Region 2 Mine Prioritization
Quality Assurance Project Plan/Data Quality Objectives
(Including Inspections with XRF)

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Project Organization

Project Manager – Lindsay Whalin – San Francisco Bay Regional Water Quality Control Board

Project Staff – Nicholas Piucci (and formerly Sarah Acker) - San Francisco Bay Regional Water Quality Control Board

Project Description

The purpose of this project is to maximize the efficient use of available resources to prioritize unremediated mines based on potential threat to State waters. Existing sources of data related to the potential for on-site contamination and connectivity to State waters will be collated and evaluated to rank mine sites for inspection. Additional chemical data and geotechnical, hydrologic, and geomorphologic information will be collected during inspections of the higher priority mines. This information will be used to prioritize regulatory action (such as requiring further investigation by responsible parties).

Data QA/QC guidance reviewed and implemented in developing this document

- *Guidance on Systematic Planning Using the Data Quality Objective Process* – EPA QA/G4 *(Feb. 2002)*
- *Abandoned Mine Site Characterization and Cleanup Handbook* -EPA 910-B-00-001 (Aug. 2000)
- *Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations In Soil And Sediment* - EPA Method 6200 *(Feb. 2007)*
- *Metals in Soil Analysis Using Field Portable X-ray Fluorescence* - Innov-X Systems (Aug. 2003)
- XRF Standard Operating Procedure – SFRWQCB Lindsay Whalin, Victor Aelion, Nicholas Piucci (September 2017)
- Mine Inspection Safety Plan - SFRWQCB Lindsay Whalin and Nick Piucci (September 2017)
- Site Specific Mine Inspection Plan and Log – SFRWQCB Lindsay Whalin (September 2017)
- *California Abandoned Mine Lands Prioritization Tool, Phase I Technical and Business Process Report* (Apr. 2017)

Instrument Information

- Niton XL3t GOLDD+ by Thermo Scientific, a mobile x-ray fluorescence spectrometer (XRF)
- Multi-Parameter PCSTestr 35 by Oakton and Eutech Instruments, a portable meter that reads pH, Salinity, Total Dissolved Solids, Temperature and Conductivity

Project Goal

The goal of the mine inspection project is to identify mine lands that could be impacting water quality, and to collect the information and data necessary to prioritize regulatory efforts, for example to require further investigations or cleanup actions. There are 38 known unremediated mines in Region 2 (and potentially more according to recent updated databases maintained by the USGS) and limited funding to oversee investigations and cleanup. Efficient and effective allocation of resources therefore requires prioritization of these mines for inspection and regulatory action.

Objectives

The data collected through this effort will be used to prioritize mines for regulatory action and may be referenced in regulatory requirements. Existing and new sources of data and information will be evaluated and used to rank mines according to their potential to impact water quality. Analysis will occur in two phases, the first utilizing existing information in Regional Water Board files and publicly available databases to prioritize the mines for inspection (desktop analysis). This analysis is sufficient to determine whether a discharge might exist and require investigation by responsible parties according to Water Code section 13267 (b.1). However, providing oversight of investigations for 38 mines is an insufficient use of resources. Therefore, additional data will be collected during inspections to improve site characterization for the second phase of analysis, prioritization for regulatory action.

Key questions for both phases:

1. Is the site contaminated? In particular, does the site contain contaminated mining waste (waste rock like overburden, tailings/calcines, low-grade ore, etc.), soils or sediments with high concentrations of metals and/or metalloids; and/or are there potentially contaminated liquids (e.g., adit drainage, seeps, waste pile leachate) that could discharge offsite?

2. Are hydrologic and/or geomorphic conditions such that contamination can be transported to State waters, and is there evidence suggesting mine related constituents of concern (COCs) might be impairing receiving waters?

This effort will primarily focus on surface waters (not groundwater) for two reasons:

1. The primary COCs associated with Region 2 mines are metals and metalloids which tend to attenuate (adsorb to soils) fairly rapidly in the subsurface, yielding a relatively low probability of drinking water contamination; and

2. The site-specific subsurface data/information currently available are insufficient to predict/estimate groundwater impacts. The GeoTracker and Envirostor databases were searched as a pilot test for several Region 2 mines, but provided no helpful information.

Potential impacts to groundwater, (as indicated by impacted domestic wells) or through groundwater/surface water interaction, will be evaluated on a case-by-case basis, as needed.

Schedule

Project Schedule: Initial inspections anticipated for Fall of 2017.

