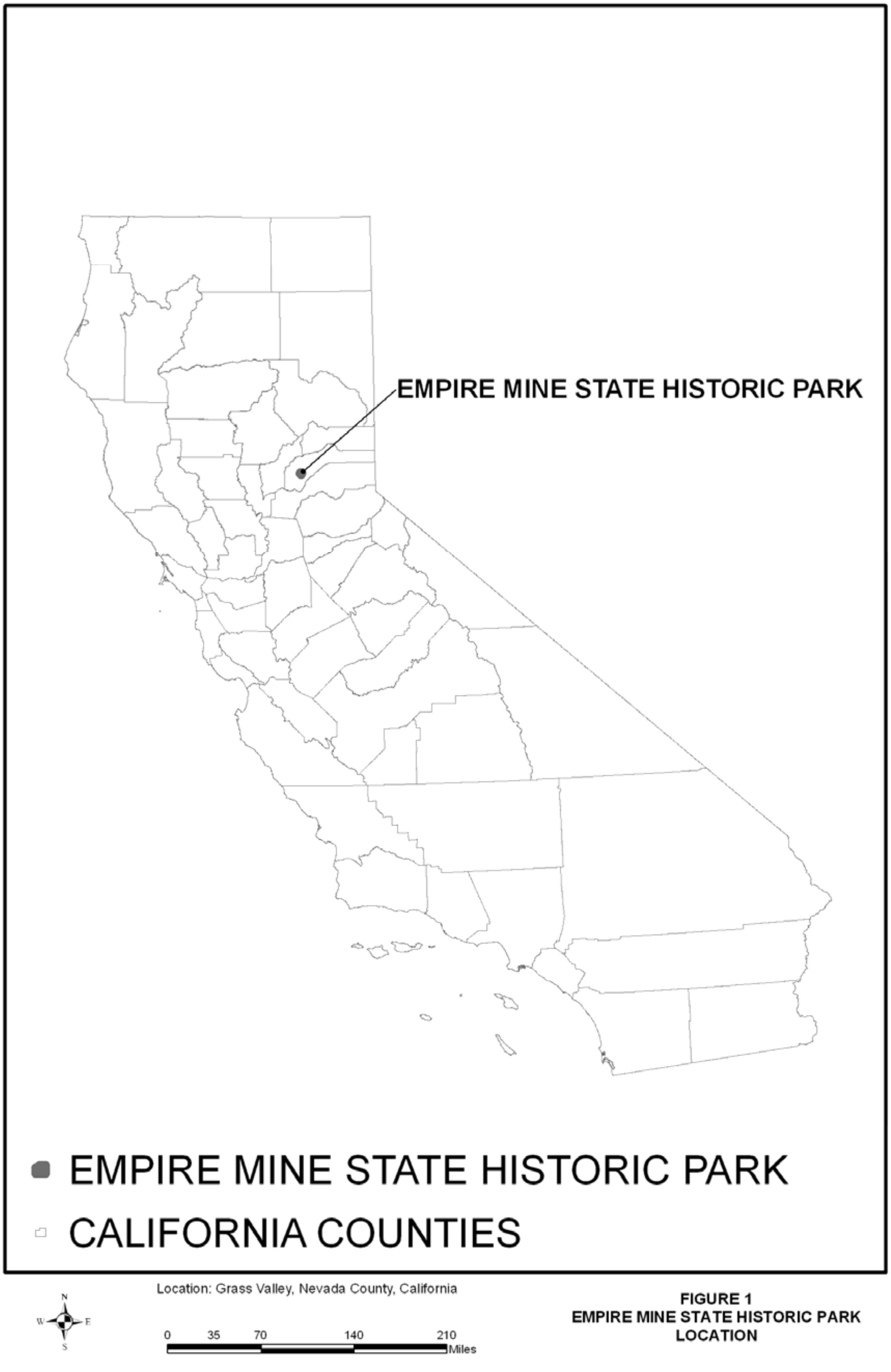
APPENDICES:

