# United States Department of the Interior

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EMS TRANSMISSION 9/24/13
Instruction Memorandum No. NV-2013-046
Expires: 09/30/2015

To: District Managers and Field Managers, Nevada

From: Amy Lueders
State Director

Subject: Nevada Bureau of Land Management Rock Characterization and Water Resources Analysis Guidance for Mining Activities

**Program Area**: Mining Law Administration, Surface Management

**Purpose:** The Bureau of Land Management (BLM) Nevada has determined the need to clarify what rock and water resources data information is collected under 43 CFR 3809.401 (b) (2) and 3809.401(c) (1) for the BLM to adequately analyze potential environmental impacts as required by the National Environmental Policy Act (NEPA) and to determine if a Plan of Operations (Plan) will prevent unnecessary or undue degradation.

This Instruction Memorandum (IM) also clarifies what is needed for rock and water baseline data and analysis to help determine when a proposed Plan is considered complete, per 43 CFR 3809.411 (a), assists in determining what the appropriate level of NEPA analysis will be required, how baseline rock and water resources data is collected, analyzed and incorporated into proposals for authorizing new or modified mine Plans.

**Policy**/**Action**: This IM reiterates policy and provides guidance on the implementation of the attached Nevada Bureau of Land Management Rock Characterization and Water Resources Analysis Guidance for Mining Activities. To facilitate the technical review process, NEPA analysis and ultimate approval of the proposed mine Plan or modification, the guidance is provided as a tool for the BLM, in coordination with the Nevada Division of Environmental Protection (NDEP) and the mining proponent, to ensure adequate baseline data collection, characterization, analysis, and reporting are consistent with BLM and NDEP protocols and standards.

The information required under the 43 CFR 3809 regulations and this IM must be incorporated into the Plan on a case by case basis to properly manage ore, waste material, and process components and long term management of all processing components in an environmentally acceptable and defensibly manner.

**Time Frame:** This IM is effective immediately.

**Background:** This Instruction Memorandum reissues Nevada's Rock Characterization and Water Resources Guidance and replaces IM No. NV-2010-014. The primary changes in the guidance include the required use of a laboratory approved or certified, as applicable, under the Nevada Laboratory Certification Program for extractions and analytical procedures. Additional details regarding kinetic testing is also included.

**Coordination:** The policies and procedures found in the IM were developed from previous Nevada BLM IMs and input from the BLM-Nevada District/Field Offices, NDEP, Nevada Mining Association, and the U. S. Environmental Protection Agency.

**Budget Impact:** There is no anticipated budget impact. It is anticipated that the IM will improve efficiencies for implementing 43 CFR 3809 regulations.

**Contacts:** If you have any questions concerning this Instruction Memorandum, please contact Scott Murrellwright**,** Solids Program Lead at (775) 861-6581 or Doug Siple, Mining Engineer at (775) 861-6636.

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| Signed by: | Authenticated by: |
| Amy Lueders | Pam Collins |
| State Director | Staff Assistant |

Attachment

1 – Nevada Bureau of Land Management Rock Characterization and Water Resources Analysis Guidance for Mining Activities (10 pp)

# NEVADA BUREAU OF LAND MANAGEMENT
# ROCK CHARACTERIZATION AND WATER RESOURCES ANALYSIS GUIDANCE FOR MINING ACTIVITIES

## 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 <u>not</u> 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.

<u>WATER RESOURCES CHARACTERIZATION:</u>

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/BMRR Water Quality Sampling Protocol for Metals (1998) – reference NDEP Form 0090, use for unfiltered sampling for total recoverable metals.

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/

ASTM D5744-07 Standard Test Method for Laboratory Weathering of Solid Materials Using a Humidity Cell.

ASTM E1915-07a Standard Test Methods for Analysis of Metal bearing Ores and Related Materials by Combustion Infrared-Absorption Spectrometry (NCV).

ASTM E2242-02 Standard Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure.