Resources

Staff

Lindsay Whalin - approximately 33%PY

Nick Piucci (Scientific Aid) - approximately 50%PY

Gear

Instruments

XRF and ancillary parameter probe

Field gear

Required Participant Gear List: Water bottle, high-caloric snacks/meal, long sleeves/pants & extra layers, hat/visor, closed-toed hiking shoes, safety glasses, high visibility vest

Provided Gear List: water, map, flashlight, gaiters, gloves , insect repellent, whistle, duct tape, sunblock, gloves, nu tech, tick remover, tweezer, whistle, hand sanitizer, walkie-talkie, particulate respirator, multi-tool, throw rope, first aid kit, towels, baby wipes, compass, cooler, ice packs

Other: garbage bag, machete, Niton XRF, sandwich bags (for XRF)

Access

Parcel searches will be performed to identify property owners using info from MSD data sources (see below), ParcelQuest, Region 2 Vineyard, SWAMP, and confined animal facility databases. RCDs are a potential additional resource for information. Mines on public property may be inspected without notification. However, several R2 mines are on private property. Property owners will be contacted by phone to request access and to collect information helpful to inspections. A follow up formal letter may be sent if official record is requested (Water Board counsel has confirmed a record must be kept that permission was granted, but a formal letter is not required). Access instructions and information pertinent to the inspection and safety will be included in the Site Specific Mine Inspection Plan & Log and Mine Inspection Plan (which will be site specific and requires inspector signature). If Water Board staff are denied access, we will initiate the process to obtain a warrant with Region 2 counsel (who may consult with Office of Enforcement). The assistance of a California Fish and Wildlife warden may be requested. A safety briefing will be held prior initiating inspection.

Reporting

Status updates will be provided to the Board via Board Meeting presentations and Executive Officer Reports, as appropriate. The primary report format will consist of a staff summary report that will include a link to a GIS layer that can be viewed in Google Earth. The user will be able to click on a mine name in the layer, view the site virtually via satellite images and historical photos, and scroll through a pop-up window that includes summary information, ranking and status. The GIS file will be produced by creating a shape file out of the Mines Summary Database (MSD), a substantially sized excel spreadsheet, serves multiple additional functions. It is the repository of all information and data collected and reviewed on Region 2 mines as part of this effort. It also is the record of prioritization factors, process, and scores and rankings for each mine. Finally, it is the record of status information for tracking progress in this effort.

MSD Protocol

Rows exist for each known mine in Region 2. Columns are categorized based on whether the text summarizes data sources, data extracted from those sources and used to prioritize the mine, access a site, and take other pertinent actions; or summaries of results and status intended for use in documents. In other words, for each mine (row), the cell in the corresponding column represents either a summary of data sources, data representing the most current understanding of the site, or an outcome of that data for use in prioritization or other action. The column categories have been color-coded and Table 1 describes the purpose of each category.

Table 1. Mines Summary Database Column Categories and Purpose

Category	***Column Type***	***Purpose***
MINE	Data	Site identification data for ease of scrolling through large excel database.
STATUS	Results	Status summary information for use in documents and GIS Layer.
LOCATION	Data	Location data for virtual and literal inspections.
PRIORITIZATION SCORES	Results	Prioritization ranking scores, summarize relevant data columns.
MINE CHARACTERISTICS	Data	Summarize relevant information from data sources columns.
HYDROLOGY/GEOMORPHOLOGY/WATERSHED CHARACTERISTICS	Data	Summarize relevant information from data sources columns.
ADMIN	Data	Administrative information, including ownership and access information.
DATA SOURCES	Data Sources	Summarize information obtained from each existing and new source of data reviewed.

<u>Data Sources</u>: These columns summarize existing and new sources of data reviewed in this project. This information has not been updated, unless specifically mentioned in the cell. Data sources include previous inspector's reports, data from USGS and other databases, and findings from satellite reconnaissance (see the QAPP for more detailed description of data sources).

<u>Data</u>: These columns contain site-specific data isolated from the data source columns to inform staff actions, such as prioritization, contacting site operators to gain access, etc. Information in data columns represents the most current understanding of site-specific data and will be revised with new or updated data as they are obtained. If updates are warranted based on a *new* source of data/information, a column will be added in the Data Sources section, except when the information relates to a single mine, in which case the information will be summarized under "Other" (rather than creating a whole column for a single site).