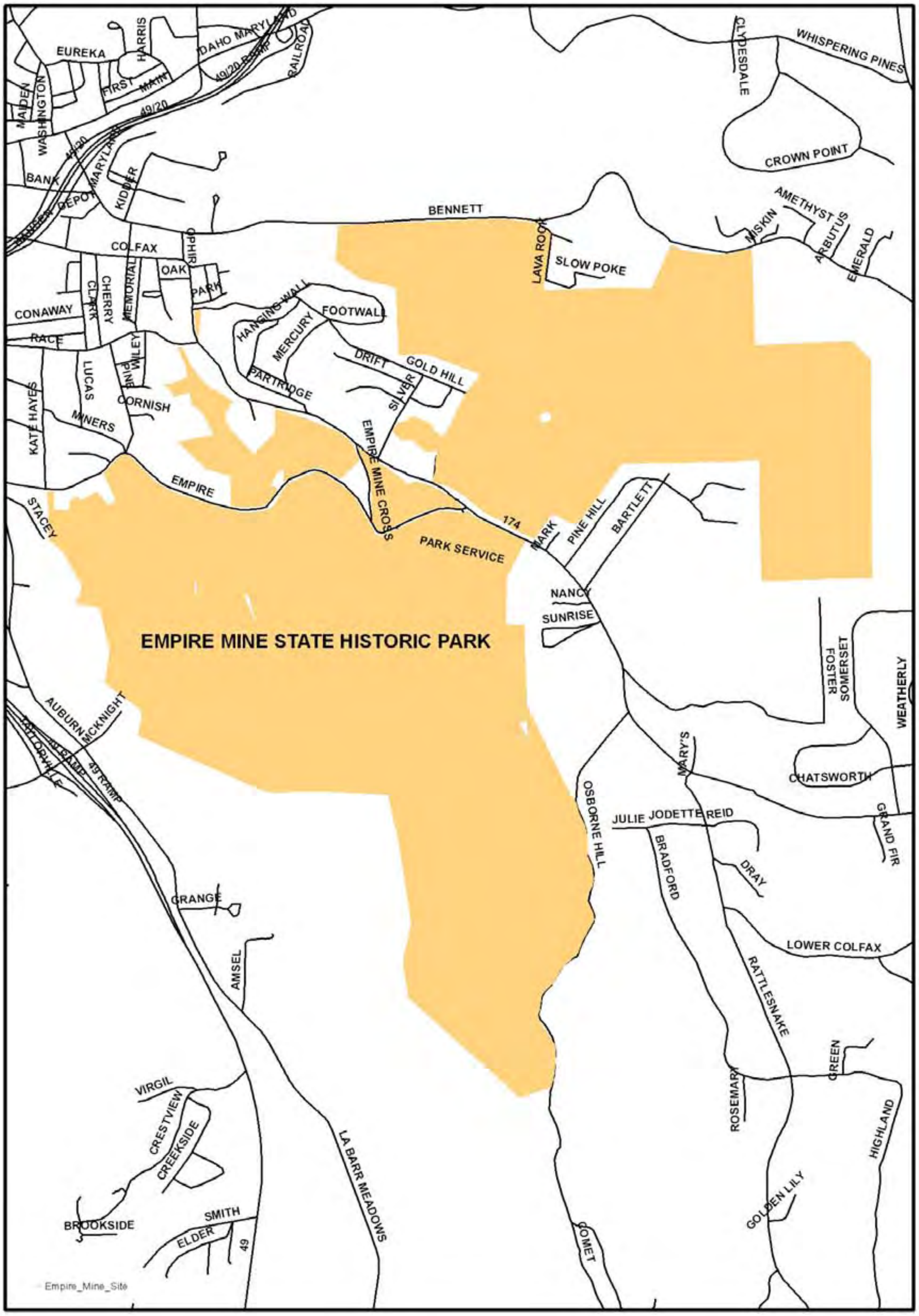
APPENDIX 1

Figures



Location: Grass Valley, Nevada County, California

FIGURE 1
EMPIRE MINE STATE HISTORIC PARK
LOCATION



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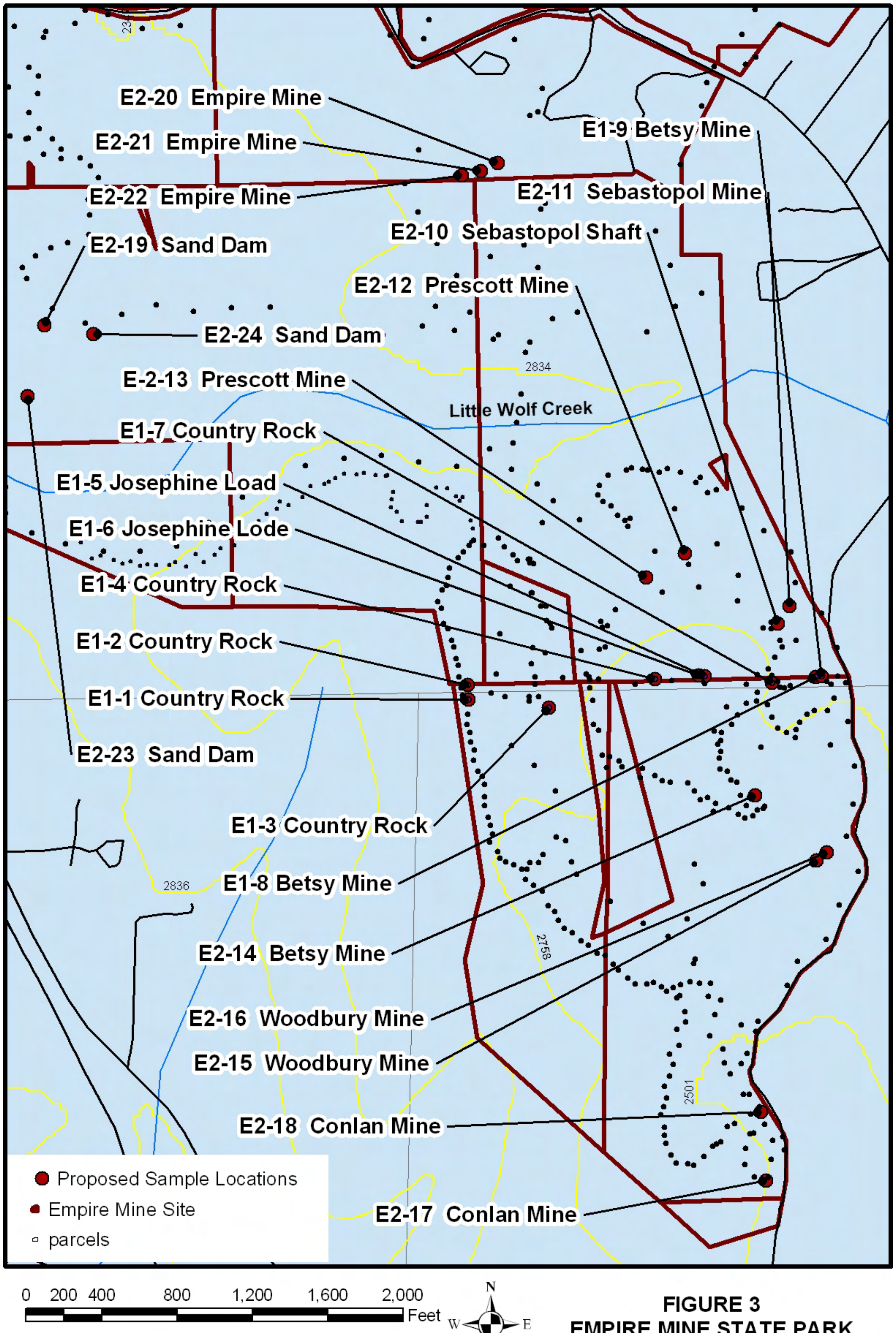
Location: Grass Valley, Nevada County, California
Data Provided Courtesy of Nevada County Department
of Environmental Health.

EMPIRE MINE STATE HISTORIC PARK
LOCATION

0 285 570 1,140 1,710 2,280 2,850
Feet



Data Provided Courtesy of Nevada County Department of Environmental Health, DTSC

FIGURE 3
EMPIRE MINE STATE PARK
PROPOSED SAMPLE LOCATIONS

APPENDIX 2

Standard Operation Procedures for Soil Sampling with Hand Instruments

STANDARD OPERATING PROCEDURE

SOIL SAMPLING with HAND INSTRUMENTS

Scope and Application

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of soil samples using hand instruments. Sampling depths are those that can be reached without the use of powered equipment. These procedures are those typically used and may be changed as required depending on site conditions and equipment used. The actual procedures used should be documented in the site report.

Method Summary

Soil samples may be collected in a number of ways depending on the depth and type of sample required, the soil type and prevailing conditions of the site. Surface samples may be collected using a shovel, trowel or scoop. Deeper samples may be collected using a hand auger, pick and shovel, or other instrument.

Sample Preservation, Containers, Handling and Storage

Chemical preservation of soil is normally not recommended (sulfides are an exception). Soil samples should be cooled and protected from sunlight to minimize potential reaction or minimize biological activity.

Interferences and Potential Problems

Cross contamination and improper sample collection are potential problems. Cross contamination can be eliminated through the use of disposable equipment that is used once for each sample then discarded. Reusable equipment requires adequate cleaning between uses. Improper collection can result in loss of analytes (i.e., volatile components), insufficient homogenization where needed (i.e., field XRF measurements), biased sampling (particle size variations), and insufficient or non-representative sample sizes.

Equipment

Documentation Supplies	
Sampling plan/maps/plot plan	Used to follow approved sampling plan and document actual locations of samples.
Survey equipment/GPS	
Tape measure/compass	
Survey stakes or flags	
Camera/log book/white board	
Sampling Equipment: soil	

Shovel, pick, rock hammer	To remove surface vegetation, rocks, debris & penetrate compacted soil.
Trowels, scoops, shovel, etc.	Disposable & stainless steel. Coring devices & associated tools for sampling volatiles.
Hand Lens	To view fine grained material for soil log
Test Pit Log Form	To log test pits
Bucket Sieve (No 4 Screen)	To reduce sample to fine fraction
Tarp	For air drying samples as required for sieving
Bucket	For storing sample
Labels	For identifying samples
Munsell Color Chart	To provide consistent color in logs.
Containers & Packaging Supplies	
Plastic bags	Appropriate size depending on analyses.
Labels & marking pens	To uniquely identify samples.
Bubble wrap/cushioning materials	To protect samples from breakage.
Shipping tape	To seal shipping container.
Custody seals & chain-of-custody	To maintain & document sample integrity.
Bucket	For storing and shipping sample
Decontamination Supplies	
Buckets & brushes	To clean reusable sampling equipment.
Water sprayer	To clean & rinse sampling equipment.
Detergent & water	
Paper towels/wipes	To speed dry equipment.
Plastic sheets/bags	To protect equipment from contamination.
Large trash bags	To collect discarded supplies & equipment.

