ALARA Report for Calendar Year 2016

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prepared for:

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Section 1.0 Site Activities

This report summarizes the activities and occupational monitoring results for the calendar year 2016 at the Ambrosia Lake site.

In the first quarter of 2016, the remaining construction work to complete closure of Tailings 2 was completed. As such, much of the licensed material subject to site remediation was consolidated in a designed repository and the repository was closed following Nuclear Regulatory Commission (NRC) approved documents. The remaining activities at the site in 2016 consisted mainly of routine environmental monitoring. The major activities for the year at the Ambrosia Lake site are summarized as follows:

1.1 1st Quarter

- GHD construction company commenced 2016 construction activities to finish closure activities of the Tailing 2 impoundment. Radiation protection activities for this site-wide reclamation work was guided by a radiation work permit (RA-2016-04-01) under a radioactive material licensed owned by the construction company subcontractor Solutient Technologies LLC. Activities included:
    - Material demolition and resizing
    - Disposing of contaminated scrap metal in Tailing #2
    - Completion of cover in Tailings #2
    - Scanning excess equipment for unconditional release, including site trailers, construction equipment and vehicles
- Routine environmental monitoring

1.2 2nd Quarter

- Routine environmental monitoring including air monitoring for particulates and radon-222, gamma radiation, vegetation and groundwater
- Site-wide gamma survey of the proposed Long Term Surveillance and Maintenance (LTSM) boundary

1.3 3rd Quarter

- Routine environmental monitoring including air monitoring for particulates and radon-222, gamma radiation, vegetation and groundwater
- Site-wide gamma survey of the proposed LTSM boundary

1.4 4th Quarter

- Routine environmental monitoring including air monitoring for particulates and radon-222, gamma radiation, vegetation, soil, sediment and groundwater.

Section 2.0 Occupational Exposures to Ionizing Radiation – Summary

Internal and external doses from ionizing radiation were monitored for personnel working with and around licensed radioactive materials. The monitoring methodologies are identified in in the "Radiation Protection and Environmental Program Manual". The methods of dose determination herein are consistent with Nuclear Regulatory Commission (NRC) approved methodologies described in USNRC Regulatory Guide 8.34, Monitoring Criteria and Methods to Calculate Occupational Radiation.

2.1 External Exposure to Ionizing Radiation

Optically stimulated luminescent dosimeters (OSLs) are used to monitor occupational exposure to ionizing radiation from external sources at the Ambrosia Lake site. All site personnel and contractors have assigned dosimeters and are required to wear the dosimeter while on site. The dosimeters allow determination of deep dose equivalent (DDE), eye lens dose equivalent (LDE), and shallow dose equivalent (SDE). All dosimeters (including control dosimeters) are stored in a background location while personnel are not on site. As a result, the measured external dose is a measurement of doses from exposure to licensed radioactive material. Landauer's® Luxel OSLs were used to monitor external dose parameters for the monitoring period. This dosimeter has a reported sensitivity of 1 mrem. All reported external dose parameters are well below regulatory limits. Historically, the external doses at the Ambrosia Lake site have been low and are typically less than 10 percent of the established limits. The data for the external dose parameters are tabulated in Tables 2.1 through 2.3.

2.1.1 Deep Dose Equivalent

The annual DDE values for Rio Algom Mining LLC (RAML) and contracted personnel are consistently low for each monitored group. Three of 22 monitored individuals received a DDE above the detection limit of 1 mrem per quarter. The 2016 annual DDE values ranged from 0 (below detection limits) to 2 mrem with a mean DDE of 0.2 mrem per year. The highest exposed individual for this dose parameter was a RAML supervisor. The dose to the highest exposed individual represents 0.04 percent of the annual limit of 5,000 mrem per year for radiation workers and 2 percent of the annual limit for members of the public. The data for each monitored group is presented in Table 2.1. The descriptive statistics in Tables 2.1 through 2.3 are based on the number of employees monitored (n = number monitored). The 2016 DDE results are well below regulatory standards and should continue to be minimal as the sources for exposure to licensed materials at Ambrosia Lake continue to be abated.

Table 2.1 2016 Summary of Deep Dose Equivalent

Monitored Group	Number of Employees Monitored	Number of Employees with Measurable Dose	Mean Dose (mrem)	% of group with dose
RAML	9	2	0.3	22
Contractor	13	1	0.1	8
Total	**22**	**3**	**0.2**	**14**

2.1.2 Shallow Dose Equivalent

The yearly SDE for RAML and contracted employees, like the deep dose equivalents, were very low for each monitored group. The annual SDE values ranged from 0 (below detection limits) to 2 mrem with a mean annual SDE of 0.3 mrem. Five of the 22 monitored individuals received a measurable SDE in 2016. The highest exposed individual for this dose parameter was a RAML manager with a dose of 2 mrem, a very small fraction of the annual limit of 50,000 mrem per year. The data for each monitored group are summarized in Table 2.2. The 2016 SDE results are well below regulatory standards and should continue to be minimal as the sources for exposure to licensed materials at Ambrosia Lake continue to be abated.

Table 2.2 2016 Summary of Annual Shallow Dose Equivalent

Monitored Group	Number of Employees Monitored	Number of Employees with Measurable Dose	Mean Dose (mrem)	% of group with dose
RAML	9	2	0.3	22
Contractors	13	3	0.3	23
Total	**22**	**5**	**0.3**	**23**

2.1.3 Lens Dose Equivalent

The annual LDE values for all monitored groups ranged from 0 (below detection limits) to 2 mrem with a mean of 0.3 mrem. The highest exposed individual for this dose parameter was a RAML manager with a dose of 2 mrem, a very small fraction of the annual limit of 15,000 mrem per year. The data for each monitored group is summarized in Table 2.3.

