INTRODUCTION

The purpose of this initiative is to provide guidance for the Nevada Bureau of Land Management (BLM) Field Offices and mine operators for rock characterization and development of waste rock management plans, baseline water resources data collection and water resource management plans consistent with 43 CFR 3809.401(b)(2) and 3809.401(c)(1). The goal of this initiative is to improve efficiency and defensibility of the BLM’s National Environmental Policy Act (NEPA) documents and Plan approvals, and to improve coordination and efficiencies with the State’s permitting processes. In addition, the intent is to expedite the NEPA and Plan of Operations approval processes by developing documents that have been thoroughly analyzed consistent with the BLM and State regulations, policies and Best Management Practices.

The scope of the guidance is to: 1) provide for proper characterization and handling of mined rock to limit its potential to generate acid or liberate other constituents, primarily metals, into the environment and, 2) provide recognized methods to evaluate baseline water resources data and analysis of the potential impacts mining and waste rock management may have for the life-of-mine (LOM) and long-term closure on the hydrologic resources.

The guidance includes references for standardized and, where applicable, certified sampling protocols, analytical methods, and Quality Assurance/Quality Control (QA/QC) procedures for testing laboratories, operators, and BLM and NDEP to ensure consistent and defensible analysis and results. Beginning 1 August 2013, laboratories performing the extraction or analytical procedures listed under Part III. Characterization Procedures, Sections 4, 5 and 6 must be approved under the Nevada Laboratory Certification Program for these methods. Extract analysis listed under Part III Characterization Procedures, Sections 5.c and 6.a.2 must be certified under the Nevada Laboratory Certification Program for these methods.

It should be noted that whenever possible, the proponent should provide site-specific sampling and testing analysis, meeting BLM and NDEP specifications, for characterization in support of modeling.

CHECKLIST

The checklist is all inclusive for characterization of rock and water resources. If certain sections do not apply, such as “Pit Lakes”, then the proponent needs to provide the appropriate documentation as to why a pit lake will not form within that section of the report. If there is any indication of potential mine operation/water resource conflicts, specific water resource data collection, testing and modeling efforts should be evaluated by the BLM, in coordination with the State and the mining company.
ROCK CHARACTERIZATION:

I. Materials Characterization
   1. Waste rock
   2. Ore
      a. Mill grade
      b. Heap leach material
   3. Tailings
   4. Pit wall and floor rock
   5. Pit backfill rock (dry/wet scenarios)
   6. Cap/cover materials (identified site specific sources)

II. Statistical Approach to Characterization (define statistical adequacy)
   1. Sample selection
   2. Number of samples
   3. Quantity of material
   4. Review by BLM/NDEP

III. Characterization Procedures
   1. Sample selection (QA/QC with BLM and NDEP)
   2. Identify by rock type/final disposition (ore, waste, pit wall, pit floor, backfill, etc.)
   3. Record locations (three dimensional)
   4. Mineralogical analyses (All analyses, unless specified otherwise, must be performed by a Nevada approved laboratory)
      a. XRD
      b. XRF (could include use of portable field units)
      c. Petrology
      d. Petrography (incident light, transmitted light)
      e. SEM/EDX/NIR/MLA
      f. Other (with BLM and NDEP approval)
   5. Static testing - (required for ore, waste rock, and tailings) (All static test analyses must be performed by a Nevada approved laboratory)
      a. ABA – (NDEP Modified Sobek Procedure, including Hot Water Leach – See NDEP/BMRR guidance)
      b. Net acid/alkaline production (AP, NP, NNP)
      c. MWMP (ASTM E-2242-12) – (includes analysis and report on any metal mobility, attenuation and accumulation potential)
      d. NCV – use of analysis to be determined by BLM and NDEP to supplement above analyses – data generated is not acceptable for ABA determination. NCV is not being approved by the State of Nevada at this time.
   6. Kinetic testing (required for ore, waste rock and tailings but not for metallurgical ore recovery)
      a. Humidity Cell/Column Leach
         1. Testing protocols (ASTM D5744-07, Option ‘A’, or the most recent approved method)
Protocol calls for weekly cycles composed of three days of dry air (<10% RH) and three days of water-saturated air (~95% RH) pumped up through the sample, followed by a leach with water on Day 7.

