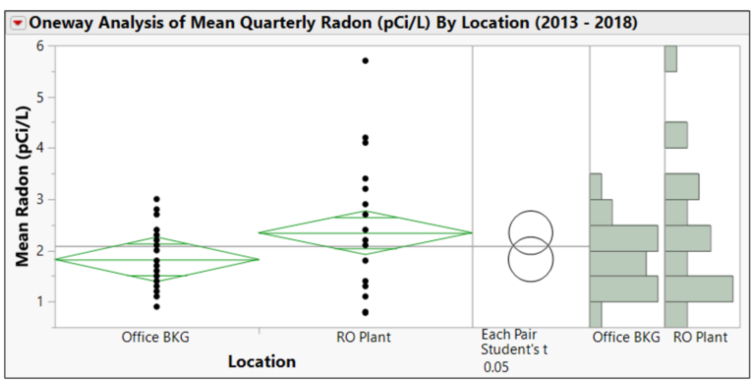
As indicated in the 1st half 40.65 report for 2018, estimated annual releases of radon gas from the LTP and STP are 694 and 88.7 Ci respectively, for a total annual release of 783 Ci.

RO Building Releases

For the RO plant, an estimate of the release of radon to the outside atmosphere due to groundwater treatment in the RO building can be calculated as follows:

Rn-222 release (Ci/yr) = (net Rn-222, Ci/L)(ventilation rate, L/yr)

The total annualized ventilation rate for the RO building is estimated to be 1.12E+12 L/yr (based on summation of flow rates for all exhaust fans). A statistical comparison of quarterly average radon gas concentrations measured in the main office building and in the RO building over the past 5 years is shown in Figure 3.



t Test

RO Plant-Office BKG
Assuming equal variances

Difference	0.5207	t Ratio	1.726906
Std Err Dif	0.3015	DF	41
Upper CL Dif	1.1297	Prob > |t|	0.0917
Lower CL Dif	-0.0882	Prob > t	0.0459*
Confidence	0.95	Prob < t	0.9541

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Office BKG	21	1.82381	0.21569	1.3882	2.2594
RO Plant	22	2.34455	0.21073	1.9190	2.7701

Nonparametric Wilcoxon Test

q*	Alpha
1.95996	0.05

Level	- Level	Score Mean Difference	Std Err Dif	Z	p-Value
RO Plant	Office BKG	4.281385	3.823941	1.119626	0.2629

Figure 3: Statistical comparison of indoor radon gas levels between the Office the RO plant.

The main office is considered representative of background indoor radon levels for onsite buildings. The net difference in these average values (0.52 pCi/L) is assumed due to RO treatment of groundwater containing 11e.(2) byproduct material. Based on these parameters, the calculated release of radon gas from the RO plant is 0.6 Ci/yr, less than 0.1% of total radon effluent releases from the tailings piles in 2018.

Static Pond Releases

With respect to the ponds that receive waste streams from the RO water treatment system, radon releases to the atmosphere were estimated based on previous studies on this issue as presented at annual Uranium Recovery Workshops hosted by the NRC and National Mining Association (NMA). One study (Baker, 2010) specifically involved determination of radon flux from Evaporation Ponds 1 and 2 at the HMC Grants site as a function of Ra-226 concentration in pond water. This study included both theoretical modeling of transport of a gas across an air-water interface using a stagnant film model (Schwarzenbach, 2002), and direct measurements of radon flux on Evaporation Ponds 1 and 2 using charcoal canisters consistent with EPA Method 115 specifications. In this case, the canisters were suspended above the air/water interface with a special floating foam platform, and a study conclusion was that modeled results (1.6 pCi/m^2-s) compared well with measured results (1.13 pCi/m^2-s).

A comparison of similar factors for release of radon from water containing Ra-226 based on results of additional studies (as presented at NRC/NMA annual workshops) is as follows:

- Chambers (2009): 0.001 pCi/m^2-s Rn-222 per pCi/L Ra-226 (for 50-cm turbulent mixing layer)
- Baker (2010): 0.01 pCi/m^2-s Rn-222 per pCi/L Ra-226 (site-specific modeling and measurements)
- Paulson (2012): 0.0004 pCi/m^2-s Rn-222 per pCi/L Ra-226 (controlled bench tests)

The site-specific release factor modeled by Baker (2010) (0.01 pCi/m^2-s Rn-222 per pCi/L Ra-226) is conservative, one to two orders of magnitude higher than radon release factors reported in the other studies referenced above. Using the conservative site-specific radon release factor from Baker (2010), along with measured Ra-226 concentrations in water contained in Evaporation Ponds 1-3 and the East/West Collection ponds in 2018, the flux from each pond (pCi/m^2-s) was calculated along with total radon release for each source term (Ci/yr), including the LTP, STP and Water Treatment Systems (representing combined releases from the RO Plant and all ponds). These values, shown in the table at right, demonstrate that overall radon releases from static water in the ponds is negligible relative to releases from the tailings piles.