Results: These columns summarize the status of the site within the project and any decisions made regarding specific actions. This includes the "Prioritization Scores" where information from the "Data" columns was converted into scores associated with each prioritization factor, as well as summaries of progress in this project. Like "Data", these are updated as needed. In addition to descriptive information from "Data" columns, "Results" will be used to populate the GIS layer. Status options include:

- Summary Complete – "Data sources" have been collected and summarized, and "Data" columns have been populated as needed to perform the inspection prioritization. This mine will appear in the GIS layer. This process is complete for all known Region 2 mines.
- Prioritized for Inspection – The mine has been scored and ranked according to the need for prompt site investigation.
- Under Investigation – The mine is currently being investigated for potential discharges and/or a remedy is being selected.
- Remediation in progress – The mine was previously inspected and a remedy selected, which is in progress.
- Monitoring and Maintenance – Remedial actions were conducted and the mine is currently being monitored to verify efficacy of the remedy, and is actively maintained.
- Closed – The site was remediated and closed by another regulatory agency.
- Refer to DTSC – Health hazard from non-water source (such as dust inhalation) drives risk.

Data Needs

There are two categories of data and information needed for both phases of analysis to meet the project's objectives:

1. Data that indicate whether a mine site might contain contamination that could be dangerous to humans and/or wildlife and could discharge offsite (information about the potential for COCs and the potential for those COCs to migrate offsite); and

2. Data that indicate that the mine is hydrologically connected to and may be impairing State waters.

Data Sources

The initial effort will focus on unremediated mines known to Water Board staff, for which there is available data. However, a review of the most up to date USGS mines database has revealed thousands of other mine features, most *but not all* of which are prospects rather than productive mines. It would take considerable effort to evaluate each to determine which are productive mines that might threaten water quality, and should be added to the current prioritization effort. Therefore, additional mines identified during this process will be recorded in the MSD for future evaluation, unless there is a compelling reason to include it in the current prioritization effort (e.g., mercury mines or those with potential acid rock drainage (ARD) near surface waterbodies).

Table 2 lists the sources of data used to evaluate the potential of mines to impact water quality:

Table 2. DATA SOURCES

Mine Characteristics	Hydrologic Connectivity
GIS Database: USGS MRDS	GIS Database: USGS topo maps
GIS Database: USGS Prospects and Mine-Related Features	GIS Database: USGS NHD (med & high resolution)
GIS Database: DOC PAMP	Google Earth and ArcGIS ruler and grade tools
Historical images (Google Earth and NMMR)	
***** XRF metal/metalloid concentration data of mining waste, soils, sediments	
***** Inspection findings	
Previous inspection/er reports, notes, input	
Google Earth and ArcGIS satellite images	
Chemical Impairment Status - GIS Database: EPA MyWaters (303d, TMDLs)	
GIS Database: OEHHA Fish Advisories	
GeoTracker and Envirostor	

* Collected during inspection, thus only used to prioritize regulatory action.
GIS – Geographical Information System (https://www.nationalgeographic.org/encyclopedia/geographic-information-system-gis/)
MRDS – Mines Resources Data System
DOC PAMP – California Department of Conservation Abandoned Mine Lands Unit Principle Areas of Mine Pollution
NMMR – National Mine Map Repository
NHD – National Hydrography Dataset

The initial prioritization will consist of evaluating the available data to rank the mines in terms of potential threat to water quality. Based on this ranking, the high and medium priority mines will be inspected to collect additional data to inform potential regulatory actions (such as issuing cleanup and abatement orders). A second prioritization effort may be performed to rank mines that require regulatory action. The following data, collected from the above sources, will be evaluated for each mine:

Mine Characteristics Indicating Potential Contamination and Offsite Discharge

Certain characteristics of the mine and mining waste can aid identification of potential water quality impacts. Mines with greater volume or higher concentrations of contaminants pose a larger threat to water quality. Mines with mobile contamination (e.g., ARD, physical erosion of mining waste/contaminated soils, or leachate) pose an even greater threat. The types of available and obtainable data that will be used in one (*) or both phases of the analysis are detailed in Table 3.