Reagents

None required for soil sampling unless field measurements (i.e., soil pH) or preservatives needed (sulfides).

Procedures

1. Preparation

1. Refer to the sampling plan to determine the extent of sampling, methods employed, the types and amounts of equipment and supplies required.
2. Obtain necessary right of entry permit from DPR.
3. Prepare schedules and coordinate with DPR a minimum of seven days prior to initiating field sampling activities. This time will be required so that DPR can schedule an archeologist and, if required, a biologist.

4. Coordinate field activities with USGS personnel.
5. Schedule Track-hoe excavator.
6. Upload GIS Shapefile of proposed sampling locations into field instrument for field verification and sample location.
7. Obtain necessary sampling and monitoring equipment, pre-clean as necessary and verify it is in working order.
8. Perform tail-gate meeting and any general site survey as required by the approved Health and Safety Plan.
9. Identify sampling locations (mark if needed) in accordance with the sampling plan. Adjust locations as needed based on site access and biological and or archeological sensitivities.

2. Sample Collection

Surface Soil Sampling

1. Remove extraneous surface material, such as rocks, glass, vegetation, unless material is pertinent to the project.
2. Using a clean shovel, trowel or other clean soil sampling tools collect samples and field sieve to produce a minimum of 50 pounds of minus No. 4 sieve soil, place in the sampling container. Close & label the container and place in a protective container. Always maintain chain-of-custody of the samples.
3. Observe and note the characteristics of the sample and any striking differences that may suggest a high variability in the subsequent analysis (i.e., abrupt color or texture change, presence of ash or other foreign substance, etc.). Visually apparent attributes may be documented by photography.

Quality Assurance/Quality Control

There are no specific quality assurance (QA) activities that apply to these procedures. The following general QA procedures apply:

1. All data must be documented on field data sheets or site logbooks.
2. All instruments must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and must be documented.

Health and Safety

Follow the approved Health and Safety Plan.

References

U.S. EPA Environmental Response Team, Standard Operating Procedure 2012, 2/18/00.

APPENDIX 3

Standard Operating Procedures for XRF Measurements

Portable X-Ray Fluorescence Operating Procedure

1.0 Scope and Application

The purpose of this Standard Operating Procedure (SOP) is to serve as a guide for the use of a Niton XLt 793 (or equivalent) field portable x-ray fluorescence instrument for screening hazardous elements. This does not replace but augments the manufacturer's operating instructions. The procedures are general operating guidelines which may be changed as required to meet specific needs. This operation procedure may also be substituted using the manufactures standard operating procedure in the event that the equipment described is substituted with a more recent version,

1.1 Principles of Operation

X-ray Fluorescence (XRF) spectroscopy is a nondestructive qualitative and quantitative analytical technique used to determine the chemical composition of samples. In a source excited XRF analysis, primary X-rays emitted from an X-ray tube are utilized to irradiate samples. During interaction with samples, source X-rays may either undergo scattering (dominating process) or absorption by sample atoms in a process known as the photoelectric effect (absorption coefficient). This phenomenon originates when incident radiation knocks out an electron from the innermost shell of an atom creating a vacancy. The atom is excited and releases its surplus energy almost instantly by filling the vacancy with an electron from one of the higher energy shells. This rearrangement of electrons is associated with the emission of X-rays characteristic (in terms of energy) of the given atom. This process is referred to as emission of fluorescent X-rays (fluorescent yield). The overall efficiency of the fluorescence process is referred to as excitation efficiency and is proportional to the product of the absorption coefficient and the fluorescent yield.

1.1.1 Characteristic X-rays

The Niton 7000 series instruments utilize characteristic X-ray lines originating from the innermost shells of the atoms, the K and L shells. The characteristic X-ray lines of the K series are the most energetic lines for any element and, therefore, are the preferred analytical lines. The K lines are always accompanied by the L lines of the same element. However, with energies much lower than those of the K lines, they can usually be neglected for those elements for which the K lines are analytically useful. For heavy elements such as cerium (Ce) (atomic number Z =58), to uranium (U, Z=92), the L lines are the preferred lines for analysis. The Lα and Lβ lines have almost equal intensities, and the choice of one or the other depends on what interfering lines might be present. A source just energetic enough to excite the L lines will not excite the K lines of the same element. An X-ray source can excite characteristic X-rays from an element only if the source energy is greater than the absorption edge energy for the particular line group of the element (e.g., K absorption edge, L absorption edge). The absorption edge energy is somewhat greater than the corresponding line energy.

Energies of the characteristic fluorescent X-rays are converted (within the detector) into a train of electric pulses, the amplitudes of which are linearly proportional to the energy. An electronic multichannel analyzer (electronic unit) measures the pulse amplitudes, which is the basis of a qualitative X-ray analysis. The number of counts at a given energy is representative of element concentration in a sample and is the basis for quantitative analysis.

1.1.2 Scattered X-rays

The source radiation is scattered from the sample by two physical processes: coherent or elastic scattering range (no energy loss), and Compton or inelastic scattering (small energy loss). Thus, source backscatter actually consists of two components with X-ray lines close together. The higher energy line is equal to the source energy. Since the whole sample takes part in scattering, the scattered X-rays usually yield the most intense lines in the spectrum. Furthermore, the scattered X-rays have the highest energies in the spectrum and, therefore, contribute most of the total measured intensity signal.

1.2 Sample Types

Solid and liquid samples can be analyzed for elements Vanadium (V) through Lead (Pb) with the current instrument configuration. The typical application is for heavy metals in soil. Other potential uses include:

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- Heavy metals in industrial waste stream effluents
- Heavy metal air particulates collected on membrane filters, either from personnel samplers or from high volume samplers.
- Heavy metal collected on dust wipes.
- Lead (Pb) in paint (will not meet HUD specifications but can be used qualitatively).
- Prohibited metals in jewelry.

2.0 METHOD SUMMARY

The Niton Portable XLt 793 XRF Analyzer employs an X-ray tube for the production of primary X-rays. Each source emits a specific set of primary X-rays which excite a corresponding range of elements in a sample.

The sample is positioned in front of the source- detector window and sample measurement is initiated which exposes the sample to primary radiation from the source. Fluorescent and backscattered X-rays from the sample enter through the detector window and are counted in the high resolution Si-PIN detector.

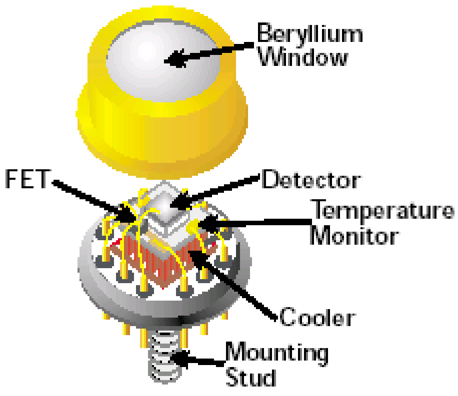


Diagram of the SI-PIN diode x-ray detector

Diagram courtesy of Amptek Corp.

Elemental concentrations are computed as follows:
1) The x-ray intensities in the various energy regions of interest (ROIs) corresponding to the elements of interest are measured and integrated. This gives us the “Raw” count rate.
2) A “blank” (Air) spectrum is subtracted to give a “Net” count rate.
3) A correction is made for the overlapping ROIs of the various elements, i.e., spectrum de-convolution. This gives the “adjusted” count rate.