Pond ID	Calculated Radon Effluent Release (Ci/yr)
EP-1	0.052
EP-2	0.040
EP-3	0.726
W Coll Pond	0.001
E Coll Pond	0.004
Total	**0.823**

Releases from Pond Spray Evaporator Operations

Estimated radon releases from active spray evaporator operations on EP-1, EP-2 and EP-3 were calculated based on EPA guidance cited by NRC (EPA, 2010). Parameters and results are provided in the table below. These calculations are conservatively based on maximum measured Ra-226 concentrations, a spray radon removal efficiency of one (unity), and an upper-bound assumption that evaporators operate 24% of the time in a given year. These values show that overall radon releases from spray evaporator operations on the ponds are negligible relative to releases from the tailings piles.

Parameter*	EP1	EP2	EP3	Units
Radon Half-life	3.8	3.8	3.8	Days
Radon Decay Const. (λ_{Rn})	2.1E-06	2.1E-06	2.1E-06	sec^{-1}
Spray radon removal efficiency (ε)	1	1	1	-
Ra-226 Conc. Pond Water	39.0	42.1	77.8	pCi/L
Ra-226 Conc. Pond Water (C_{Ra})	3.9E-11	4.2E-11	7.8E-11	Ci/L
Evaporator Flow Rating	80	80	80	gpm
Total spray flow rate	720	720	480	gpm
Total Spray Flow Rate (F_s)	45.4	45.4	30.3	L/s
Pond Volume (V_P)	1.2E+08	2.9E+08	1.9E+08	L
Fractional radon release rate (f_s)	3.8E-07	1.6E-07	1.6E-07	sec^{-1}
Calculated Radon Release**	1.1E-02	1.3E-02	1.7E-02	Ci/yr

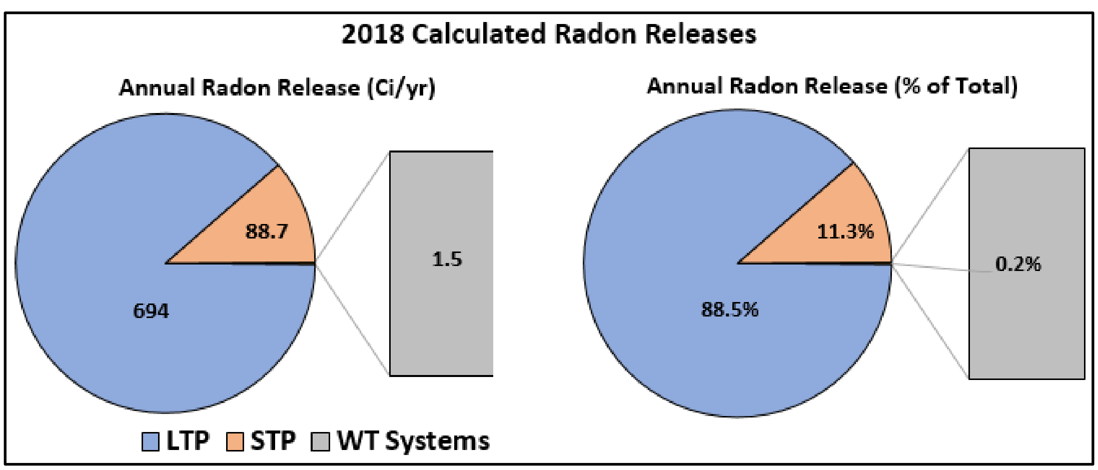
*Based on calculation method parameters specified in EPA, 2010
**Assumes evaporators operate 24% of the time on average

Clarifier Tank Releases

The clarifier tanks receive mixed groundwater influent discharge from all "onsite" groundwater extraction wells. The maximum measured Ra-226 concentration in this influent discharge is 3.2 pCi/L. The average influent discharge rate is about 1,211 L/min (320 gpm). Based on this data, and conservatively assuming that dissolved Rn-222 in the influent water is present in secular equilibrium with Ra-226, and that all Rn-222 is released to the atmosphere, the calculated maximum annual radon release from the clarifier tanks is on the order of 0.002 Ci/yr. This calculation demonstrates that overall radon releases from clarifier tanks outside the RO plant are negligible relative to releases from the tailings piles.

Comparison of Radon Releases from Identified Sources

The following charts compare the relative annual radon releases from the tailings piles, and collectively, releases from all water treatment system facilities including the RO building, static ponds, active spray evaporation, and discharge to open outdoor clarifier tanks. This comparison demonstrates conclusively that radon releases from all water treatment operations at the HMC Grants site are negligible relative to releases from the tailings piles.



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RAI #4

Please provide further justification for using an occupancy factor of 0.75 for residence and an equilibrium factor of 0.2.

HMC Response

As detailed in HMC's response to RAI #2, these parameter values will be replaced with more conservative generic values per the ISG Radon Guidance (USNRC, 2019a).