Table 3. MINE CHARACTERISTIC DATA

Data Type	Applicability	Data Source Quality (for existing)
Mineralogy (commodity and gangue)	Indicates potential COCs and ARD	USGS High DOC Low
Mine productivity	More productive mines may contain more contamination	USGS High DOC Low
Mine size	Larger mines may contain more contamination	USGS High DOC Low
Mining waste at surface (known /suspected from aerials)	Wastes at the surface may be more mobile	Known High Suspected Low
Volume of mining waste (known/suspected from aerials)	If mining waste is contaminated, the larger the volume the greater the threat	Known High Suspected Low
Mining waste mobility, e.g., evidence of erosion or drainage (known/suspected from aerials)	Increases probability of offsite discharge	Known High Suspected Low
Evidence ore processed on site	- Processed ore (tailings) can contain more environmentally available contaminants, and - Ore processing was generally inefficient, leading to contamination of native soils.	USGS High DOC Low
Mining Equipment remains on site (known/suspected from aerials)	- Evidence Ore processed on site - Can be a continuing source of contamination (and can inform targeted sampling)	Medium/Low
WB files/reports	Indicates previous inspectors determinations and recommendations regarding water quality threat	High (Except water quality data, which is too variable to be determinative)
***** XRF data of mining waste, soil, sediment	Indicates metal/metalloid contamination	High
* pH data		High
***** Inspection of geotechnical characteristics of mining waste and/or contaminated soils/sediments and for evidence of leaching or ARD.	Indicated offsite discharge	High

*** Collected during inspection, thus only used in second phase of analysis to inform regulatory action. (This table will be amended to include additional data used to prioritize mines for regulatory action, post inspection)**

Aerial Images

Satellite images and historical aerial photos available in Google Earth, the National Mine Map Repository, and ArcGIS basemaps from World Imagery Map ESRI will be used to search for mine workings/features and identify and perform desktop investigations of potential or known waste piles, including estimating volume/area or evidence of erosion. We refer to this as satellite reconnaissance.

Databases

GIS databases like USGSs *Mines Resources Data System* and *Prospects and Mine-Related Features* shape files, and reports/information from previous Water Board inspectors will provide useful mine characteristics. For example, commodity and gangue data indicates potential COCs, mine productivity and size and information regarding potential processing of ore on site aids estimation of the potential magnitude of contamination. DOCs PAMP data has correlated less well with information in our files.

Inspections

The mines ranked highest in the prioritization effort will be inspected first (as feasible in consideration of access issues) to collect additional information about mine characteristics. Mine inspections will be targeted to identify mining waste and other contamination, and to collect information regarding the potential for contamination to discharge offsite. Features discovered during satellite reconnaissance or detailed in reports (desktop analysis) will be inspected to confirm findings. Surface mining waste volume estimates will be refined, drainages will be evaluated, and contaminant concentrations in mining waste/soil/sediment will be evaluated using a mobile x-ray fluorescence spectrometer (XRF). This data will be evaluated in conjunction with evidence of contaminant mobility (erosion/erodability, leaching, ARD, mine opening drainage) to evaluate whether contamination may discharge offsite.

XRF

The XRF will be used to field-screen mine sites to determine whether contaminated mining waste might be present at the site. This information will aid any follow-up effort to prioritize mines impacting water quality for regulatory action, and may be referenced in requiring responsible parties to perform a more comprehensive and robust site investigation. Solid mining waste can be variable in characteristic, however there are some visual cues (intrinsic properties or how the rock/soil is present in the environment) that suggest certain rocks/soil may be mining waste that will aid targeted sampling, including:

- Slopes with lack of vegetation signaling toxins or lack of nutrients;
- Unnatural benches or slopes suggesting anthropogenic placement, rather than natural geologic/geomorphologic depositional processes;
- Particle size (ore was typically crushed meaning more uniform, smaller size, while overburden is typically highly variable in size from fine to boulder);
- Odor (e.g., sulfur has a characteristic smell); and

- Color (e.g., roasted cinnabar, also known as calcines, are often pink or red with white crust).

Depositional areas of drainages may also be tested if offsite discharge is suspected.

Paradoxically, water samples are not ideal for identifying potential water quality impacts from mine sites. Concentrations of mine COCs in receiving waters can be expected to be highly variable, for a number of reasons, the most important of which are:

1. Offsite discharge can be variable, with both liquid and solid waste discharges typically dependent on or significantly increased by rain events (erosion and discharge), water table elevation, etc.; and

2. Water column concentration can be variable, dependent upon geochemical factors that can change on different time scales (diurnal, seasonal, etc.), such as redox potential and pH. Therefore, absence of a mine-derived COC in a discrete water sample does not confirm that discharge has not occurred.

pH, EC, and ORP Meter

If appropriate, we will evaluate the acidity or alkalinity of mine drainages, leachate, or receiving waters. This information will inform whether conditions exist, that might exacerbate leaching of metals or metalloids, for example ARD. We may also take electrical conductivity and oxidation-reduction potential measurements to evaluate potential dissolved content.