2. Although a test duration as short as 20 weeks may be suitable for some samples, more recent 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 BLM and NDEP periodically, the frequency of submittal shall be based on discussion with the applicant. However, the BLM and NDEP must be consulted prior to terminating the tests. Regardless of the data, 20 weeks is the minimum test period.

Minimum Sampling Requirements

- Weekly (all weeks) sampling and analysis for:
  - redox potential (ORP);
  - pH;
  - specific conductance (µmhos/cm);
  - acidity and alkalinity;
  - sulfate;
  - iron (total, ferric, and ferrous if pH less than 5 s.u. and/or iron (total) >0.6 mg/L, otherwise, only iron (total) is required); and
  - dissolved calcium and magnesium.
- 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:
  - NDEP Profile I or Profile II parameters (agency discretion);
  - specific conductance (µmhos/cm); and
  - acidity and alkalinity.
- 4-week extracts thereafter (i.e., weeks 24, 28, 32, etc.) shall be analyzed for:
  - NDEP Profile I or Profile II parameters (agency discretion);
  - specific conductance (µmhos/cm); and
  - acidity and alkalinity.
- Final results reported shall include an NDEP Profile I or Profile II (agency discretion) analysis of the final leachate.
- ANP/AGP analysis of the leached material using a LECO-type analysis as specified above.
- Mineralogical analysis via appropriate methods, XRD, SEM, etc., may also be required.
- All HCT extractions shall be performed by a Nevada approved laboratory.
• All extract analyses shall be performed by a Nevada certified laboratory
  b. BAPP test and other kinetic test procedures - supplemental testing as necessary – to be determined by the BLM and NDEP

7. Field Tests (No laboratory approval required)
   i. Other with BLM and NDEP approval
      1. Paste pH
      2. Net Acid Generation (NAG test)

IV. Cap/Cover Geotechnical Protocols (may include waste rock, spent leach ore, etc.)
   1. Full range of particle size distribution (PSD) through sieve analysis and/or hydrometer method
   2. Atterburg limits
   3. Initial moisture content
   4. Dry bulk density
   5. Calculated porosity
   6. Constant head or falling head analyses for saturated hydraulic conductivity test
   7. Soil Water Characteristic Curve (SWCC)
      a) Hanging column
      b) Pressure plate
   8. Unsaturated hydraulic conductivity derived from saturated hydraulic conductivity and SWCC
   9. Proctor or modified Proctor compaction

V. Infiltration Modeling
   1. Heap Leach Draindown Estimation (modeling required)
      a. Saturated volumetric moisture content
      b. Residual volumetric moisture content
      c. Saturated hydraulic conductivity
      d. Porosity
      e. Particle size distribution
   2. Tailings Impoundment Draindown Estimation (modeling required)
      a. Saturated volumetric moisture content
      b. Residual volumetric moisture content
      c. Saturated hydraulic conductivity
      d. Porosity
      e. Particle size distribution
   3. Cap/cover materials (modeling required)
      a. Saturated volumetric moisture content
      b. Residual volumetric moisture content
      c. Saturated hydraulic conductivity
      d. Porosity
      e. Particle size distribution

