Rio Algom Mining LLC

March 4, 2016

Mr. Scott T. Anderson
Utah Division of Environmental Quality
Division of Waste Management and Radiation Control
PO Box 144880
195 North, 1950 West
Salt Lake City, Utah
84114-4880

RE: Work Plan Addendum 2 for the Lisbon Facility Hydrogeological Supplemental Site Assessment Radioactive Material License Number UT 1900481, Rio Algom Mining LLC, San Juan County, Utah

Dear Mr. Anderson:

In follow-up to our teleconference with members of your key staff on February 18, 2016, the attached Addendum 2 Work Plan presents our proposal for *Tailings Characterization Water Balance Assessment* of the Lower and Upper Tailings Impoundments at the Lisbon Facility.

We sincerely appreciate your consideration of this Addendum and any input you might have regarding the proposed scope of work. Please do not hesitate to call me if you have questions about the Work Plan.

Sincerely,

Rio Algom Mining Company LLC

Theresa Ballaine
Site Manager

Enclosure

cc: Rich Bush, DOE

ADDENDUM 2 TO WORK PLAN FOR THE LISBON FACILITY HYDROGEOLOGICAL SUPPLEMENTAL SITE ASSESSMENT:

TAILINGS CHARACTERIZATION AND WATER BALANCE ASSESSMENT

Radioactive Material License Number UT 1900481
San Juan County, Utah

Prepared for:

Rio Algom Mining LLC
P.O. Box 218
Grants, NM 87020

Prepared by:

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

6000 Uptown Boulevard NE, Suite 220
Albuquerque, New Mexico 87110

March 4, 2016

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ACRONYMS AND ABBREVIATIONS

ATT	Advanced Terra Testing
cm/sec	centimeters per second
$cm/sec/cm^2$	centimeters per second per square centimeter
DBS &A	Daniel B. Stephens & Associates
INTERA	INTERA Incorporated
Guernsey	C.H. Guernsey & Company
HSA	hollow-stem auger
HELP	Hydrologic Evaluation of Landfill Performance model
IDW	Investigation-Derived Waste
LEC	Lower Evaporation Cell
LTI	Lower Tailings Impoundment
MSW	Municipal Solid Waste
PVC	polyvinyl chloride
RAML	Rio Algom Mining LLC
Site	Rio Algom Mining LLC, Lisbon Facility, San Juan County, Utah
SMS	Soil Measurement Systems
SOW	Scope of Work
UEC	Upper Evaporation Cell
UTI	Upper Tailings Impoundment
Work Plan	Work Plan for characterization of the final cover and tailings at the closed Upper Tailings Impoundment and Lower Tailings Impoundment in Lisbon, Utah (Site).

1.0 INTRODUCTION

This Work Plan Addendum 2 to the *Work Plan for the Lisbon Facility Hydrogeological Supplemental Site Assessment* (Addendum 2) is for characterization of the final cover and tailings at the closed Upper Tailings Impoundment (UTI) and Lower Tailings Impoundment (LTI) of the Rio Algom Mining LLC (RAML) location in Lisbon, Utah (Site). In addition, this Addendum 2 includes water balance modeling of the closed UTI and LTI to assess the performance of the final impoundment covers, and the long-term percolation rate of fluids from the impoundments. The execution of work as proposed herein would ultimately provide source-term data for the groundwater solute transport modeling at the Site, which is included in the *Work Plan for the Lisbon Facility Hydrogeological Supplemental Site Assessment*.

2.0 BACKGROUND

This section provides a brief background describing preliminary water balance modeling of the UTI and LTI final covers, and performance assessment methodology as they relate to the proposed Scope of Work (Section 3).

2.1 Preliminary Water Balance Assessment Using the HELP Model

INTERA, at the request of RAML, has conducted preliminary water balance modeling of the as-built final covers for the UTI and LTI using the Hydrologic Evaluation of Landfill Performance (HELP) model. The preliminary modeling only addressed the water balance of the final cover for the UTI and LTI, and not the full profile of the impoundments including the tailings. In order to assess groundwater impacts at the Site resulting from tailing leachate draining from the closed impoundments, a more comprehensive profile of the cover and tailings is required. The preliminary HELP modeling will be enhanced and expanded to conduct the comprehensive closed impoundment water balance modeling (Section 3.2). The HELP modeling results for the UTI and LTI covers at Lisbon are considered preliminary because much of the input data for the cover components were assumed based upon default values for similar materials. As such, in order to refine the modeling results and connect them to the specific Site conditions, field testing is proposed as discussed herein.

