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To: All Field Offices

From: Director, National Applied Resource Sciences Center

Subject: Site Characterization for Abandoned Mine/Mill Sites

1.0 Introduction

The purpose of this Instruction Bulletin (IB) is to provide technical guidance for characterizing abandoned mine sites with the goal of remediating or reclaiming the site. The IB focuses on characterizing releases of hazardous substances in surface water and soils, assessing risk, and collecting information for design of the remedy.

2.0 Preliminary Site Evaluation

A site visit should be conducted by personnel trained and experienced with Abandoned Mine Land (AML) or hazmat sites. Detailed notes, photographs, and/or video should be taken on the location of any suspected hazardous substances, safety hazards, surface water bodies, nearby human receptors, including recreational visitors, wetlands, or sensitive environments. Flowing adits or seeps should be tested for pH and electrical conductivity. Observations of areas where plant growth is absent or impaired should be noted. A detailed site sketch should be performed.

If the personnel are trained and equipped for sampling, sampling of adits and seeps is recommended. These samples should be collected for the analytical package shown in Table 1. Samples for dissolved metals analysis should be field filtered through a 0.45 micron filter and preserved with HNO_3 to pH<2 in a 250 ml (or larger) polyethylene bottle. Alkalinity, anions, pH, EC, and TDS samples should also be field filtered with no preservative in a one-liter polyethylene (or larger) bottle and shipped at 4 degrees C (on ice). Field filtration is accomplished using disposable cartridge and a peristaltic pump or disposable disk filters and syringes.

After the preliminary site visit, it is recommended that the results be written up in a removal preliminary assessment or similar report. The format for such a report may be found in 40 CFR 300.410. The report should describe the waste sources and potentially affected media, e.g. soil, surface water, groundwater, air, and biota. Based on the number and proximity of human and environmental receptors, the decision to progress to a more detailed site evaluation is made.

3.0 Site Characterization

Careful planning of the site characterization work is necessary to obtain the data necessary to make decisions about the need for and type of remediation for the site. A site conceptual model (SCM) is helpful to determine the most important receptors and exposure pathways at the site, hence sample locations. Figure 1 contains a generic SCM. In preparation for the site characterization, sampling and health and safety plans should be prepared. Laboratory arrangements and mapping expertise will also be required. This section briefly addresses these needs.

3.1 Site Breakdown

Breakdown the site into the following media: wastes, surface water, groundwater, and if necessary, air and biota. Based on the site conceptual model, determine the number and types of samples required for each medium. For water samples, analytical package is recommended (Table 1). The analytical method for water samples must have low detection limits for evaluation with respect to water quality standards. Table 2 presents the recommended EPA Method, method detection limits, and low-range water quality standards. For water samples, sample each adit and seep, and surface water bodies potentially affected, both upstream of the wastes and downstream. If monitoring wells or domestic wells are present, sample these also. Samples should be collected for dissolved metals analysis by field filtration through a 0.45 micron filter and preserved with HNO_3 to pH<2 in one-liter polyethylene bottles. Seep and adit flows should be accurately measured for use in design of potential water treatment systems.

For soil, tailings, and waste rock, analytical package is recommended (Table 3). It is recommended that tailings be gridded and sampled on the grid nodes to fully characterize the extent of contamination. Waste rock may also require gridding. Waste rock is sometimes of less concern than tailings because of its larger particle size. Tailings are often acid, and reclamation may require lime amendment. Acid-base accounting (ABA) is a laboratory method that can be used to determine the amount of lime required. Samples should be taken horizontally and vertically to determine the volume of tailings/contaminated soil for possible removal. Inexpensive gold and silver assays on a portion of the samples may also be worthwhile if reprocessing is possible. If private residences are located near the site, yard soil samples may be required.

The National Applied Resource Sciences Center (NARSC) has a field x-ray fluorescence spectrometer (XRF) that can also be used to accurately and inexpensively determine metals concentrations in soil/tailings. Information Bulletin SC-93-153 explains further about the use of this instrument.