Note: Steps 2 and 3 above are made possible by the initial calibration step that involves measurement of some 23 standards. These are “air” and pure metals for Alloy mode and “air” and oxides or foils for Bulk and Thin film modes. These measurements produce the **“Cal File”** and its **“inverse matrix”** which is used for spectrum deconvolution.

4) In the bulk (soil) mode the adjusted count rate is first ratioed to the Compton peak.
5) Standard reference materials are measured to relate the adjusted (de-convoluted) and ratioed count rate to concentrations. The slope of the calibration curve generated gives the **Cal Factors**.
6) Element concentration is determined by,

$$\text{ppm} = [\text{adj.cps(element of interest)} / \text{adj.cps(Compton)}] \times \text{CalFactor}$$

The measurement time is manually controlled. Shorter measurement times (30 to 100 seconds) are generally used for initial screening and hot spot delineation, while longer measurement times (100 to 500 seconds) are typically used for higher precision and accuracy requirements.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

This SOP specifically describes equipment operating procedures for the Niton; hence, this section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The total method error for XRF analysis is defined as the square root of the sum of squares of both instrument precision and user or application related error. Generally, the instrument precision is the least significant source of error in XRF analysis. User- or application-related error is generally more significant and will vary with each site and method used. The components of this error are the following.

4.1 Sample Placement

This is a potential source of error because the X-ray signal decreases as the distance from the radioactive source is increased. The variability of this error is minimized by maintaining the same distance for each sample. The magnitude can be reduced by using sampling cups with thin film covering to shorten the distance.

4.2 Sample Representativeness

In order to accurately characterize site conditions, samples collected must be representative of the site or area under investigation. Representative soil sampling ensures that a sample or group of samples accurately reflects the concentration of the contaminant(s) of concern at a given time and location. Analytical results from representative samples reflect the variation in pollutant presence and concentration range throughout a site. Variables affecting sample representativeness include: (1) geologic variability, (2) contaminant concentration variability, (3) collection and preparation variability, and (4) analytical variability. Attempts should be made to minimize these sources of variability.

4.3 Reference Analysis

Soil chemical and physical matrix effects may be corrected by using site-specific soil samples which have been analyzed by Inductively-Coupled Plasma (ICP) or Atomic Absorption (AA) spectroscopy as calibration samples. A major source of error can result if these samples are not representative of the site and/or if the analytical error is large. Additionally, when comparing XRF results with reference analyses results, the efficiency of the sample digestion reference analysis should be considered. Some digestion methods may break down different sample matrices more efficiently than others.

The Niton instrument is capable of Industrial Bulk mode (used when looking for elements at concentrations greater than 1%) that allows for entry of site-specific calibration factors. Otherwise the correction must be performed on the reported results.

4.4 Chemical Matrix Effects (Due to the Chemical Composition of the Sample)

Chemical matrix effects result from differences in concentrations of interfering elements. These effects appear as either spectral interferences (peak overlaps) or as X-ray absorption/enhancement phenomena. Both effects are common in soils contaminated with heavy metals. For example, iron (Fe) tends to absorb copper (Cu) X-rays, reducing the intensity of Cu measured by the detector. This effect can be corrected mathematically through the use of FP coefficients. Conversely, iron fluorescence can excite elements of lower atomic number (e.g., chromium) increasing the intensity measured.

4.5 Physical Matrix Effects (Due to Sample Morphology)

Physical matrix effects are the result of variations in the physical character of the sample. They may include such parameters as particle size, uniformity, homogeneity, and surface condition. For example, consider a sample in which the analyte exists in the form of very fine particles within a matrix composed of much courser material. If two separate aliquots of the sample are prepared in such a way that the matrix particles in one are much larger than in the other, then the relative volume of analyte occupied by the analyte-containing particles will be different in each. When measured, a larger amount of the analyte will be exposed to the source X-rays in the sample containing finer matrix particles; this results in a higher intensity reading for that sample and, consequently, an apparently higher measured concentration for that element.

4.6 Mode Error

Generally, the error in the mode calibration model is insignificant (relative to the other sources of error) **PROVIDED** the instrument's operating instructions are followed correctly. However, if the sample matrix varies significantly from the design of the application, the error may become significant (e.g., using the soils application to analyze a 50 percent iron mine tailing sample).

4.7 Moisture Content

Sample moisture content will affect the analytical accuracy of soils or sludges. The overall error may be secondary when the moisture range is small (5-20 percent), or it may be a major source of error when measuring the surface of soils that are saturated with water.

4.8 Cases of Severe X-ray Spectrum Overlaps

When present in the sample, certain X-ray lines from different elements can be very close in energy and, therefore, can interfere by producing a severely overlapped spectrum. The typical spectral overlaps are caused by the Kβ line of element Z-1 (or as with heavier elements, Z-2 or Z- 3) overlapping with the Kα line of element Z. This is the so-called Kα /Kβ interference. Since the Kα :Kβ intensity ratio for the given element usually varies from 5:1 to 7:1, the interfering element, Z-1, must be present in large concentrations in order to disturb the measurement of analyte Z. The presence of large concentrations of vanadium (V) could disturb the measurement of chromium (Cr). The V Kα and Kβ energies are 4.951 and 5.427 Kev, respectively. The Cr Kα energy is 5.41 Kev. The resolution of the detector is approximately 250 eV. Therefore, large amounts of V in a sample will result in spectral overlap of the V Kβ with the Cr Kα peak (see Figure 1, Appendix A) and the measured X-ray spectrum will include TOTAL counts for Cr plus V lines.

Other interferences arise from K and L line overlaps, for example, the As Kα (10.54 keV) and the Pb Lα (10.55 keV). In this case, Pb can be measured from the Pb Lβ line, and arsenic from the As Kα line; this way the unwanted interference can be corrected. However, due to the limits of mathematical corrections, measurement sensitivity is reduced. Generally, arsenic concentrations can not be efficiently calculated in samples with Pb:As ratios of 10:1 or more. This may result in zero arsenic being reported regardless of what the actual concentration is.

The Niton uses overlap factors to correct for X-ray spectral overlaps for the elements of interest for a given mode.

5.0 EQUIPMENT/APPARATUS

5.1 Description of the Niton System

The analyzer utilizes the method of Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometry to determine the elemental composition of soils, sludges, aqueous solutions, oils, and other waste materials.

The Niton XLt 793 analyzer owned by DTSC uses an X-ray tube to generate the x-rays. Each unit is equipped with a high resolution silicon PIN detector. The instrument can store up to 3,000 readings and spectra in nonvolatile memory. The data can be downloaded for use in the software provided. The software allows for exporting the data into Excel or other applications. The on-board screen displays the concentration for the multiple elements detected. The replaceable and rechargeable battery provides for field portable operation.

The Niton is supplied with factory installed modes. The "Bulk Sample Mode" is for analysis of soils where the balance of the sample (that portion not directly measured by the instrument) is silica (SiO_2). The units can be adapted to measure filters and wipes, as well as, a broad set of elements.

The units can be powered using a 115-volt supplied charger or the rechargeable batteries. (Note: When the unit is powered by the charging unit the battery will not charge.) It can be operated in temperatures ranging from 32 to 120^o Fahrenheit (F).

5.2 Equipment and Apparatus List

5.2.1 Niton Analyzer System

The currently owned XLt 793 Analyzer System includes:

The analyzer unit using a miniaturized x-ray tube, two rechargeable batteries, a battery charger, waterproof carrying case, data cable for downloading port, built-in barcode scanner for data entry, and shielded belt holster with belt. Contained in a separate carrying case are a testing stand with calibration check standards, sample grinding equipment, sieves, Mylar film, and a utility box.

