

Bureau of Mining Regulation and Reclamation

WASTE ROCK , OVERBURDEN, AND ORE EVALUATION

February 28, 2014

Waste rock, overburden, and ore shall be evaluated for its potential to release pollutants to the environment and for its acid generation/neutralization potential. The material shall be managed appropriately based on its relative potential, specific site conditions, and ultimate placement location. Initial characterization results, methods to be utilized for sample collection and evaluation going forward, and proposed actions to mitigate potential acid generation and any other release of pollutants, as warranted, must be included in a waste rock and ore management plan to be submitted with the Water Pollution Control Permit (WPCP) application, or as required by the Nevada Division of Environmental Protection (the Division).

It is the project proponent's responsibility to ensure use of a properly NDEP-Approved and/or NDEP-Certified laboratory; and to request the laboratory use appropriate analytical methods to ensure future data acceptability by the Division. Initial rock characterization data collected by the proponent during the exploration phase of the project may be used, if appropriate analytical methods are performed early in the project.

SAMPLE COLLECTION

In order for this evaluation to be meaningful, the sample material must be representative of the entire range of material(s). Characterization must be completed for all the following where applicable:

- a. Waste rock;
- b. Ore:
 - i. Mill grade;
 - ii. Heap leach material;
- c. Tailings;
- d. Pit wall and floor rock;
- e. Pit backfill rock (dry/wet scenarios);
- f. Underground backfill (dry/wet scenarios):
 - i. Cemented paste backfill (tails, binder);
 - ii. Cemented waste rock;
 - iii. Waste rock;
- g. Cap/cover materials (identified site specific sources).

The following factors must be considered in establishing a representative sampling program:

- a. Sampling density and frequency;
- b. Lithological variation;
- c. Hydrothermal alteration extent and type;
- d. Mineralogical variation;
- e. Extent of sulfide mineralization;
- f. Degree of fracturing;
- g. Degree of oxidation;
- h. Extent of secondary mineralization;
- i. Final disposition (ore, waste, pit wall, pit floor, pit backfill, underground backfill, etc.);
- j. Historical environmental context (e.g., – historic minesites with known issues/concerns).

Drill core and/or rock chip samples of ore and waste collected during initial ore body definition may be used for initial material characterization. All samples used in the evaluation must be from the volume of rock to be mined or immediately adjacent thereto. Illustrate this using cross-sections showing sample locations relative to the proposed mining limits. During mining, samples may be collected from those materials that have been sent to the assay lab. All or a portion of the latter materials must be saved and representatively composited, as appropriate, during the quarter for on-going evaluations. Samples shall also be collected of those materials that are determined to be waste prior to being assayed. During mining, sampling may also be required as determined by the ultimate placement location (e.g., waste rock dump face composites).

EVALUATION PROCEDURE

- I. Collect a representative sample and submit a synopsis of the sampling procedures used.
- II. Minimum analytical requirements shall include the following: Total Metals content, Mineralogical Analysis, Meteoric Water Mobility Procedure (MWMP), Acid-Base Accounting (Nevada-Modified Sobek Procedure - Alternative I or II), and Humidity Cell Testing (HCT), as applicable.
- III. Total metals analysis shall consist of an acid digestion followed by AA, ICP-AES, and/or ICP-MS analysis for the NDEP Profile II metals
- IV. As part of the characterization and evaluation of materials, the Division requires a complete mineralogical analysis of all rock/alteration/mineralization types, ore and waste, in an effort to determine the specific sulfide and non-sulfide minerals (pyrite, pyrrhotite, calcite, dolomite, etc.) present to help determine the potential to form acid rock drainage (ARD). These data must be included as part of the WPCP application.

Mineralogical analyses shall be performed using the following methods, as appropriate, and must be performed by a Nevada-approved laboratory. At a minimum, X-ray diffraction (XRD) is required.

- a. XRD – with or without X-ray fluorescence (XRF);
- b. Petrography (reflected light, transmitted light)*;
- c. SEM/EDX/NIR/MLA/EMPA – Scanning Electron Microscopy/Energy Dispersive X-ray/Near Infrared/Mineral Liberation Analyzer; Electron Microprobe Analysis.
- d. Other (with Division approval).

*No approval currently required for petrography.

- V. The potential to release pollutants shall be evaluated by the MWMP, American Society for Testing and Materials (ASTM) E2242-13, or most recent version, “Standard Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure”. The extract shall be analyzed for the NDEP Profile I list of parameters, plus any other parameters/constituents required by the Division on a site specific basis. Extraction and analyses must be performed by a Nevada-approved and -certified laboratory, respectively.
- VI. If solution does not percolate through the column, or the material is fine-grained, (i.e., tailings, sludge, etc.), see guidance document entitled “Meteoric Water Mobility Procedure Bottle Roll Extraction Option”, located on the Division website <http://ndep.nv.gov/bmrr/regapp.htm#docs>, or Appendix XI of ASTM E2242-13.
- VII. Reporting requirements for the MWMP are located on the Division website, <http://ndep.nv.gov/bmrr/regapp.htm#docs>. This information is required for all MWMP extractions and must be included with all analytical reporting.
- VIII. The potential for acid generation shall be evaluated in accordance with the following testing procedures:
 - A. **Static Testing** – also known as Acid-Base Accounting (ABA)
 1. Determine Acid Neutralization Potential (ANP) following the Nevada-Modified Sobek (NMS) Procedure, located on the Division website, <http://ndep.nv.gov/bmrr/regapp.htm#docs>, and the Montana State University Procedure EPA 600/2-78-054 “Field and Laboratory Methods Applicable to Overburden and Minesoils”.