HELP was developed by Paul Schroeder for the U.S. Army Engineer Waterways Experiment Station in Vicksburg, Mississippi, to evaluate movement of water across, into, through, and out of landfills. HELP has become a requirement for obtaining operating permits for municipal solid waste (MSW) landfills in the United States. HELP has been effective in assessment of groundwater recharge rates (Stephens and Coons, 1994), and the use of the model for predicting infiltration of water through earthen covers has compared favorably with other, more sophisticated 2-D numerical models (Coons et al., 2000).

While HELP was originally developed for use in design and evaluation of MSW landfills, HELP treats solid waste as a porous medium with soil-like properties within the layered sequence. As such, any impoundment designed and constructed to contain regulated soil-like materials (such as the tailing impoundments at Lisbon) can effectively be evaluated using HELP.

HELP is a quasi-two-dimensional hydrologic model that requires the following input data:

- Weather (precipitation, solar radiation, temperature, and evapotranspiration parameters)
- Soil (porosity, field capacity and wilting point moisture contents, and saturated hydraulic conductivity)
- Design (surface slope, engineered features such as liners, collection systems, etc.)

HELP uses numerical solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, unsaturated vertical drainage; or leakage through soil, geomembranes, and composite liners.

2.2 Performance Assessment Methodology

Figure 1 shows a generalized conceptual model of the water balance of a closed tailing impoundment, similar to the impoundments at the Site. The profile in **Figure 1** shows a final cover similar to that at the Site, and an underlying thickness of tailing. At the base of the tailing, slimes are represented just above native materials. The purpose of the field testing proposed in this Addendum 2 (Section 3.1) is to characterize the components of the profile such that conditions at the UTI and LTI are accurately represented. The layering and geometry of the final cover is relatively well-known, but will be better defined once the cover has been further investigated as described herein. The tailing profile is likely more complicated and layered, as materials would typically range in texture from sands to silts/clays.

Once the tailing impoundments are closed with a final cover and re-vegetated, the process of moisture re-distribution largely controls the quantity of leachate that exits the base of the impoundments (and is therefore available to mix with underlying groundwater). This time distribution of leachate flux is referred to as a transient drainage curve (Coons, 1993) as illustrated in **Figure 1**. Typically—especially for waste impoundments where the tailing are slurried in place—initial flux rates are high, the tailings drain, and moisture is re-distributed within the impoundment. Over time the flux rate becomes less until the long-term flux is equal to the infiltration/percolation-limiting process within the closed impoundment.

For closed impoundments in arid to semi-arid climates using earthen evapotranspiration covers (like those at the Site), long-term flux is typically limited by the net percolation rate of precipitation through the final cover. Alternatively, there may be rate-limiting layer(s) within the tailings, or beneath the tailings, of low permeability (clays, slimes) that physically impede the downward percolation of leachate to groundwater. The preliminary water balance modeling of the cover for the LTI and UTI as described in Section 2.1, indicates that the annual percolation rate through the cover, as modeled, is 1 inch per year (8E-08 centimeters per second per square centimeter [cm/sec/cm^2]) and 0.2 inch per year (2E-08 cm/sec/cm^2), respectively.

These results suggest that the cover will ultimately limit the long-term flux from the impoundments since it is unlikely that there are layers within the tailing with saturated hydraulic conductivities equal to or less than these flux values; however, in the future, when the tailing leachate flux rates reach these low values, the flux rates will be higher and dictated by the drainage of moisture with the tailings. The preliminary modeling indicates that ultimately, the moisture contents of the tailings components will be equal to those corresponding to an unsaturated hydraulic conductivity of ~5E-08 centimeters per second (cm/sec).

3.0 SCOPE OF WORK

The Scope of Work (SOW) for this addendum includes characterization of the final covers and tailings of the UTI and LTI, and associated water balance modeling of the impoundments by INTERA. Associated drilling and testing of the final cover materials by C.H. Guernsey & Company (Guernsey), to investigate the final covers is still being considered as of the date of this addendum. In the event work is done by Guernsey to evaluate the impoundment covers, INTERA will coordinate with Guernsey to complete the work proposed in this Addendum 2.