Soil geotechnical properties may be required for repository design. Soils used for the base and cover may be tested for permeability, ABA, and particle size analyses using American Society Testing and Materials (ASTM) methods. Tailings may be tested for compaction and optimum moisture with an ASTM Proctor test. Depth to groundwater and the 100-year floodplain should also be determined.

3.2 Site Mapping

Because the site may require cleanup, the locations of site features, samples, waste piles, mine openings, surface hydrology, floodplains, land ownership, and topography should be mapped. The map scale should be adequate and accurate enough to calculate volumes, determine slopes, etc. A scale of 1 inch equals 50 feet is an appropriate scale for this type of mapping. Depending on the cleanup objectives, the site can be mapped via GPS, photogrammetry, electronic distance meter, or conventional surveying.

3.3 Quality Assurance

Since analytical results are sometimes measured to the ppb level, proper field quality assurance practices are essential. New sample bottles of correct size and material will be furnished in advance by the laboratory. All reusable sampling equipment must be decontaminated with a soapy water wash, tap water rinse, and distilled water rinse. Equipment rinsate blanks should be prepared from decontaminated sampling equipment. Duplicate water samples are recommended on a 1:20 basis. All samples should be maintained under proper chain of custody from collection to receipt at the laboratory. All field observations should be maintained in the field logbook.

The laboratory should have a quality assurance plan and should be able to provide data packages per EPA SW-846 or other EPA methods. If non-EPA methods are used, it is recommended that a certain percent of the samples be split and analyzed by EPA methods for comparability.

Table 1. Analytical Package for Water Samples

Parameter	Method
Dissolved Metals (filtered)	EPA 200*
Total Metals (optional)	EPA 200*
Free Cyanide/Total Cyanide 4^{o} C	Electrode/EPA 335
Anions, lab pH, EC, TDS, alkalinity (optional); unfiltered, no preservative, 4^{o} C	EPA 300, etc.

Benthic macroinvertebrates (optional, streams only)	BLM (Utah State University)

*See Table 2

Table 2. Recommended Analytical Methods for Dissolved Metals in Water

Metal	Ambient Water Quality Criterion (ug/L) (25 mg/L hardness)	EPA Analytical Method	Method Detection Limit (ug/L)
Antimony	14	200.8 or 200.9	0.4 or 0.8
Arsenic	0.018	200.9	0.5
Cadmium	0.32	200.13	0.016
Copper	2.5	200.10	0.023
Lead	0.14	200.10	0.074
Mercury	0.012	245.7	0.01
Nickel	7.1	200.9 or 200.9	0.5
Selenium	5	200.9	0.6
Silver	0.31	200.8	0.1
Thallium	1.7	200.8	0.3
Zinc	28	200.7 or 200.8 or 200.9	0.2-2.0

Table 3. Chemistry Package for Soil/Tailings

Parameter	Method	Alternate Method
Total Metals/Au assay	EPA 6010 (except Au)	Mine exploration package via ICP and Au
Acid Base Accounting	EPA (Sobek)	
Cyanide/WAD Cyanide	EPA 335/ASTM D2036	
Bioaccessibility	University of Colorado	
XRF	SW-846 Method 6200	

3.4 Other Information

After completing the site characterization and removal preliminary assessment, a study of reclamation alternatives, their effectiveness in reducing risk, implementability, and cost should be completed. As specified in 40 CFR 300.410, this is an Engineering Evaluation/Cost Analysis. For further information, NTC has a course, 1703-14, Site Characterization for Abandoned Mine Sites that covers these topics in greater detail. Contact Robert Sykes at 602-906-5556 for more information. If you have any questions concerning this IB, please contact Karl Ford 303-236-6622 or Bill Carey 303-236-0103 of NARSC.

Signed by:
Lee Barkow, Director
National Applied Resource Sciences Center

Authenticated by:
Elsie Pacheco
Staff Assistant

1 Attachment
1 - (Figure 1) Mine Waste Conceptual Site Model for Human and Ecological (1 p)

Distribution
WO-230, LS, Room 204
WO-360, LS, Room 406
RS-150, BLM Library
RS-130, Reading File

Mine Waste Conceptual Site Model for Human and Ecological