5.2.2 Limits and Precautions

1. The measurement window should always be in contact with the surface of the material being analyzed (separated by a thin film or bag), and that material should completely cover the probe opening (aperture) when x-rays are emitted by the instrument. Do not move the instrument while the indicators show that the shutter is open.

2. When x-rays are emitted, under no circumstances should the unit be pointed at the operator or surrounding personnel.

3. Do not place any part of the operator's or coworker's bodies in line of exposure when the sources are exposed or partially covered.

4. Niton Corporation should be notified immediately of any condition or concern relative to the instrument's structural integrity, source shielding, or operability.

5. The appropriate section of the California Department of Health Services must be notified immediately of any damage to the radioactive sources, or any loss or theft of the device (see factory supplied data on radiological safety).

6. The source(s) in the Niton 732Q must be leak tested every 6 months as described in the manual. The leak test certificates must be kept on file, and a copy must accompany the instrument at all times.

7. During operation, the probe should be kept at least 10 feet from computer monitors and any other source of radio frequency (RF) to avoid a possible reduced resolution. Some monitors have very poor RF shielding and may affect measurement results.

8. The Niton should not be dropped or exposed to conditions of excessive shock or vibration.

Additional precautions include:

1. The Niton should not be stored at an ambient temperature below -4^{o}F or above 110^{o}F.

2. The battery charging unit should only be used indoors in dry conditions.

3. Battery packs should be changed only in dry conditions.

5.3 Peripheral Devices

5.3.1 Communication Cable Connection

XLt 793: Connect the DB9 connector on the serial cable into the COM port on your computer. Insert the micro stereo connector on the serial cable into the port in the handle of the XRF Analyzer.

XL 732: A LIMO to 9-pin RS-232 connector cable is provided for connecting the Niton to the computer.

5.3.2 Communication Port Setup

The software provided is easy to install and will handle the setup. Electronic manuals are installed with the software and are clearly written. The software allows for controlling the instrument via the computer, downloading the readings and spectra, printing reports and export of the data (including spectra) into other software.

5.4 Instrument Maintenance

5.4.1 Measurement Window

Should the window become damaged or punctured, it should be replaced as soon as possible to prevent dust and moisture from entering the instrument. The Niton manual provides a clear description for replacing the Kapton window. The window should be kept clean using a cotton swab. Do not use detergents or solvents to clean the instrument.

5.4.2 Further Information and Troubleshooting

Refer to the Niton Operating Instructions for additional detailed operational and/or maintenance and troubleshooting instructions. If no solution is found in the manual, contact Niton Corporation for assistance. An instrument log should be maintained to document specific corrective actions taken to alleviate any instrumental problems, and for recording any service that has been performed.

6.0 STANDARDS

Generally, calibration standards are not necessary for site screening and determining the extent of contamination using the Niton. The unit performs a self-calibration. As a check Standard Reference Materials (SRMs) are provided to verify that the instrument is performing properly. National Institute of Standards and Technology (NIST) SRMs 2709, 2710, and 2711 are stored in the test stand for this purpose. The Industrial Bulk Mode is an option available with the Niton XLt 793 that allows for altering the calibration factors. Refer to the manual before attempting this.

For long term or ongoing projects, analyses can be optimized or verified to be proportional to another analytical (reference) method. This can be done be analyzing a suitable set of Site-Specific Calibration Standards (SSCS) or Standard Reference Materials (SRMs) and performing a regression analysis on the reference (dependent) and Niton results (independent) for each element of concern.

7.0 PROCEDURE

7.1 Prerequisites

If the Niton will be used in a location where AC power outlets are conveniently accessible, connect the battery charger to the attached battery and plug the charger cord into the outlet. Power the Niton down before disconnecting from the power source.

The Niton is designed to operate from rechargeable batteries and comes with two batteries. Each battery should last for a full four hours of use.

Follow operating instructions for turning on the Niton and allow 15 minutes for warm-up. The XLt 793 will require entering a pass code to reach the main menu. The stored analysis results will include the time and date of analysis. Following warm-up, initiate calibration.

7.1.1 Setting Mode

The XLt 793 includes a Thin Sample Mode that provides for testing dust wipes and filters. Follow instructions to insure that the proper mode has been selected: normally the Bulk Sample Mode.

7.2 General Keys and Menu Software

XLt 793

The unit is manually operated using two buttons, a 4-way touch pad, & a LCD touch screen. The left button turns the instrument on and off, and escapes up menu from the current screen. The right button (called the clear/enter button) has different functions depending on the current screen. The 4-way touch pad allows movement within the screen chosen.

One of the easiest methods of operation is to use the touch screen with your finger or a provided stylus. This allows entry of information such as sample number, site, sampler, and other pertinent information, via an alpha numeric screen. Information can also be entered using a barcode reader.

The operator must become familiar with the operation of the instrument and the various menu options. The operator must check to see that the date and time are correct, the screen display is set up as desired, and the proper measurement mode selected. While the triggers to initiate a measurement may be different the following steps are the same.

7.3 Preoperational Checks

7.3.1 Calibration

The Niton performs a self calibration. This should be done following warm-up and prior to taking any measurements. The screen should display the resolution. Look for the resolution to be near 200 eV. If the resolution is abnormally high, allow additional time for warm-up then recalibrate. Poor resolution may be due to inadequate warm-up, high ambient temperature, radio frequency interference, or failure of the instrument. The instrument should be recalibrated if it is turned off for more than 30 minutes or if there has been significant changes in ambient temperature. It is recommended that recalibration occur with each shift (at lunch and dinner breaks, or change of operators).

7.3.2 Blank (Zero) Sample Check

The blank sample provided with the instrument is used to verify that there is no residual contamination attached to the instrument. The blank is composed of silicon dioxide (SiO_2) and should provide below detection level readings for all of the elements reported. The blank sample check should be performed after calibration and between readings of high level samples. It should be used whenever there is a chance of cross-contamination which can occur when the samples undergo a great deal of handling or the instrument is not properly protected.

7.3.3 Target Element Response Check

The purpose of the target element response check is to ensure that the instrument and the selected application are working properly prior to performing sample analysis. This check should be performed at the beginning of the day. One strategy is to use low, mid, and high samples, or standards with known concentrations for some or all of the target elements to be checked. You may choose to select a low sample near the quantitation limit of the target elements, or a mid sample near the site action level and/or a high sample near the maximum concentration of the target elements expected on site. Your approach will depend on your overall data quality objectives and sampling strategy.

