



Bureau of Mining Regulation and Reclamation

GUIDANCE DOCUMENT

WASTE ROCK, OVERBURDEN, AND ORE CHARACTERIZATION AND EVALUATION

1 July 2022

Waste rock, overburden, and ore shall be representatively evaluated for its potential to release pollutants to the environment and for its acid generation/neutralization potential pursuant to Nevada Administrative Code (NAC) 445A.396 and NAC 445A.414. The material shall be managed appropriately based on its potential to degrade Waters of the State (WOTS), 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 Management Plan (WRMP). The WRMP must be submitted with the Water Pollution Control Permit (WPCP) application, pursuant to NAC 445A.396 or as required by the Nevada Division of Environmental Protection (the Division), Bureau of Mining Regulation and Reclamation.

It is the responsibility of the applicant or Permittee to ensure use of a Nevada-approved certified laboratory, and to request the laboratory use appropriate analytical methods to ensure future data acceptability by the Division. A listing of the Nevada-approved and/or Nevada-certified laboratories may be found on the Division's website [Nevada's Mining Labs](#).

Initial rock characterization data collected during the exploration phase of the project may be used, if appropriate analytical methods are performed or if the Division approves a representative correlation study between the methods used and the Division-approved methods.

An expansion of a pit, underground workings, or other new mining area must be representatively characterized and approved by the Division prior to the onset of mining, because previous characterization may not be applicable for the new area. The samples must be collected within the proposed new mining area and must be chemically and spatially representative (as reasonably possible) of the entire range of materials that will be encountered during mining. If saturated conditions (e.g. pit lake or flooded underground workings) are predicted to form after the cessation of mining, samples in close proximity to the mined area will be required for characterization and incorporation into the ground water model and pit lake(s) study, as applicable.

In accordance with NAC 445A.XXX (definition of waste rock effective 30 August 2018; number not yet defined [R046-18A]), overburden and any other material that is mined as part of the process to reach the ore, but from which a metallic mineral of economic value cannot be extracted at the time that it is mined, are considered to be waste rock, and must be evaluated per the requirements for waste rock in this guidance.

Please utilize the Reporting Guidelines at the end of this document to allow the Division to review the submittal more efficiently and subsequently decrease the time required for the issuance of a Water Pollution Control Permit.

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1 Material Sample Requirements

For the characterization and 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, all geochemically distinct type based on lithology, alteration and mineralization;
- b. Ore:
 - Mill grade;
 - Heap leach material;
- c. Tailings, reject or off-spec material;
- d. Ultimate pit wall and pit floor rock;
- e. Pit backfill rock (above and below groundwater rebound elevation);*
- f. Underground backfill (above and below groundwater rebound elevation);*
- g. Cemented paste backfill (all ingredients separately and combined);
 - Cemented waste rock;
 - Waste rock;
- h. Cap/cover materials (identified site-specific sources).

*The Division may require a minimum vertical distance above or below the predicted groundwater rebound elevation for placement of certain materials.

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

- a. Sampling density and frequency;
- b. Sample size;
- c. Lithological variation;
- d. Hydrothermal alteration types and extent;
- e. Mineralogical variation;
- f. Extent and variation of sulfide mineralization;
- g. Degree of fracturing;
- h. Degree of oxidation;
- i. Extent of secondary mineralization;
- j. Presence/mass of evaporative mineral precipitates (EMPs) on rock surfaces;
- k. Final disposition (ore, waste, pit wall, pit floor, pit backfill, underground backfill, etc.);
- l. Historical environmental context (e.g., former mine sites with known issues/concerns);
- m. Final conditions at closure (e.g. pit lake, saturated conditions).

Use of existing or operational samples in rock characterization:

- a. Drill core and/or rock chip samples of ore and waste collected during initial ore body definition may be used for preliminary material characterization. Pulps are acceptable for the Nevada Modified Sobek Procedure and mineralogical analysis. Pulps are not acceptable for Meteoric Water Mobility Procedure and Humidity Cell Tests.
- b. All samples used in the evaluation must be from the volume of rock to be mined or immediately adjacent thereto.

- c. Illustrations must be included using cross-sections showing sample locations relative to the current and proposed mining limits.
- d. During mining (after Division approval), analyses may be required from blast-hole samples that have been sent to the assay lab.
- e. The Division may require all or a portion of the blast-hole materials to be retained and representatively composited, as appropriate, during the quarter for on-going evaluation of waste rock and ore character.
- f. During mining, (after Division approval), sampling may also be required during the quarter from the waste rock dump where material has been placed.