Table 2.3 2016 Summary of Lens Dose Equivalent

Monitored Group	Number of Employees Monitored	Number of Employees with Measurable Dose	Mean Dose (mrem)	% of group with dose
RAML	9	2	0.3	22
Contractors	13	3	0.3	23
Total	**22**	**5**	**0.3**	**23**

2.1.4 Summary of External Exposure to Ionizing Radiation

The external exposures to ionizing radiation were very low compared to the annual limits. For all groups and parameters collectively, a measurable dose equivalent was detected in 20 percent of the possible cases. Even though the sources of external doses from licensed material are low at the Ambrosia Lake site, the results of annual external doses are dependent on the type of work scheduled for a given year. This makes comparing external dosimetry from year to year less informative when evaluating monitoring trends. The external dose equivalents in all cases are below 10 percent of any applicable limit.

2.2 Long-lived Radionuclide Intake Analysis

Due to the nature of the work performed by RAML its contracted employees, which is composed of site management, supervision, and environmental monitoring, no breathing zone samples of employees or environmental monitoring contractors were collected in 2016. Data from the decommissioning contractors in 2015 and 2016, a task with much higher potential for intakes of radionuclides, showed internal doses from long-lived radionuclides were very low and less than 10 percent of applicable limits, therefore not required to be monitored. Should future activities at the site require this type of monitoring, as indicated in a Radiation Work Permit (RWP), it will be performed and reported in the ALARA Report.

2.2.1 Committed Dose Equivalent (CDE) to the highest exposed organ.

No estimate of CDE were made since no occupational long-lived air samples were collected. As discussed above, data from the decommissioning contractors in 2015 and 2016, tasks with much higher potential for intakes of radionuclides, showed internal doses from long-lived radionuclides were very low and less than 10 percent of applicable limits, therefore not required to be monitored.

2.2.2 Committed Effective Dose Equivalent (CEDE) Summary.

No estimate of CEDE were made since no occupational long-lived air samples were collected. As discussed above, data from the decommissioning contractors in 2015 and 2016, tasks with much higher potential for intakes of radionuclides, showed internal doses from long-lived radionuclides were very low and less than 10 percent of applicable limits, therefore not required to be monitored.

2.3 Total Effective Dose Equivalent (TEDE) Summary

The TEDE is the sum of the internal dose component (CEDE) and the external dose component (DDE). The range of TEDE values observed in 2016 was from 0 to 2 mrem with a mean of 0.2 mrem. The highest exposed individual accumulated 0.04 percent of the annual limit of 5 rem. The TEDE yearly trends can be obtained by looking at trends in the DDE.

2.4 Bioassay Summary

Eleven bioassay samples were collected from RAML and contract employees in March 2016 as part of the routine monitoring program. All samples were reported as non-detect (ND) with the method detection limit at 5 μg/L as recommended by USNRC Regulatory Guide 8.22 "Bioassays at Uranium Mills" (RG 8.22). Two spiked samples were also submitted, each were within the acceptable range of the suggested spiked amount in RG8.22

The requirement for routine bioassay sampling was eliminated in June 2016 following an update of the Radiation Protection and Environmental Program Manual. In September 2016, bioassay samples were collected from RAML employees and contractors although not required. Eight samples were collected and sent to a contract laboratory for uranium analysis. All samples were reported as non-detect (ND) with the method detection limit at 5 μg/L as required RG 8.22. Two spiked samples were also submitted, each exceeded the suggested spiked amount in RG8.22. This was due to uncertainty in the concentration of the uranium standard stock solutions, which are not clearly marked. For future bioassays, a spike study to determine stock solution concentrations will also be conducted.

Data from routine bioassays at the facility are no longer meaningful and have been eliminated from the radiation protection program. In the future, any bioassay samples will be collected as required by a RWP.

2.5 Radiation Work Permit Summary

No RWPs were issued for activities required by SUA-1473.One radiation work permit (RWP) was issued for water sampling of mine ventilation holes, work that is performed to meet State permit requirements and is outside the scope of SUA-1473.

2.6 Contamination Surveys-Personnel and Equipment

Personnel who access the LTSM or perform other activities that may result in contamination perform self scanning before leaving the site. Scanning techniques are reviewed and demonstrated in annual radiation safety training. No personnel surveys exceeding the action level of 100 counts per minute above background was reported.

Periodic equipment surveys for unconditional radiological release are performed for equipment that has potentially been exposed to licensed material. These surveys are documented and the records maintained in the RAML Grants office or the site trailer. Most of the equipment released was associated with the construction activities occurring in the 1st quarter of 2016.

2.7 Safety and Training Activities

The annual training as outlined in Section 3.1 of the 2016 Radiation Protection and Environmental Program Manual was completed for all employees and included the topics as outlined therein.

Safety meetings, conducted throughout the year, reviewed various topics pertaining to general safe work practices and included radiation safety.

2.8 Audits and Inspections

An audit of the radiation protection program was conducted by the RSO in July 2016, prior to the USNCR inspection. No deficiencies were identified.

Monthly inspections of the facility to ensure radiation protection practices are being used and that the site fences and gates are secure and posted properly are being conducted by the RSO or the RSO designee.