3.1 Field Investigation and Testing

INTERA proposes to complete the following additional investigation and testing related to assessing the water balance of the UTI and LTI:

- Extend a total of 4 borings: One boring each through the cover and tailings and into underlying native subgrade, both inside and outside the area of the Evaporation Cells, at both the UTI and LTI
    - Determine the locations of the borings at the Site as more information is available
    - Continuously collect drive samples using 24-inch split-spoon California sampler with sample sleeves (2.4-inch (outside diameter) stainless steel rings) through the cover to total depth
    - Record blow counts

   - Select representative ring samples for characterization of the cover components, tailings, and subgrade
- Send samples for laboratory testing
   - Index properties (grain size, gravimetric moisture, Atterberg limits, Unified Soil Classification System)
   - Dry density, total porosity, volumetric moisture content
   - Saturated and unsaturated hydraulic properties
   - Total number of lab test suites per boring: 6 (2 in cover; 3 in tailings; 1 in subgrade)
   - Total number of lab test suites: 24
   - Depending upon radioactivity of the samples, lab testing can be conducted at either Daniel B. Stephens & Associates (DBS&A) Lab in Albuquerque, New Mexico ("clean samples") or Advanced Terra Testing (ATT) Lab in Lakewood, Colorado (total activity up to 10 microcuries)
- If the tailings are saturated, the boring(s) will be completed as a temporary monitoring point using 2-inch or 3-inch polyvinyl chloride (PVC) casing and screen for collection of tailing pore water chemistry
   - Additional sample(s) of pore water will be collected through the augers at shallow depths in the boring(s) if intermediate perched zones exist within the tailings
- If the tailings are unsaturated, one suction lysimeter will be installed at depth in the boring(s) (near the base of the tailing) to collect a representative sample of pore water
   - Lysimeters to be Soil Measurement Systems (SMS); stainless steel dual-chamber, 540-milliliter capacity
   - Total number of pore water sampling installations (2-inch/3-inch wells or lysimeters): 4
- Send pore water samples for aqueous chemistry lab tests
- Abandon pore water sampling installations
   - Fill wells with cement/bentonite slurry to within 24 inches of grade; cut off the casing at 24 inches below grade; then re-construct the final cover to grade
   - Plug lysimeter tubing with sealant; cut off tubing 24 inches below grade; then re-construct the final cover to grade
- Manage Investigation-Derived Waste (IDW)

- IDW (auger cuttings from the borings) will be containerized and shipped to an appropriate facility for disposal

3.2 Water Balance Assessment

Using information obtained from the characterization proposed in Section 3.1, the HELP model will be used to assess the water balance of the UTI and LTI impoundments. Key components of the assessment will include:

- Development of representative profiles (geometry) of the UTI and LTI
- Development of representative material characteristic input data for the profile components
- Generation of representative climatological input data using historical information from La Sal, Utah
- Model runs to profile equilibrium or a minimum of 250 years