7.4 Selecting Source Measuring Time

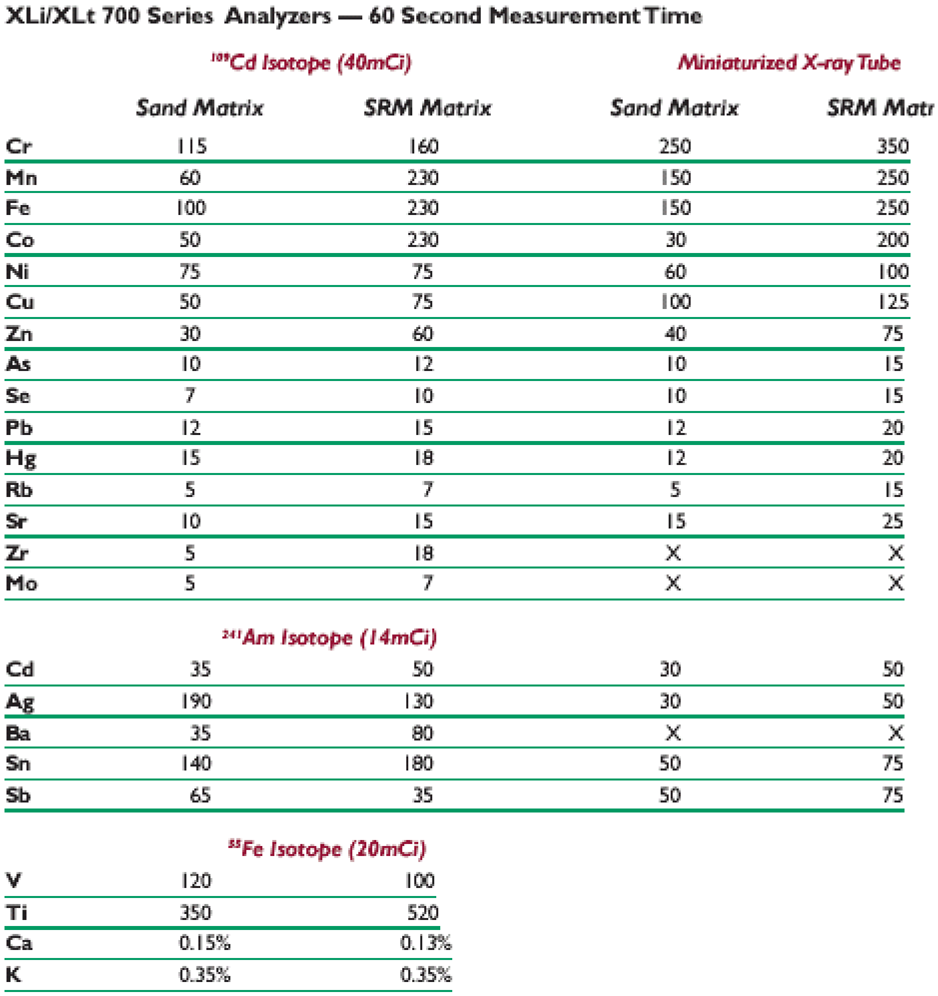
7.4.1 Minimum Source Measuring Times

The measurement time necessary will depend on the project objectives, the sensitivity of the instrument for the elements of concern, and the site threshold levels. Measuring times for a source that excites a target element can be increased if lower detection limits are required. In many cases the measurement can be stopped once the element is detected, especially when scouting for hot spots or delineating a given area.

7.4.2 Typical Minimum Detection Limits (MDLs) for the Soil Samples Application

Below are listed the MDLs for Xli & XLt 700 series analyzers at the time of this writing. The particular instrument used may differ from these.

NOTE: These typical MDLs are provided as an aid for selecting source measurement times; observed values for a given situation may vary depending on the matrix of the soil standard used to calculate MDLs, age of sources, moisture content, and other factors discussed in Section 4.



XLi/XLt 700 Series Analyzers — 60 Second Measurement Time

	^{109}Cd Isotope (40mCi)		Miniaturized X-ray Tube	
	Sand Matrix	SRM Matrix	Sand Matrix	SRM Matr
Cr	115	160	250	350
Mn	60	230	150	250
Fe	100	230	150	250
Co	50	230	30	200
Ni	75	75	60	100
Cu	50	75	100	125
Zn	30	60	40	75
As	10	12	10	15
Se	7	10	10	15
Pb	12	15	12	20
Hg	15	18	12	20
Rb	5	7	5	15
Sr	10	15	15	25
Zr	5	18	X	X
Mo	5	7	X	X
	^{241}Am Isotope (14mCi)			
Cd	35	50	30	50
Ag	190	130	30	50
Ba	35	80	X	X
Sn	140	180	50	75
Sb	65	35	50	75
	^{55}Fe Isotope (20mCi)			
V	120	100		
Ti	350	520		
Ca	0.15%	0.13%		
K	0.35%	0.35%		

Generally, the detection limit is reduced by 50 percent for every four-fold (x4) increase in source measuring time. Additionally, more elements may be added to the application. Contact Niton for information about modifications to applications.

7.4 Sample Handling and Presentation

When making XRF measurements, be sure to maintain constant measurement geometry in order to minimize variations in analysis results. Document any anomalies in measurement geometry, sample surface morphology, moisture content, sample grain size, and matrix (see Section 4.0).

7.5.1 Soil Samples

Soil samples may be analyzed either in-situ or in prepared X-ray sample cups. The Bulk Sample Mode assumes the sample to be infinitely thick. For in-situ measurements this is almost always the case. However, for sample cup or bagged sample measurements it is advisable to present a minimum of 1 cm soil thickness to the instrument. When using the cup tap it on the bench to compact the soil. This ensures that the sample is as uniformly thick as possible from analysis to analysis. The Niton test stand should be used when analyzing sample cups.

An area for in-situ analysis should be prepared by removing large rocks and debris. The soil surface should be rendered flat and compact prior to analysis. The Niton should be held firmly on the ground to maximize instrument contact with the ground (avoid rough surfaces that may damage the window). The probe should not be moved during analysis. Analysis of water saturated soils should be avoided. A thin layer of 0.2-mil polypropylene XRF film may be mounted on the surface probe to minimize contamination. Use of varying thicknesses of plastic (bags) has been shown to interfere in the measurement of light elements (low atomic number). Additionally, plastic may contain significant levels of target element contamination.

Course-grained soil conditions or nuggets of contaminated material may preclude a truly representative sample and adversely affect the analysis results (typically by under reporting the target element). Such samples should be prepared before analysis. Preparation consistency is important to minimize variation in analytical results.

This application is specifically designed for soil with the assumption that the balance of the material is silica. If samples with a much lighter (lower atomic number) balance are analyzed, the results will typically be elevated by a factor of two to four.

7.5.2 Thin (Filter) Samples

The Thin Sample Mode is for analysis of thin samples such as filters or wipes. The detection limits are affected by the thickness of the substrate. Best results are obtained on the thinnest substrates. Always use the test stand for safety and for a controlled background.

Filters and wipes should be prescreened before use to establish background and contamination levels. Check disposable gloves for powder that may contain zinc oxide instead of cornstarch. The Niton User’s Guide should be consulted in the proper application of this method.

8.0 CALCULATIONS

The Niton is a direct readout instrument that does not require any calculations.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

9.1 Precision

The precision of the method is monitored by reading a low- or mid-target element concentration sample (or SSCS or SRMs selected as described in Sections 6.0) at the start and end of sample analysis and after approximately every tenth sample. (A daily total of seven measurements is recommended.) Determining the precision around the site action level can be extremely important if the XRF results are to be used in an enforcement action. Therefore, selection of a sample with a target element concentration at or near the site action level or level of concern is recommended. The sample is analyzed by the instrument for the normal field analysis time, and the results are recorded. The standard deviation for each target element is calculated. The relative standard deviation (RSD) of the sample mean can be used to calculate precision. The RSD should be within ± 20 percent for the data to be considered adequately precise. (3)

9.1.1 The Method Detection Limit (MDL) and Method Quantitation Limit (MQL)

The MDL and MQL may be calculated from the measurement of a low sample (or a SSCS or SRMs selected as described in section 6.0), at the start and end of sample analysis, and after approximately every tenth sample (a daily total of seven measurements is recommended). Measure the sample using the same mode and measuring time used for the samples.

The sample standard deviation of the mean for each target element is calculated. If the standard deviation has a fractional component, round up to the next whole number prior to calculating the MDL and MQL. The definition of the MDL is three times the calculated standard deviation value. The MQL generally falls between 5 and 10 times the calculated standard deviation value. (The MQL can only be verified by analysis of split samples.) The estimate gives the operator a feel for when the results should be more accurate.