Hydraulic Connectivity and Data Indicating Water Quality Impacts Possible

Connectivity of the site to State waters, in particular eroded, contaminated mining wastes or drainage from mine openings will also be evaluated. In addition to information provided in existing inspection reports, tools in Google Earth and ArcGIS (such as topographic maps, satellite images, and tools to estimate distance and grade) will be used to evaluate drainage pathways. This information will aid prioritization of inspections, and may be used secondarily to prioritize regulatory actions. Information on receiving water impairment status will also be used to evaluate potential connectivity, as well as waterbody sensitivity to COC inputs. The types of available and obtainable data that will be used in one (*) or both phases of the analysis are detailed in Table 4.

Table 4. HYDROLOGIC CONNECTIVITY AND IMPAIRMENT DATA

Data Type	Applicability	Data Source Quality
Satellite and historical images	Indicates current and historic drainages	Medium
National Hydrography Dataset (NHD)	Indicates drainages and receiving waters	Medium
USGS Topographic Maps	Provides rough estimate potential for off-site discharges to reach receiving waters	Medium
“Ruler” and “Grade” tools to estimate distance and grade of mine and mine features (e.g., piles of mining waste) to receiving waters or drainages	Provides rough estimate potential for off-site discharges to reach receiving waters	Low
Receiving water impairment with potential mine COC (e.g., 303d)	- Can signal potential discharge - Indicates potential sensitive habitat	High if impaired, low if not (e.g., lack of 303d listing does not indicate waterbody is not impaired)
Fish advisories	- Can signal potential discharge - Indicates potential sensitive habitat	High
WB files/reports	Indicates previous inspectors determinations and recommendations regarding water quality threat	High
***** Inspection of drainages, tributaries…	- Confirm surface water connectivity - Identify discharged waste - Identify sensitive habitats	High
***** Inspection for geomorphological characteristics of site and drainage		High

*** Collected during inspection, thus only used in second phase of analysis to inform regulatory action. (This table will be amended to include additional data used to prioritize mines for regulatory action, post inspection)**

Aerial Images

Satellite images and historical aerial photos available in Google Earth, the National Mine Map Repository, and ArcGIS basemaps from World Imagery Map ESRI will be used to identify watersheds and basins, and track potential drainages and receiving waters.

Hydrology Databases

Hydrologic information in USGS National Hydrography Dataset and EPAs MyWaters will be used to identify drainages and their hydrologic category (ephemeral, intermittent and perennial) and receiving waters.

Impairment Databases

Databases indicating the impairment status (303d-listed waterbodies, those with TMDLs, and those with OEHHA fish advisories) will be used to evaluate if receiving waters may be impacted by mine contamination. California Environmental Data Exchange Network (CEDEN) and Surface Water Ambient Monitoring Program (SWAMP) are potentially useful sources of water column and sediment chemistry from receiving water and/or toxicity. However, a pilot test to search for data in receiving waters downstream of two of the highest priority mercury mines produced no useful data, suggesting these sources may be too variable and sparse for use in prioritizing sites for inspection. Thee databases may be used to in future phases of the project, including prioritizing sites for regulatory action.

Drainage Distance and Gradient

An estimate of the distance of a mine feature to a drainage or receiving water can be determined using tools in Google Earth and ArcGIS. A rough estimate of gradient (sufficient for relative comparisons) can be produced using path, ruler, and grade tools in Google Earth satellite images and USGS topographic maps available in GIS format.

Data Use in Prioritization Process

The data collected will be evaluated to rank mine sites first for inspection, then potentially for regulatory action. The evaluation process is phased:

Phase I: Determine whether the mine might contain COCs, based on data about the commodity, gangue, and any evidence suggesting ARD might be produced on site. If there is no indication of potential COCs, then the case will be closed. GeoTracker cases will be created to summarize findings and the resultant report/GIS layer will list these sites as closed. Mines with low potential for threat can be addressed when higher priority site investigation and remediation is complete or if new information/data is discovered.

Phase II: The remaining mines will be ranked according to factors that signal potential water quality impacts and for which sufficient data exists. Table 5 lists these factors and the scores used for ranking. The scores will be summed to rank the mines, those with the highest rank being the highest priorities. Again, mines with low potential for threat can be addressed when higher priority site investigation and remediation is complete or if new information/data is discovered.