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:
http://www.blm.gov/nv/st/en/prog/minerals/mining.html

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:

U.S. EPA 2006, Guidance on Choosing a Sample Design for Environmental Data Collection, December 2002.

U.S. EPA 2006, Data Quality Assessment: Statistical Methods for Practitioners, EPA QA/G-9S, EPA/240/B-06/003.

U.S. EPA 530-D-02-02, August 2002, RCRA Waste Sampling Technical Guidance, Office of Solid Waste.

General References:

| Category/Document Title | Number/Date |
|---|---|
| **Rock Characterization, Test Methods, Modeling, and Concept Discussions** | |
| "Glossary of Terms Used in Metals Leaching and Acid Rock Drainage Work" | Anonymous |
| The International Network for Acid Prevention (INAP), Global Acid Rock Drainage Guide (GARD Guide) http://www.gardguide.com/ | 2009 |
| "Static-Test Methods Most Commonly Used to Predict Acid Mine Drainage: Practical Guidelines for Use and Interpretation", White III, Lapakko, Cox | 1999 |
| "EPA and Hardrock Mining: A Source Book for Industry in the Northwest and Alaska; Appendix 'C', Characterization of Ore, Waste Rock, and Tailings" | January 2003 |
| "Standardization of Mine Waste Characterization Methods by ADTI-MMS", Charles Bucknam, William White III, Kim Lapakko | June 2009 |
| "Static and Kinetic Tests Commonly Used for Prediction of Acid Mine Drainage from Metallic Sulfide-Bearing Waste Rock: Methods, Costs & Confidence Limits", White III and Froisland | October 1991 |
| "Field and Laboratory Methods Applicable to Overburden and Minesoils", Andrew Sobek, William Schuller, John Freeman, Richard Smith (SOBEK Excerpt EPA-600/2-78-054) | March 1978 |
| "Solid Phase Characterization in Conjunction with Dissolution Experiments for Prediction of Drainage Quality", Lapakko | June 1990 |
| "Effects of Protocol Variables and Sample Mineralogy on Static-Test NP", W.W.White III, K.A.Lapakko, R.L.Cox | April 1997 |
| "Kinetic Testing 1. Effects of Protocol Variable on Rates of Weathering", Frostad, Klein, Lawrence, ICARD 2000 | 2000 |
| "Acid-Base Accounting to Predict Post-Mining Drainage Quality on Surface Mines", Skousen, Simmons, McDonald, Ziemkiewicz | 2002 |
| "A Simple Accelerated Rock Weathering Method to Predict Acid Generation Kinetics", Kargbo and He | July 2004 |
| "Acid Base Accounting (ABA) Test Procedures", Chris Mills Editor | January 2005 |
| "Humidity Cells: How Long? How Many?", Kevin A. Morin, Nora M. Hutt | 13-15/ix/1999 |
| "Developments in Humidity-Cell Tests and Their Application", Kim A. Lapakko | 2003 |
| "Pyrite Oxidation Rates from Humidity Cell Testing of Greenstone Rock", Lapakko and Antonson | March 2006 |
| SGS Technical Memorandum "Continuation/Decommissioning of Osisko Humidity Cell Tests, Malartic Project", Chateauneuf | October 2008 |
| "University of Utah Acid Mine Drainage Research Group, Humidity Cell Model Version 4.01", Lin, Guard, Dumett, Trujillo | 2000 |
| "Advances in Acid Drainage Prediction Using the Net Acid Generation (NAG) Test", Miller, Robertson, Donohue | 1998 |
| "Use of the Net Acid Generation pH Test for Assessing Risk of Acid Generation", William M. Schafer | 2000 |
| "A Comparison of Kinetic NAG Tests with Static and Humidity Cell Tests for the Prediction of ARD", Sapsford, Bowell, Dey, Williams, Williams | 2000 |
| "Evaluation of the Net Acid Generation (NAG) Test for Assessing the Acid Generating Capacity of Sulfide Minerals", W. Stewart, et al | 12-18/vii/2003 |
| "Violation of Common ABA Prediction Rules by Molybdenum-Related Minesites in British Columbia, Canada", Kevin . Morin, Nora M. Hutt, et al | June-July 2001 |
| "Release of Acid from Hydrothermal Quartz-Carbonate Hosted Gold-Mine Tailings", Lapakko and Wessels | June 1995 |
| "Progress of BLM-Funded Acid Mine Drainage Research", White III, Lapakko, Trujillo | 2002 |
| ***Water Resource Characterization, Test Methods, Modeling, and Concept Discussions*** | |
| "Water Quality Sampling for Metals" (NDEP Guidance Document) | December 1998 |
| "Nevada Bureau of Land Management's Water Resource Data and Analysis Policy [Guide] for Mining Activities", BLM, State Director, Nevada, Instruction Memorandum No. NV-2008-032 | 15 April 2008 |
| "Groundwater Modeling Guidance for Mining Activities" with "Table of References", | 21 April 2008 |