9.2 Reporting Results

All raw XRF data should be reported including the individual results of multiple analyses of samples and sampling points. The average and concentration range of each multiple analysis should also be reported. A "reported" value for each analysis or average of multiple analyses should be processed in the following manner.

1. Round the value to the same degree of significance contained in the SSCS or SRM sample assay values (usually two significant figures) for sample results. DO NOT round results for standards used to determine MDL or RSD values (use raw data).

2. Report all values less than the MDL as not detected (ND).

3. Flag and note all values greater than or equal to the MDL and less than the MQL (usually with a "J" next to the reported value). The MQL can be defined as 10 times the calculated standard deviation unless otherwise known.

4. Report all values equal to or greater than the MQL and within the linear calibration range (if the element's calibration has been adjusted [see section 6.0]).

5. Flag and note all values above the linear calibration range (greater than the highest SSCS used in the calibration adjustment procedure) if SSCS were used and the calibration was adjusted.

9.3 Accuracy

Accuracy, relative to a specific digestion method and elemental analysis procedure, is determined by submitting an XRF analyzed sample (prepared sample cups may be submitted) for AA or ICP analysis at a laboratory.

The on-site analysis of soils by XRF instrumentation should be considered a screening effort only. Data derived from the instrument should be used with discretion. Confirmatory analyses on a subset of the screening samples (minimum 5 percent) can be used to determine if the XRF data meets data objectives. The confirmation samples should ideally be selected randomly from the sample set and include a number of samples at or near the critical level. The results of the metal analysis (dependent) and the XRF analysis (independent) are evaluated with a regression analysis. The correlation factor (R^2) should be 0.7 or greater. (3)
[Note: If the 5% confirmatory samples fall below 10 in number, then judgmentally select 10 samples whose concentration is spread out over the range of observed values. Avoid submitting several samples having the same value.]

XRF results may be multiplied by the slope prior to substitution for metal analysis results in contouring, kriging programs, or removal volume estimates. Correcting the XRF results based on confirmatory analyses should only be undertaken after careful consideration. It must be understood that the confirmatory analysis (AA or ICP) is an estimate of the concentration of metal contamination and is dependent upon the specific instrumentation and sampling methodology used. Since XRF is a total elemental technique, any comparison with referee results must account for the possibility of variable extraction, dependent upon the digestion method used and its ability to dissolve the waste or mineral form in question. If the XRF results will be corrected using the confirmatory analysis results, then 10 to 20% of the samples should be submitted for analysis to provide a good basis for corrections.

9.3.1 Matrix Considerations

Other types of QA/QC verification should include verification that the instrument calibration is appropriate for the specific site to be assessed. This includes verification of potential multiple soil matrix types that may exist at a site. Matrix differences which affect the XRF measurement include large variations in calcium content, which may be encountered when going from siliceous to calcareous soils, as well as large variations in iron content.

10.0 DATA VALIDATION

10.1 Confirmation Samples

Confirmation samples are recommended at a minimum rate of 5 percent (preferably 10 percent) as required by the data objectives established for site activities. Ideally, the sample cup that was analyzed by XRF should be the same sample that is submitted for AA/ICP analysis. When confirming an in-situ analysis, collect a sample from a 6-inch by 6-inch area at 1 inch depth for both an XRF measurement and confirmation analysis.

The XRF and metals results are analyzed with a regression analysis using a statistical program such as SAS® or Statgraphics® with the slope and intercept calculated in the regression. The correlation factor between XRF and AA/ICP data must be 0.7 or greater for qualitative screening data objectives.

10.2 Recording Results

Maintain field notes on activities. Keep track of sample locations, sample numbers and Niton reading number. Any data entry errors made with the Niton are permanently recorded and can not be altered using the software provided. Field notes will be needed to correct errors in the final report.

10.3 Downloading Stored Results and Spectra

Results and spectra which have been stored in the Niton internal memory should be downloaded and captured in disk files on a PC (see section 5). Niton provides software for this purpose. Additionally, they provide software to prepare results or spectra for importing into a spreadsheet. Refer to the instructions provided with the programs for details on their operation. After capturing results to a file, print a copy and save both the disk files and the printout for future reference and documentation purposes.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow DTSC health and safety practices. Follow Calif. DHS regulations regarding radiation safety requirements and monitoring.

12.0 FOOTNOTES

(1) U.S. EPA/ERT, “Spectrace 9000 Field Portable X-Ray Fluorescence Operating Procedures,” 1/26/95 SOP#1713.

(2) Kalnicky, Dennis, “Effects of Thickness Variations on XRF Analyses of Soil Samples When Using Plastic Bags as Measurement Containers,” U.S. EPA Contract No. 68-03-3482.

(3) U.S. EPA, Environmental Technology Verification Report, “Field Portable X-Ray Fluorescence Analyzer, Niton XL Spectrum Analyzer,” EPA/600/R-97/150, March 1998.

13.0 REFERENCES

1. Niton XLt 700 Series Environmental Analyzer User’s Guide, Version 3.5.

2. USEPA Method 6200, Test Methods for Evaluating Solid Waste, January 1998.

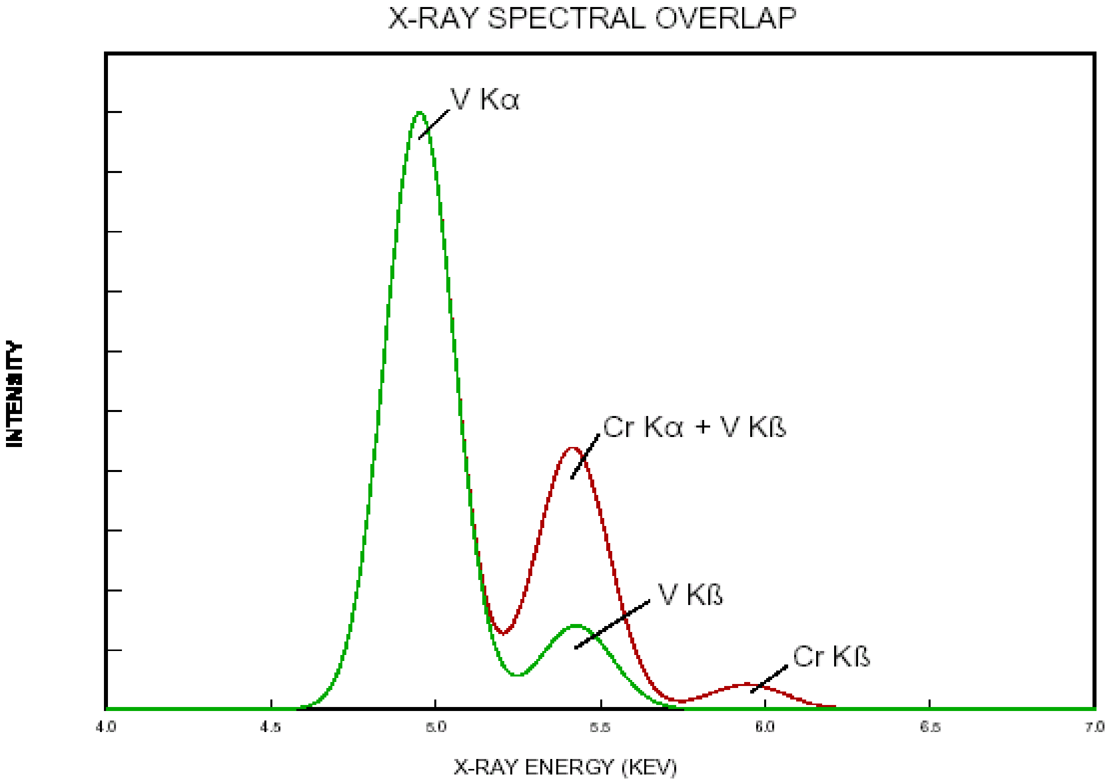
APPENDIX 3 (Continued)