VI. Waste Rock Management Plan
1. Work plan history with geochemical and geotechnical summaries.
2. Operating/post reclamation management of the waste rock dumps (WRDs)
3. Describe mining sequence of rock types/volumes/final disposition (see Part III.2 above).
4. Describe how potentially acid generating (PAG) rock will be selectively mined, segregated and managed to preclude exposure to air and water. Need to address metals mobility/accumulation for both PAG and non-PAG materials (see Part III.5.c.).
5. For each benign and PAG WRD facility, include a text description for: toe elevation, crest elevation, ultimate height, reclaimed slope, plan dimensions, tonnage capacity and acres. Provide a summary table for volumes by facility for LOM.
6. Supplement the text with plan and cross sectional drawings showing: plan views and related alluvial/cover stockpile locations, cross sectional views showing operational and post reclamation slopes, grades; toe and crest elevations, existing ground slope and cap thicknesses for LOM.
7. For pit backfill scenarios, include the same text and supporting drawings previously described, describe any amendment requirements. Provide information on the total volume to be backfilled with rock type and its origin, final backfill elevation and rebound ground water elevation.
8. Tailings impoundments, heaps, ore stockpiles, topsoil stockpiles should include the same text and supporting drawings previously described.

WATER RESOURCES CHARACTERIZATION:

VII. Geology/Hydrogeology
1. Regional geology/stratigraphy/tectonics (maps, cross sections with grids, scales)
2. Areal regional aquifer and groundwater conditions (maps, cross sections)
3. Site specific groundwater conditions
   a. Unsaturated zone
   b. Perched water
   c. Unconfined water
   d. Confined water

VIII. Springs/Streams and Well Inventories
1. Location (including UTM coordinates)
2. Flow/Production
   a. Perennial springs and streams (include historical flows)
   b. Intermittent springs and streams (include historical flows)
   c. Well production (include average/peak or other baseline data)
3. Quality (chemistry)
   a. NDEP Profile (Profile I for groundwater, Total Metals for springs/streams/seeps and pit lakes (no filtering of samples))
4. Temperature
5. Well drilling log or geologic log
6. Water rights
7. Jurisdictional waters
8. Habitat types, areal distributions and number of acres (include maps)

IX. Hydrologic System
1. Meteorology (use on-site meteorological station data)
   Ambient Temperature (min/max), Relative Humidity, Wind Speed (max gust/hr.)
   and Wind Direction, Total Precipitation, Solar Radiation, Barometric Pressure,
   Snow Water Equivalent (SWE); at a minimum with a data logger. Pan
   Evaporation; measured in field or calculated by Penman - Monteith equation
2. Recharge
   a. Type
   b. Distribution
3. Discharge
   a. Type
   b. Distribution
4. Aquifer potentiometric surface
5. Groundwater flow
   a. Hydraulic gradient and flow direction.
   b. Effective Porosity
   c. Pore Water Velocity
6. Hydraulic boundary conditions/hydrologic divides
   a. Type
   b. Distribution

X. Hydrologic Budget – summary of groundwater recharge and discharge

XI. Conceptual Groundwater Model
1. Ground and surface water systems (based on site specific field data)
2. Project hydrogeologic setting (relative to regional hydrology)

XII. Pit Lakes
1. Modeling based on chemistry from Part I.1 and I.2, hydrology from Part VII, VIII
   and IX (above). Also see IM NV–2008-034 in the References section.

XIII. Geothermal Waters
1. Address any potential resource issues

XIV. Other (site specific)

REFERENCES/LINKS/REGULATIONS/PROTOCOLS

The following sources may be useful in rock characterization, development of waste rock
management plans, baseline water resources data collection and water management plans.
Note that the BLM does not require specific models as part of the Plan submittal, but may use specific models to verify modeling results. Modeling of water resources must be approved by the BLM and NDEP. Certified labs, testing procedures and protocols are required, as appropriate. The proponent should coordinate with the BLM and State representatives prior to sample suite selection and conducting characterization testing. In addition, the proponent must have the BLM and NDEP’ written concurrence that materials testing are appropriate, representative and stabilized prior to completing testing at analytical labs.

Analytical Profiles:

NDEP Profile I – reference NDEP Form 0190.

NDEP Profile II - reference NDEP Form 0090.