2 Nevada-certified and Nevada-approved Laboratory Required

All laboratories performing mining-specific preparation methods and analytical procedures not explicitly covered under the Clean Water Act (CWA) may be subject to approval by the Division pursuant to Nevada Revised Statutes (NRS) 445A.428. All laboratories performing analytical procedures that are explicitly covered under the CWA programs must be certified by the Division per NRS 445A.428. These requirements are a condition of the WPCP.

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

The Lab Certification Branch of the Bureau of Safe Drinking Water manages the Nevada-certified and Nevada-approved methods and procedures.

Please note: 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 Nevada-certified laboratory, as applicable, unless the Permittee has received prior Division approval.

A listing of the Nevada-approved and/or Nevada-certified laboratories may be found on the Division's website at [Regulation Branch Guidance Documents](#) and at [Nevada's Mining Labs](#).

2.1 Definition of Nevada-certified vs. Nevada-approved

Nevada-certified is mandatory, enforceable by regulation NAC 445A, certified labs must abide by our regulations and follow State law. Methods and procedures that are certified when meeting all requirements for compliance.

Nevada-approved is for methods that cannot meet the regulatory definition of certified, but the Division has approved the methods or procedures based upon review of standard operating procedures and an acceptable on-site assessment and participation in performance evaluation studies where available. Participation of laboratories in a Nevada-approved method is voluntary but the lab must be deemed Nevada-approved for the Division to accept the data. The Nevada-approved methods are the only methods that BMRR will accept for Permitting and compliance unless prior approval has been granted.

3 Characterization and Evaluation Procedures

3.1 Multi-Element Spectrographic Analysis per NAC 445A.396.4 (a):

The Division has determined that the minimum requirement for a spectrographic analysis is an analysis for Division Profile I and Uranium constituents from a Meteoric Water Mobility Procedure (MWMP). Additional spectrographic analyses (e.g., ICP-MS, etc.) may be provided to augment the required characterization data but will not be accepted as the only characterization completed.

3.2 Evaluation of Samples for the Potential to Release Pollutants per NAC 445A.396.4 (b):

The Division required static testing and kinetic testing, as applicable, for ore, waste rock, and tailings evaluation but not for metallurgical ore recovery.

The Division has incorporated Net Neutralizing Potential (NNP) and MWMP data as criteria for HCT selection to ensure evaluation of samples for the potential to release neutral mine drainage. Neutral mine drainage is characterized as neutral pH and high metals and has a high potential to degrade the waters of the State.

The Division requires:

- I. Collect representative samples and submit a synopsis of the sampling procedures used.
- II. Required minimum analytical requirements, mandatory for all mining operations except placer operations that do not include crushing, shall include the following:
 1. Nevada-Modified Sobek Procedure (Acid Based Accounting) and
 2. MWMP – Profile I and Uranium (total).
- III. If any potentially acid generating (PAG) material will be mined or if saturated conditions (e.g. pit lake or flooded underground workings) are predicted to form at the site, the Division will require Humidity Cell Testing (HCT) and a complete mineralogical analysis of all rock/alteration/mineralization types, both ore and waste.

The purpose of the complete mineralogical analysis is to evaluate the potential for acid generation and identify the specific sulfide and non-sulfide minerals (e.g., pyrite, pyrrhotite, calcite, dolomite, quartz, silica, etc.) that are involved in acid generation, neutralization, and encapsulation.

4 Summary of Division Approved Testing Procedures

The potential for acid generation shall be evaluated in accordance with the following testing procedures:

4.1 Nevada Modified Sobek Procedure – Static Testing

The Division's approved method for static testing also known as Acid-Base Accounting (ABA) is the Nevada Modified Sobek Procedure (NMSP). The most recent version of the NMSP is located on the Division's website [Regulation Branch Guidance Documents](#).

The NMSP provides a potential for acid generation by utilizing the siderite corrected acid neutralization potential (ANP) and sulfur speciation to evaluate the acid generation potential (AGP).

a. Nevada Modified Net Acid Generation (NV-NAG) Test

Sulfate-bearing minerals (e.g. barite, gypsum, alunite and other similar-type minerals) have been observed to exhibit “false positive” PAG results on repeated occasions when tested under the commonly used and industry-accepted Nevada Modified Sobek Procedure (NMSP). When the presence of sulfate-bearing minerals is suspected and an accurate laboratory PAG determination is necessary, the Division will require samples to be characterized using the NV-NAG test procedure, mineralogical characterization, and NMSP testing of suspect samples by a Nevada-approved/certified laboratory.