Table 5. PRIORITIZATION RANKING FACTORS

Prioritization Factors	Scores for Ranking
Commodity COC	++++ Hg, S (or ARD), Pb, Cr + Cu, Ag, Au, Sb, coal - Remaining
Other COC (e.g., associated with gangue)	++ Hg, S (or ARD), Pb, Cr + Cu, Ag, Au, Sb, coal 0 Remaining
Buffering Mineralogy	- For carbonates (Only relevant if commodity or COC indicates potential for ARD. Also, to be conservative, will only apply f0r carbonates in addition to silica-carbonate alterations of mercury)
Mine Productivity/Size	++ thru --
Ore Processed On Site	++ Known yes + Suspected yes -- Known no 0 Remaining
Waste Piles Evident	++ Known, large volume + Suspected, large volume or known or suspected small volume 0 Remaining
Erosion or Mine Drainage Evident	+++ Known, large volume ++ Suspected, large volume, Known or suspected small volume -- Known none 0 Remaining
Potential Connection to Receiving Water (distance and grade from mine feature to receiving water)	+++ Known Waste Pile ++ Suspected Waste Pile, Known Connected Drainage + Suspected Connected Drainage, Known Closest Mine Feature -- Known none 0 Remaining
Potential Connection to Drainage (ephemeral or intermittent creek, distance and grade)	++ Known connection of waste pile + Suspected connection of waste pile, known connection of other mine feature -- Known none 0 Remaining
Adjacent Receiving Water Impaired By Mine COC	++ to +++ Yes 0 No
Distant Receiving Water Impaired By Mine COC	+ Yes 0 No
Fish Advisory Based on Mine COC in Receiving Water	+ Yes (Cumulative with impairment) 0 No

(This table will be amended to include additional data used to prioritize mines for regulatory action, post inspection)

Acceptance Criteria for Existing Data

The quality of existing data (as reported by each source and/or as evaluated by the project manager) is variable, as indicated in Tables 3 and 4. Where there are discrepancies between data sources, higher quality data sources will applied in all evaluations. Questionable data will be confirmed, as feasible, during inspections.

Newly Collected Data Criteria

This section details performance criteria and quality assurance information associated with new data collected, and outlines the collection and analysis processes.

Performance Criteria

The consequences of misidentifying a contaminated/hydrologically connected site as clean or unconnected (i.e., a false negative determination) are greater than the converse (false positive). Therefore, prioritization ranking for inspection and regulatory action will always be skewed towards a presumption of contaminated or hydrologically connected, unless the data/information indicates with a high probability that it is not. Furthermore, it is important to note that our analysis does not need to prove mine contamination exists and is discharging off-site. In accordance with Water Code section 13267.b.1, it need only demonstrate the potential for contamination and discharge. In this respect, analytical data, including the XRF and pH data, are not mandatory for our inspections. Information about mining activity is sufficient to require further investigations. However, these instruments will help staff prioritize R2 mine sites by identifying those where high concentrations of metals and/or metalloids are present and/or where acidity or alkalinity might increase the solubility, and therefore mobility of COCs. The project Data Quality Objectives are therefore significantly less stringent than are necessary for an investigation to characterize a site or to inform remedial actions.

XRF

The XRF data collection effort will consist of field screening, skewed towards finding potential contamination, meaning:

- Mining wastes of concern are anticipated to contain high concentrations of metals and metalloids, suggesting high detection limits (relative to laboratory analytical methods) is acceptable.
- Rather than randomizing our sample collection, a visual survey for potential mining waste will be used to target sampling to identify contamination (grid, randomized sampling selection schemes unnecessary).
- Sample collection for laboratory analysis to confirm concentrations is unnecessary (accuracy is not critical).

The instrument settings will be adjusted to maximize analytical sensitivity in order to minimize detection limits in lieu of maximizing collection efficiency, as needed. The Niton reports the measurement error at the completion of analysis, therefore a decision to increase analysis times to lower the detection limit can be made in the field.

pH, EC Meter

The pH and electrical conductivity collection effort will also consist of field screening, skewed towards finding potential acidity/alkalinity or signs of elevated dissolved content in leachate, drainages, and potentially receiving waters. This means that the same performance criteria outlined for the XRF apply to pH data.