NDEP Modified Sobek Procedure – see NDEP/BMRR interim guidance. Modified Sobek Procedure, including Hot Water Leach – MSU – Reclamation Research Unit (EPA-600/2-78-054).

ASTM Protocols:

Note: ASTM standards are copywrited. As such, the proponent or their contractors are responsible for any fees.

http://www.astm.org/


Modified Sobek Procedure - incl. Hot Water Leach- MSU - Reclamation Research Unit.

BLM Instruction Memorandums:

IM NV-2008-032 (or as renewed) Nevada Bureau of Land Management’s Water Resource Data and Analysis Policy for Mining Activities

IM NV-2008-033(or as renewed) Nevada Bureau of Land Management Reclamation/Closure Policy for Hardrock Mining Activities

IM NV-2010-030 (or as renewed) Ecological Risk Assessment Guidelines for Open Pit Mine Lakes in Nevada
IM NV-2008-035 (or as renewed) Groundwater Modeling Guidance for Mining Activities

Memorandums of Understanding:

NV EPA MOU 2013 Memorandum of Understanding for Mining Environmental Impact Statements within the State of Nevada between the Bureau of Land Management and the U.S. Environmental Protection Agency

NV MOU 11.20.08 (or as renewed) Memorandum of Understanding for Mining and Mineral Related Activities within the State of Nevada Among Nevada Dept. of Conservation, Division of Environmental Protection and U.S. Department of Agriculture –Forest Service Humboldt – Toiyabe National Forest and Inyo National Forest and the Nevada BLM

BLM guidance, Reclamation Permit guidance, WPCP guidance:

BLM guidance:

POO Format 2009 tsm 1.9.09 Voluntary 3809 Plan of Operations Outline/Format

Reclamation Permit guidance:
http://ndep.nv.gov/bmrr/recapp.htm#docs

WPCP guidance:
http://ndep.nv.gov/bmrr/regapp.htm

Regulatory Authorities:

43 CFR 3809– BLM Surface Management Regulations

State of Nevada NAC 445A regulations – Water Pollution Control Permit

State of Nevada NAC 519A regulations – Reclamation Permit

Statistical references:


General References:
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<td>“Neutralization Potential: What is it and Why is it Important for Drainage Chemistry?”</td>
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<td>Standard Guide for Reporting Results of Analysis of Water</td>
<td>D 596-01</td>
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<td>Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort</td>
<td>D 698-91</td>
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<td>(12,400 ft-lbf/ft³ (600 kN-m/m³)) [Standard Proctor]</td>
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<td>Standard Terminology Relating to Water</td>
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<td>Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort</td>
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<td>Standard Guide for Collection of Water Temperature, Dissolved-Oxygen</td>
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ACRONYMS/TERMINOLOGY
The following are acronyms contained within this document.

ABA – Acid Base Accounting
AP – Acid Potential
ASTM – American Society for Testing and Materials
BAPP – Biological Acid Production Potential
BMRR – Bureau of Mining Regulation and Reclamation
BLM – Bureau of Land Management
CFR – Code of Federal Regulations
EDX – Energy Dispersion X-ray spectroscopy
HLDE – Heap Leach Draindown Estimator (Excel spreadsheet)
LOM – Life of Mine
MWMP – Meteoric Water Mobility Procedure
NAG – Net Acid Generation
NDEP – Nevada Division of Environmental Protection
NEPA – National Environmental Policy Act
NIR – Near Infra-Red
NP – Neutralizing Potential
NNP – Net Neutralizing Potential
NCV – Net Carbonate Value
PAG – Potentially Acid Generating (in reference to rock)
QA/QC – Quality Assurance/Quality Control
RH – Relative Humidity
SEM – Scanning Electron Microscope
WPCP – Water Pollution Control Permit

WRD – Waste Rock Dump

XRD – X-ray Diffraction

XRF – X-ray Fluorescence