2. Determine Acid Generation Potential (AGP) by Alternative I or II below:

Alternative I

Determine total sulfur content using LECO-type furnace. All sulfur is assumed to be acid generating. Convert sulfur content to AGP in tons CaCO₃ per 1000 tons (T/kT) material by multiplying percent total sulfur by 31.25. Determine ANP per Section 3.2.3 of the NMS Procedure.

Additional Nevada Requirement

Divide ANP by AGP to determine ratio. If ratio is less than 1.2:1, the material is considered potentially acid generating (PAG); the Division requires sulfur speciation per Alternative II below and recalculation of ANP/AGP ratio. If ratio is greater than 1.2, no additional testing is required.

Alternative II

Determine pyritic sulfur content in accordance with procedures described in the NMS Procedure. Convert percent pyritic sulfur to AGP in tons CaCO₃ per 1000 tons (T/kT) material by multiplying by 31.25. Determine ANP/AGP ratio.

If ANP/AGP ratio is $\geq 1.2:1$, no kinetic testing is required.

If ANP/AGP ratio is $< 1.2:1$, kinetic testing is required, unless previously approved otherwise by the Division. The Division requires that HCT be utilized; specifically method ASTM D5744-13 Option A. Other methods may be acceptable only if previously reviewed and approved by the Division.

Note: Federal land management agencies (Bureau of Land Management, Forest Service) may have different ratio designations and requirements.

ASTM E1915, Net Carbonate Value (NCV) – The NCV method is not being approved by the Division at this time. Any use of this method will be supplementary to, not in place of, the analyses required by the Division.

Static testing and kinetic testing, as applicable, is required for ore, waste rock, and tailings evaluation but not for metallurgical ore recovery.

B. Kinetic Testing – also known as HCT

The Division minimum test protocol requirements for HCT are:

1. Testing protocols (ASTM D5744-13, Option ‘A’, or the most recent approved method). Each test shall continue for a minimum of 20 weeks. Tests shall not be terminated without Division approval; if public lands will be affected, federal land management agency approval may also be required.

Test protocol calls for weekly cycles composed of three days of dry air (<10% Relative Humidity (RH)) and three days of water-saturated air (~95% RH) pumped up through the sample, followed by a leach with water on day 7.

Although a test duration as short as 20 weeks may be suitable for some samples, research indicates that test durations well beyond 20 weeks may be required depending on the objectives of the test and the test results. Identified test protocols contain specific criteria to determine when tests may end. Analytical results shall be submitted to the federal land manager and the Division periodically, the frequency of submittal shall be based on discussion with the applicant. However, Division approval must be obtained prior to terminating the tests.

2. All extractions shall be performed by a Nevada-approved laboratory. All extract analyses shall be performed by a Nevada-certified laboratory.
3. Minimum Sampling Requirements
 - A. Weekly (all weeks) sampling and analysis for:
 - i. Oxidation/reduction potential;
 - ii. pH (standard units (SU));
 - iii. Specific conductance ($\mu\text{mhos/cm}$);
 - iv. Acidity and alkalinity;
 - v. Sulfate;
 - vi. Iron (total, ferric, and ferrous if pH less than 5.0 SU and/or iron (total) >0.6 mg/L, otherwise, only iron (total) is required);
 - vii. Dissolved calcium and magnesium.
 - B. Weekly filtered extracts per the method will be digested and analyzed for total dissolved concentrations during weeks 0, 1, 2, 4, 8, 12, 16, and 20;
 - i. NDEP Profile I or Profile II parameters (agency discretion);
 - ii. Specific conductance ($\mu\text{mhos/cm}$);
 - iii. Acidity and alkalinity.
 - C. 4-week extracts thereafter (i.e., weeks 24, 28, 32, etc.) shall be analyzed for:
 - i. NDEP Profile I or Profile II parameters (agency discretion);
 - ii. Specific conductance ($\mu\text{mhos/cm}$);
 - iii. Acidity and alkalinity.

- D. Final results reported shall include a NDEP Profile I or Profile II (agency discretion) analysis of the final leachate.
- E. ANP/AGP analysis of the leached material using a LECO-type analysis as specified above.
- F. Mineralogical analysis via appropriate methods, XRD, SEM, etc., may also be required.
- G. All HCT extractions shall be performed by a Nevada-approved laboratory. All extract analyses shall be performed by a Nevada-certified laboratory.

Beginning August 1, 2013, any analyses that are submitted to the State (or BLM) for characterization, permitting, or compliance must be performed by a Nevada-approved and/or -certified laboratory, as appropriate.

All laboratories performing mining specific preparation methods and analytical procedures not explicitly covered under the CWA or RCRA may be subject to approval by the State under Nevada Revised Statutes 445A.428.

All laboratories performing analytical procedures that are explicitly covered under the CWA or RCRA programs must be certified by the State in the appropriate program(s).

These requirements will be a condition of the WPCP.

If the analytical laboratory is not approved or certified, as applicable, the Division will not accept data for the analyses in question and will require re-testing, re-sampling, and/or re-analysis by a Nevada-approved and/or -certified laboratory, as applicable.

A listing of the Nevada-approved and/or -certified laboratories may be found on the Division website here: http://ndep.nv.gov/bsdw/lab_mining_industry.htm and here: <http://ndep.nv.gov/bsdw/labservice.htm>