Visual Inspections

A Site Specific Inspection Plan/Log will be produced for each mine inspected. This will be both a planning document and a log of the inspection. Prior to the inspection, the document will be populated with access and route (driving and route) information, as well as the location and descriptive information of known and suspected mine or hydrologic/geomorphic features gleaned from the desktop analysis. However, it will also be a log to record information/data collected during the inspection. Visual inspection elements specific to mine characteristics and potential offsite discharge include:

Mine Feature Type

Adit, tunnel, shaft, exposed waste pile, mining equipment, mining structures, surface water impoundments or other man-made water features, exposed ore vein, etc. The latitude and longitude and a descriptive location will be included.

Mine Feature Descriptions

A description and an estimate of size. Evidence of drainage from an adit, tunnel, or shaft. Potential mining waste characteristics such as particle size (overburden is typically heterogeneous and variable in size, tailings are small and more homogeneous), odor and color. Evidence of leaching or ARD.

Mine Feature Characteristics Indicating Contaminant Mobility

Slope stability and steepness, evidence of erosion, dust, or leaching from potential mining waste, as well as mine opening drainage (noting staining, corrosion, or precipitates), ARD, vegetation, cementation. Evidence volume of mining waste is located within a surface water feature. Any evidence of off-site discharge.

Measurements Taken

Soil/Sediment/Mining waste XRF, electrical conductivity, pH, oxidation-reduction potential, topographic measurements.

Data Collection

This section describes how and where the data will be obtained and potential any constraints on data collection.

XRF

A Thermoscientific Niton XL3t GOLDD+ XRF will be used to measure concentrations of metals and metalloids in mining waste, soils, and sediment. The procedure is outlined in this agency's XRF Standard Operating Procedures (September 2017), which was produced following guidance provided in US EPAs *Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in*

*Soil and Sediment (*Method 6200) and the instrument manufacturers user's guide. Briefly, measurements will be made *in situ* by analyzing the soil directly from the ground, unless conditions prevent it. The terrain and soil characteristics will be visually inspected on site to identify potential mining waste, to target sampling locations. Signs that soil or sediment may be mining waste include siting in unnatural slopes or benches, lack of vegetation, soil particle size, odor and color. Samples will primarily be taken at or near the surface, though a shovel may be used to dig for subsurface samples. After debris removal, the top 1 inch of soil will be brushed aside with nitrile gloves using trace metal clean techniques. A clear plastic barrier (a clean sandwich bag) will be placed over the sample window of the XRF to prevent contamination. The XRF will be held directly to the ground surface to analyze for metal and metalloid concentrations. The instrument will be set to record the latitude, longitude, and elevation of the sample as it is collected.

Collection of samples for *ex situ* analysis may be performed if samples are wet or if higher data quality than can be achieved *in situ* is needed. Field-drying samples will consist of collecting a sample with a nitrile glove using trace metal clean techniques, noting the latitude, longitude, and elevation of the location, and laying the sample in a thin layer on a plastic bag in the sun until dry. The analysis will either occur directly on the sample once dry, or the sample will be collected in a sample cup (provided with the XRF) using trace metal clean techniques and analyzed in the office.

The XRF cannot be used for analysis of water or sludges, and moisture content above 20% reduces the accuracy of the results. However, sludges and sediments can be dried prior to analysis. As necessary, these types of samples may be collected and air-dried in the field prior to analysis. Water Board staff do not possess the appropriate equipment (including safety equipment) to oven-dry samples; however, this method is not recommended for sample that may contain mercury (a primary COC in this effort) because heating vaporizes elemental mercury, making the sample unrepresentative. The process is also unsafe because gaseous elemental mercury is toxic to inhale.

pH, EC Meter

An Oakton Multi-parameter PCSTestr 35 pH meter will be used to test site and receiving waters for acidity or alkalinity. At sites where ARD is suspected or where arsenic or selenium is a potential COC (metalloids with species that become more mobile at high pH); surface water (drainages and receiving waters) may be tested for pH. The pH meter is a pen type, in which the probe is submerged into the sample (or an aliquot collected in a clean, plastic container). Data is recorded once the reading has stabilized. The standard operating procedure for taking a pH measurement with this instrument is as follows:

1. Rinse the probe with DI water and allow to air dry in a clean environment.
2. Turn the meter on.
3. Select MODE ENT until pH USA or COND appears on the screen .
4. Submerge in sample and wait until the reading is stabilized.
5. Record the data in the log.