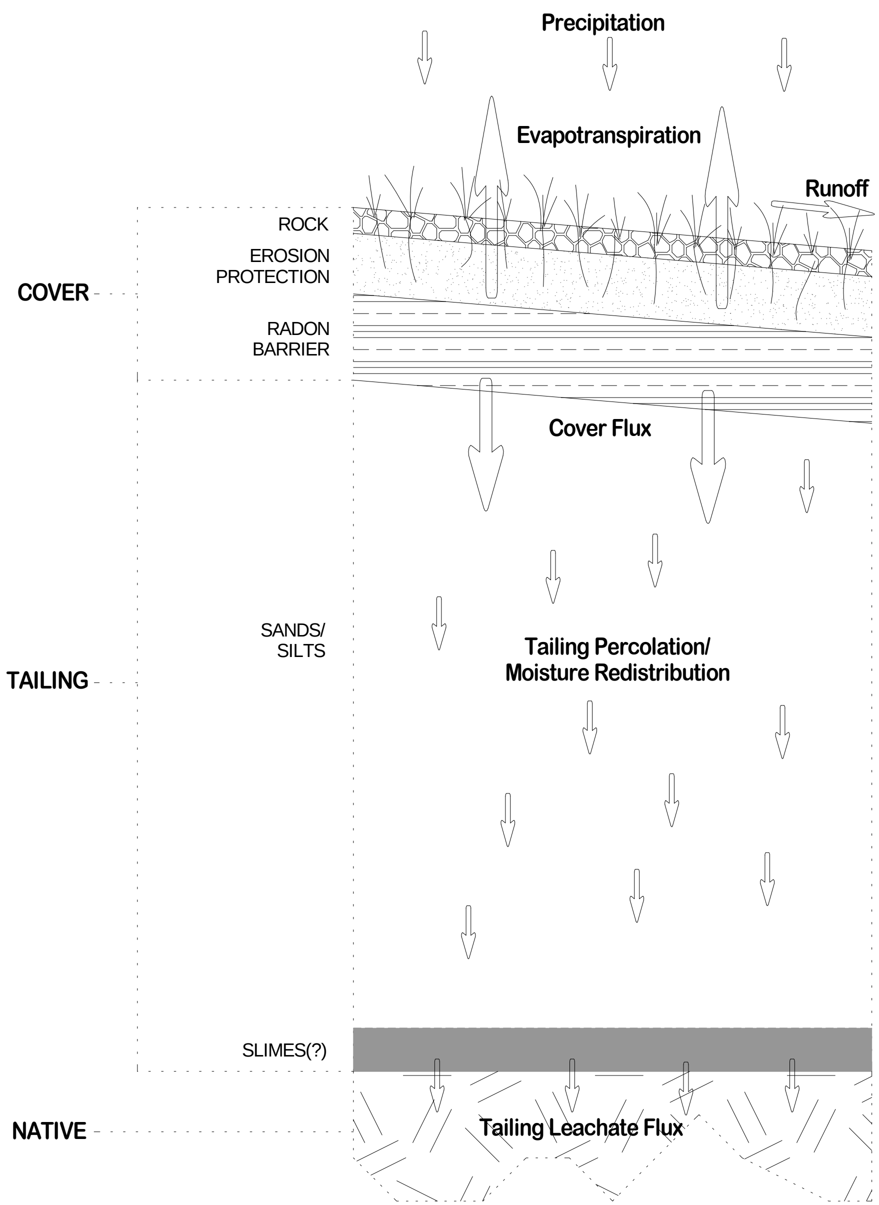
4.0 REFERENCES

Coons, L.M., 1993. *The Effects of Transient Drainage from Waste Impoundments on Ground Water Quality*. Rocky Mountain Ground Water Conference, October 27-29, 1993, Albuquerque, NM

Stephens, D.B., and L.M. Coons, 1994. *Landfill Performance Assessment at a Semiarid Site: Modeling and Validation.* Ground Water Monitoring and Remediation, Winter 1994

Coons, L.M., M.D. Ankeny, and G.M. Bulik, 2000. *Alternative Final Earthen Covers for Industrial and Hazardous Waste Trenches in Southwest Idaho. Proceedings of 3rd Arid Climate Symposium.* Solid Waste Association of North America, Silver Springs, MD, 14-1-14-16

FIGURE



GENERALIZED CLOSED IMPOUNDMENT PROFILE

SIMPLIFIED CLOSED IMPOUNDMENT WATER BALANCE

COVER:

Steady-state (dynamic equilibrium) Cover Flux water balance is a function of:

PRECIPITATION - EVAPOTRANSPIRATION - RUNOFF (+/-) CHANGE IN COVER STORAGE

IMPOUNDMENT:

Steady-state (dynamic equilibrium) Tailing Leachate Flux water balance is a function of:

COVER FLUX (+/-) CHANGE IN TAILING STORAGE

GENERALIZED TRANISENT DRAINAGE CURVE

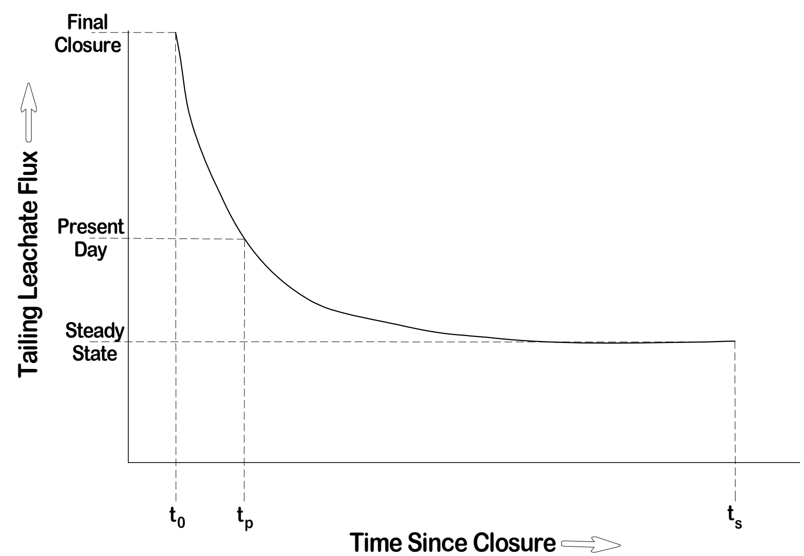


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Figure 1. Closed Tailing Impoundment Water Balance Conceptual Model

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