Although typically not required for initial characterization, depending on results of ongoing test work, the Division may require the NV-NAG be performed on specific samples or lithologic types.

The most recent version of the Nevada Modified Net Acid Generation (NV-NAG) Test Procedure can be found on the Division’s website: [Regulation Branch Guidance Documents](#).

4.2 Meteoric Water Mobility Procedure

The potential to release pollutants shall be evaluated by the MWMP, ASTM International E2242-13, or the most recent version, “Standard Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure”. The extract shall initially be filtered using a coarse filter paper, e.g. shark skin filter paper (approx. 8 - 12 µm retention). An extract sub-sample for dissolved metals can then be filtered at 0.45 µm and preserved, as applicable, within 12 hours of sample collection, prior to sub-contracting. The extract shall be digested and analyzed for the Division Profile I list of parameters and Uranium, plus any other parameters/constituents required by the Division on a site-specific basis (e.g., radio-chemical analysis). For the purpose of initial characterization studies, the Division also requires analysis for total uranium, i.e. extract shall be unfiltered, preserved, digested, and analyzed for the total concentration. Data generated will aid in determining future monitoring requirements.

To meet the requirements of Paragraph 5.2 of the method, which states “the pH of the extraction fluid used in this test method should reflect the pH of precipitation in the geographic region in which the mine rock is being evaluated,” BMRR has made the determination that the pH of rainwater in Nevada ranges between 5.5 and 6.0 SU.

In the instance of characterization being completed for pit-lake modeling, the extract shall be digested and analyzed for the Division Pit-Lake Characterization Analytical Profile (Profile I, Uranium, plus Profile III), located on the Division’s website [Regulation Branch Guidance Documents](#). Extraction, digestions, and analyses must be performed by Nevada-approved and Nevada-certified laboratories, respectively.

In the instance of MWMP characterization where total recoverable metals of the Division Profile III, or the radiochemical components of the Profile R, are required, the extract shall be unfiltered, preserved, digested (as per method requirements), and analyzed. The Division Pit-Lake Characterization Analytical Profile (Profile I and Uranium plus Profile III) and the Profile R can be found on the Division’s website at [Regulation Branch Guidance Documents](#). Extraction, digestion, and analyses must be performed by Nevada-approved and Nevada-certified laboratories, respectively.

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’s website [Regulation Branch Guidance Documents](#) or Appendix XI of ASTM E2242-13.

Reporting requirements for the MWMP are located on the Division’s website [Regulation Branch Guidance Documents](#). This information is required for all MWMP extractions and must be included with all analytical reporting.

4.3 Mineralogical Analysis

Mineralogical analysis shall be performed using the following methods (listed below), as appropriate, by a Nevada-approved laboratory or as approved by the Division.

1. XRD – X-ray Powder Diffraction;
2. SEM – Scanning Electron Microscopy;
3. Petrography (reflected light, transmitted light);
4. Division Approval Required before analysis:
 - XRF – X-ray fluorescence;
 - EDX – Energy Dispersive X-ray;
 - NIR – Near Infrared;
 - MLA – Mineral Liberation Analyzer;
 - EMPA – Electron Microprobe Analysis;
 - QEMSCAN - Quantitative Evaluation of Materials by Scanning Electron Microscopy;
 - Other analysis proposed by Permittee.

The purpose of this evaluation is to guide geochemical understanding of the reactions occurring during testing, such that appropriate geochemical modeling can be completed for the site. Sample selection for pre- and post-kinetic testing should be made in conjunction with site-specific guidance from the Division. Mineralogical characterization must include primary rock-forming minerals (e.g., silicates, carbonates, etc.), hypogene minerals (e.g., pyrite, galena, etc.), and supergene (secondary) minerals (e.g., melanterite, coquimbite, etc.).

The table below summarizes the minimum required tests for mineralogical analysis:

Scenario	Minimum Required Analysis Unless Otherwise Approved
PAG Material	XRD, SEM
PAG Material and Saturated Conditions	XRD, SEM, optical Petrography (pre and post HCT for all)
Saturated Conditions and no PAG Material	XRD

4.4 Humidity Cell Tests - Kinetic Testing

5 Scenarios for Kinetic Testing

- If the ANP/AGP ratio is ≥ 1.2 , the Net Neutralization Potential (NNP, or ANP – AGP) is greater than 20 tons per kiloton (T/kT), and the MWMP extract analysis does not indicate exceedances of Division Profile 1 reference values (RV) or background for any parameters and no pit lakes will form at the project, then no kinetic testing will be required.