| Category/Document Title | Number/Date |
|---|---|
| BLM, State Director, Nevada, Instruction Memorandum No. NV-2008-035 | |
| ***Rock Characterization Internet Case Studies*** | |
| "Neutralization Potential: What is it and Why is it Important for Drainage Chemistry?" | November 1997 |
| "Upside-Down Oxidation Profile in Sulfide-Bearing Tailings" | May 1998 |
| "Contribution of Bacteria to Sulfide-Mineral Reaction Rates in Natural Environments" | November 1998 |
| "Comparison of NAG Results to ABA Results for the Prediction of Acidic Drainage" | January 1999 |
| "Prediction of Minesite-Drainage Chemistry Using the "Wheel" Approach" | November 1999 |
| "Why Include Ore Samples in the Prediction of Minesite-Drainage Chemistry; When Ore is not Waste?" | August 2004 |
| "Should a Humidity-Cell Sample Be Gently Agitated During Testing?", Morin and Hutt | 2006 |
| "Errors from Sampling Humidity Cells Every Second Cycle", Morin and Hutt | 2007 |
| **ASTM International Test Methods** | |
| Standard Guide for Reporting Results of Analysis of Water | D 596-01 |
| Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$ (600 kN-m/m$^3$)) [Standard Proctor] | D 698-91 |
| Standard Terminology Relating to Water | D 1129-04 |
| Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$ (2,700 kN-m/m$^3$)) [Modified Proctor] | D 1557-91 |
| Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System) | D 2487-93 |
| Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) | D 2488-93 |
| Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils | D 4318-93 |
| Standard Guide for Sampling Ground-Water Monitoring Wells | D 4448-01 |
| Standard Test Methods fro Screening pH in Waste | D 4980-89 |
| Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter | D 5084-90 |
| Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers | D 5092-90 |
| Standard Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in the Vadose Zone | D 5126-90 |
| Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell | D 5744-07 |
| "Modification of the ASTM 5744-96 Kinetic Test", Lapakko and White III | 2000 |
| "Preliminary Indications of Repeatability and Reproducibility of the ASTM 5744-96 Kinetic Test for Drainage pH and Sulfate Release Rate", White III and Lapakko | 2000 |
| Standard Guide for Planning and Preparing for a Groundwater Sampling Event | D 5903-96 |
| Standard Guide for Documenting a Ground-Water Sampling Event | D 6089-97 |
| Standard Guide for Field Preservation of Ground-Water Samples | D 6517-00 |
| Standard Guide for Collection of Water Temperature, Dissolved-Oxygen Concentrations, Specific Electrical Conductance, and pH Data from Open Channels | D 6764-02 |
| Standard Test Methods for Analysis of Metal Bearing Ores and Related Materials by Combustion Infrared-Absorption Spectrometry | E 1915-07a |
| Standard Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure | E 2242-02 |

**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