Visual Inspections

A Site Specific Inspection Plan/Log will be produced for each mine inspected. This will be both a planning document and a log of the inspection. Prior to the inspection, the document will be populated with access and route (driving and route) information, as well as the location and descriptive information of known and suspected mine or hydrologic/geomorphic features gleaned from the desktop analysis. However, it will also be a log to record information/data collected during the inspection. Visual inspection elements to evaluate hydrologic connectivity and potential offsite discharge include:

Surface Water Feature Description

Name (if known), estimated distance and grade from mine feature, feature type, location (latitude and longitude), description of creek bed (culverted, incision, deposition zones), steepness of banks and terraces. Evidence of use by wildlife, farm animals, or humans (including anglers). Evidence of sensitive habitats (riparian zone, wetland/marsh). Evidence of mining waste or ARD. Confirm drainages and suspected off-site discharge from desktop analysis.

Measurements Taken

Topographic measurements to gage slopes.

Quality Assurance

This section describes the quality assurance and quality control activities performed to meet the performance criteria.

XRF

System Check

A system check will be performed whenever the instrument is turned on, unless it is in constant use (e.g., turned off for less than 30 minutes). The system check includes internal automatic calibrations and confirms the instrument is in operating order. If an error occurs, the instrument will be rebooted and another system check performed. A second failure will take the instrument out of commission until the error can be addressed with the manufacturer.

Blanks

Blank samples (of clean silica provided by the manufacturer) will be taken regularly to ensure the instrument does not become contaminated. At a minimum, blanks will be taken before the first sample and after the last sample of each mine site (or mine feature where multiple features are identified or sites are large). Blanks results can be viewed directly on the instrument screen and will be logged and compared to the manufacturer's specifications for the silica (<10mg/kg for each COC). If a blank sample indicates the instrument may be contaminated, a confirmatory blank sample will be taken before measures to decontaminate the instrument are performed (e.g., changing the sample window). All data taken between the contaminated blank and the previous blank will be "B" flagged in the log, and their mean concentration will be subtracted from the result and/or the data will be deemed qualitative rather than quantitative in the report.

Calibrations

The Niton XRF is calibrated at the factory to eliminate systematic errors. Calibrations will be performed to ensure the instrument is stable throughout the sampling event. A minimum of two certified reference materials (CRMs) will be analyzed, as feasible, bracketing the range of concentrations anticipated in site samples. Calibration results can be viewed directly on the instrument screen, and will be logged and compared to the CRM specifications.

The Niton XRF self-calibrates (including correcting for inter-element matrix effects) and XRF spectrometry in general requires only a single measurement to calculate measurement error (rather than the minimum of 7, as indicated in EPA method 6200, see Niton user's guide page 197).

Instrument stability will be evaluated in the field. Drift will be addressed by first running a blank to check for contamination, then turning off and resting the instrument. Results within ±20% (±30% for chromium) of the CRM specification will be considered quantitative, others will be "J" flagged and treated as qualitative, according to the manufacturer's recommendations.

Detection Limits

The XRF confidence level will be set to 95% (two standard deviations or ±2σ), which is reported in real-time on the instrument screen. In accordance with manufacturer recommendations, the limits of detection will be calculated as 1.5 times 2σ of the blank or a low CRM. Calculation of detection limits for COCs will be performed and logged in the field, and analysis times will be increased if lower detection limits are desired (e.g., if visual evidence suggests mining waste and sample concentrations are consistently near the detection limit). For example, at mercury mine sites, the analysis time for the initial (main) element range will be increased from the default 30s to up to 120s (increasing by a factor of 4 approximately doubles the precision). A maximum of 300s may be used.

pH, EC Meter

Calibrations

Calibrations will be performed with pH7, pH10 and pH4 NiST standards a minimum of once daily when the instrument or at each site the instrument is used, using the following protocol:

1. Rinse meter with DI water and allow to air dry.
2. Turn the meter on.
3. Choose SET UP and press ENT.
4. Use the up and down keys to select PArA and press ENT. You will see the pH displayed on the screen first, press ENT.
5. Use the up and down keys to select NiST BUFF to indicate the type of standard (select USA BUFF if the standard used changes).
6. Press ENT to confirm.
7. Use the up and down keys to select three-point calibration (3-pt CAL).
8. Press ENT to confirm.

9. Submerge the probe into the standard indicated by the screen.
10. Repeat with the next two standards.

Standards will be replaced daily.

Detection Limits

When calibrated properly, the instrument promises an accurate pH reading of ± 0.1, which is sufficient for this field screening effort.