- If saturated conditions (e.g. a pit lake or flooded underground workings) will form at the Project, kinetic testing is required unless otherwise approved by the Division.
- If MWMP analysis indicates exceedances of Profile 1 RV or background, even though ANP/AGP ratio is ≥ 1.2 and NNP > 20 , kinetic testing may be required, if necessary to define chemical release functions (e.g. groundwater modeling, pit lake modeling). Contact the Division for further details/discussion.
- If ANP/AGP ≥ 1.2 , but NNP < 20 T/kT, kinetic testing may be required. Contact the Division for further details/discussion.
- If ANP/AGP ratio is < 1.2 , kinetic testing is required, unless previously approved otherwise by the Division.

Note: Federal land management agencies, (e.g., U.S. Bureau of Land Management [BLM], or Forest Service [USFS]) may have different ANP/AGP and NNP limits and requirements. The Division concurs with the use of the most conservative ANP/AGP and NNP limits applicable to the particular mining operation.

6 Kinetic Testing Protocol

The Division minimum test protocol requirements for HCT are:

- a. 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 (approximately 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 are commonly required depending on the objectives of the test and the test results. Identified test protocols contain specific criteria to determine when tests may end. The determination as to the timeframe for test termination must be made using site-specific considerations such as leachate quality and the consumption rates of acid-generating and acid-neutralizing material. 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 each test.

- b. The HCT extract shall be initially filtered using a coarse filter paper, e.g. shark skin filter paper (approx. 8 - 12 μm retention). An extract sub-sample for dissolved metals can then be filtered at 0.45 μm and preserved, as applicable, within 12 hours of sample collection, prior to sub-contracting. All HCT extractions shall be performed by a Nevada-approved laboratory. All extract analyses shall be performed by a Clean Water Act (CWA) Nevada-certified laboratory.

7 Kinetic Testing Minimum Sampling Requirements

A. Minimum Sampling Requirements

- i. Weekly unfiltered sampling and analysis for:

1. Oxidation/reduction potential (mv);
 2. pH (standard units [S.U.]);
 3. Specific conductance ($\mu\text{S}/\text{cm}$);
 4. Alkalinity, only when pH >4.5 S.U.;
 5. Acidity when pH <5.0 S.U.;
 6. Sulfate;
 7. Iron total (ferric, and ferrous only if pH <5.0 S.U.); otherwise, only iron (total) is required.
- ii. Weekly sample extracts for dissolved metals analysis shall be filtered at 0.45um and preserved, as applicable, within 12 hours of sample collection, prior to sub-contracting and analyzed for:
1. Calcium and
 2. Magnesium.

Filtered or unfiltered extracts, as applicable, generated per the method will be preserved, digested, and analyzed during weeks 0, 1, 2, 4, and 4-week extracts thereafter (e.g., weeks 12, 16, 20, 24, 28, 32, etc.) for the following:

1. For Projects mining below the groundwater table: Each week shall be sampled for Profile III, total recoverable metals. All metal parameters that are above the corresponding Profile I reference limit shall have the remaining sample filtered at 0.45 μm and analyzed to provide a dissolved concentration as well.

Typical weekly Profile III extract samples for HCTs should be split into the following sub-samples for analysis (suggested volume only):

- a. 200 milliliters (mls) – unfiltered, preserved with HNO_3 for total recoverable metals,
- b. 300 mls - unfiltered, unpreserved for parameters in IX.C.2.c.i. above; this split may be further sub-sampled for Cl, F, $\text{NO}_2+\text{NO}_3\text{-N}$, TDS, etc. analysis, as needed.
- c. Unless otherwise requested by the Division, analysis for WAD cyanide is not required.

2. For Project mining above the groundwater table: Each week shall be sampled for Profile I with dissolved metals and Uranium (total recoverable).

Typical weekly Profile I extract samples for HCTs should be split into the following sub-samples for analysis (suggested volume only):

- a. 200 mls. – filtered at 0.45 um, preserved with HNO_3 for dissolved metals
- b. 300 mls - unfiltered, unpreserved for parameters in IX.C.2.c.i. above, this split may be further sub-sampled for Cl, F, $\text{NO}_2+\text{NO}_3\text{-N}$, TDS, etc. analysis, as needed.
- c. Unless otherwise requested by the Division, analysis for WAD cyanide is not required.

Please note if total uranium in the first 4 weeks is above 0.03 mg/L then the Division will require an MWMP-Profile I and Profile R analysis, no matter if mining will occur above or below the groundwater table. Please refer to Division's website for specific analytical requirements and reporting requirements.

3. A request to terminate an HCT may be submitted following a minimum 20 weeks of testing. The request shall include, at a minimum, the initial ABA data, all weekly analytical parameters, and all Profile I, III, or R results, as applicable. The HCT shall continue its testing protocol until a decision to approve termination is made by the Division. Under no circumstance will the HCT be placed on 'hold' pending Division review. If the project is on public land, separate concurrence from the BLM or USFS will be required.

7.1 Modifications to Approved Testing Protocols

With prior approval, the Division may allow the use of mine site specific groundwater as the lixiviant for certain extraction procedures, including, but not limited to, MWMP, HCT, attenuation testing, etc.

A request to modify a procedure must be received prior to commencement of any characterization program and include justification for the proposed modification(s).

7.2 Methods Not Approved by the Division

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

8 Reporting Requirements

Final results reported shall include a Division Profile I, Uranium (total) and Profile R, or Profile III, or combination thereof, as applicable, analysis of the final leachate.

- i. NMSP analysis of the leached material using a LECO-type analysis as specified above may be required depending on HCT results.
- ii. Mineralogical analysis via appropriate methods, (see item IV of the "Characterization and Evaluation Procedure" section above, within this guidance) is also required for any PAG material characterized as part of a pit-lake study.
- iii. The Nevada Modified Net Acid Generation (NV-NAG) Test Procedure may be required for samples undergoing the HCT protocol. If, at the time a request to terminate the HCT is submitted, (e.g. at the 20-week test timeframe), and the initial HCT feed sample indicated an ANP/AGP ratio of ≤ 1.2 , and the HCT data indicates neutral leachate, the Division may require the NV-NAG procedure be performed on the initial HCT feed sample as part of the HCT termination request. The NV-NAG procedure can be found on the Division's website at [Regulation Branch Guidance Documents](#).

8.1 Reporting Guidelines

To increase the efficiency of the Division's review of characterization analyses, please use the following guidelines for reporting characterization data.

Please include in your submittal:

1. A summary table of MWMP test results sorted by rock type.

2. A summary table of the NMSP results sorted by rock type.

Table should include the following columns: Sample Name, Rock Type (based on lithology, alteration, and mineralization), Paste pH, ANP, AGP, ANP/AGP, NNP. Label the sulfur speciation types as required in the most recent update of the Nevada Modified Sobek Procedure.

3. HCT analyses provided in a reviewable format, including weekly results and Profile 1, Uranium, or Profile III, as applicable, in Excel file format. Within the data file, include the progressive week number and the corresponding extract sample date. Total uranium and MWMP/Profile R shall be reported separately.
4. Map displaying the sample locations in plan view. Display rock type (based on lithology, alteration, and mineralogy), pit shell and/or underground extents (proposed and current if applicable), and cross section locations.
5. Cross-sections of the characterized areas displaying: existing ground surface, pit shell and/or underground extents (proposed and current if applicable), location of samples (ABA and HCT), rock types, faults.
6. A table showing the percent each rock type will make up in each waste rock dump and the percent of each rock type that will be left exposed in the walls/floor of each mine pit and/or underground workings (before and after any backfill is placed including in-pit waste rock facilities).
7. All analyses provided must be accompanied with the laboratory quality control and quality assurance documentation (electronic copy consistent with WPCP Part II.E.5).
8. If any supplemental data in addition to the required characterization were completed, please include all test results in a reviewable format and electronic copy consistent with WPCP Part II.E.5 (e.g. Total Metals, blast hole data).

While the Division will accept other formats for presenting the characterization data, presenting the information as mentioned above will aid in the timely review of the Water Pollution Control Application.

9 Other Considerations

If Uranium is >0.03 mg/L in solution or is known or /suspected to be $\geq 0.05\%$ in the ore, BMRR recommends that the Permittee contact the Nevada Department of Health and Human Services - Radiation Control Program to further discuss characterization and associated potential Permitting or licensing/license requirements.

10 Revisions

Revised 7/1/2022: Reformatted for ease of use and edited Pit Lake to read saturated conditions (e.g. pit lake or flooded underground workings); Added requirement of coarse filtration of MWMP and HCT extracts.

Revised 4/12/19