Standard Operating Procedures for XRF Measurements

Section A, Figures

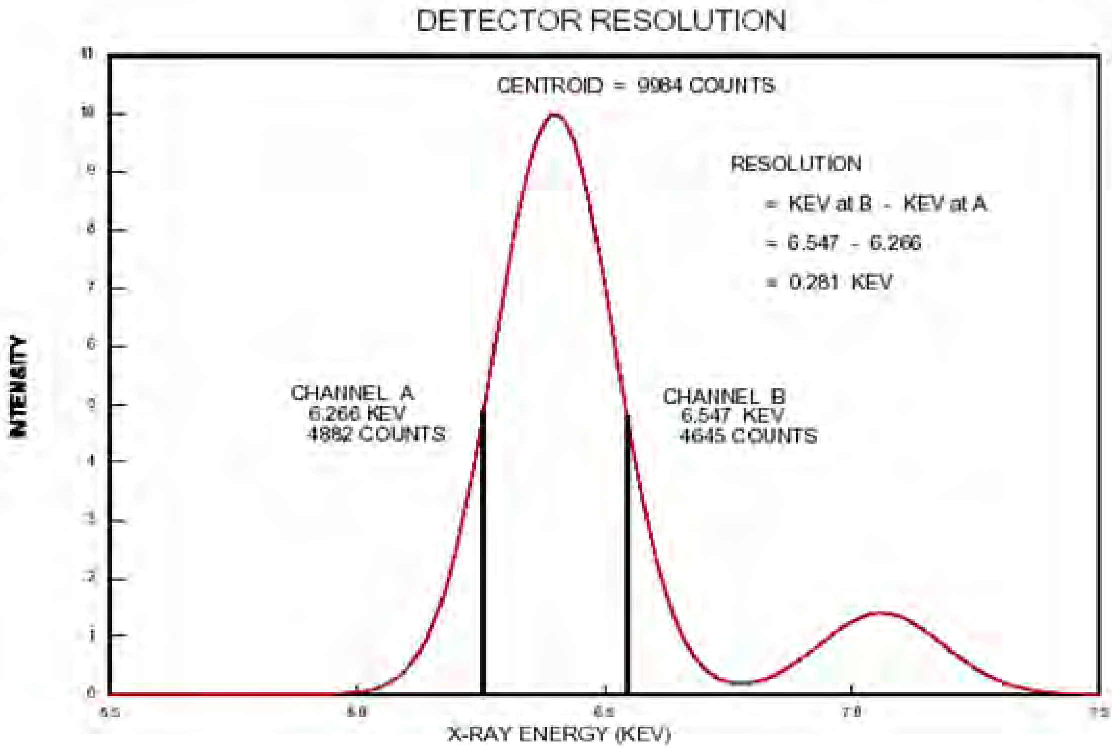
Figures

FIGURE 1. X-Ray Spectral Plot Showing Overlap of Vanadium K_{β} X-Rays in the Chromium K_{α} Measurement Region.



Figures

FIGURE 2. Iron X-Ray Spectrum Illusrating Detector Resolution Measurement



APPENDIX 3 (Continued)

Standard Operating Procedures for XRF Measurements

Section B, Field Measurements

The accuracy of the field XRF is very dependent on the sample preparation. The data quality objectives for the project will determine the best approach. For instance, if the purpose is to determine whether high levels exist, to get a general idea of the extent of contamination, or to select samples for laboratory analysis, then the accuracy of the measurements are not as important as the relative results among samples tested. In these cases emphasis should be placed on the consistency of the sample preparation so that results are repeatable if not directly comparable to standard laboratory analysis. If the data must stand on its own or be used to make critical decisions, then extensive sample preparation may be required.

In-Situ Field Preparation

Direct readings of the soil are not recommended. At a minimum the soil should be homogenized, screened and packed prior to measurement.

Example 1: Remove debris and vegetation from the soil surface. Using a trowel homogenize the soil surface to the desired depth. Remove the soil and pass it through a screen back onto the ground discarding material not passing the screen. Compress the soil flat using a tool. Place mylar film or other suitable material over the soil to protect the instrument. Take a measurement. For increased accuracy, move the instrument and take an additional reading on another portion of the same soil and average the results. [Duplicate readings may indicate how well or poorly the soil was homogenized.]

Example 2: Perform the same steps as above except place the screen containing the soil inside a large zip-lock bag and perform the sieving inside the bag. This serves to minimize dust creation and potential cross-contamination. Remove the screen and discard the extraneous material. Close the bag and rotate end over end in such a way that the soil is mixed. As you rotate the bag the soil should fall as in a ball mill and this can be accomplished by alternately grabbing the corners of the bag and rotating like a pinwheel. If the soil is dry, 10 rotations should be sufficient. A direct reading through the bag can be performed; the soil can be placed on the ground and measured as in example 1; or the soil placed into a thinner bag prior to reading.

Example 2 is technically an ex-situ method meaning that the sample is not analyzed in its original position.

Ex-Situ Measurement

Ex-situ methods are generally characterized by a more extensive sample preparation including placement into a sample cup for measurement. Improved accuracy can be achieved by drying, grinding, sieving, and thorough homogenizing.

Example 3: A field sample that has been coarsely screened is obtained and dried at 110^{o} C for 2 hours. The sample is ground until it passes a 60 mesh or finer screen. As necessary it is further homogenized then placed into sample cups covered with thin mylar film. The sample is placed into a holder and measured.

The example 3 scenario is usually accomplished when a field lab with supplied power can be used or the samples are taken to a remote location. To the extent any of these steps can be accomplished the results will gain in accuracy. If the soil is wet a reduction in moisture will improve results but may be difficult to accomplish in the field.

Moist samples can be sequentially spread onto plastic sheets and allowed to air dry. After laying out the last sample for drying the first sample may have lost sufficient moisture to proceed with analyzing. A portable camp stove or oven may be used. Grinding of the samples can be accomplished with a mortar and pestle. Fine sieving can only be done if the samples are fairly dry and well ground. Obviously weather conditions, such as wind or fog, will preclude some options. Care must be taken to ensure that staff is not unduly exposed to contamination when trying different innovations.

The only other variables that affect results and you have control over is measurement time and the number of measurements. As you extend the time of measurement the detection limit decreases but with diminishing returns. By averaging the results of multiple measurements (when measuring different portions of a sample or duplicate samples of the same location) your accuracy will be improved.

Quality Objectives and Sampling Strategies

A well thought out sampling plan will use the advantages of the instrument while minimizing the limitations. The constraints of or needs for time, accuracy, detection limit, staffing levels, costs, etc. are balanced to achieve the objectives. Consider these scenarios:

1) If your objective is to test for lead about housing in accordance with HUD standards then part of the sampling protocol will focus on the top ½ inch of soil. You can take multiple discrete or composite samples. The number of composites will be limited by your detection limit against the maximum allowable concentration and your estimated accuracy. You can lower your detection limit by increasing the measurement time. If you have a team, then some members can composite and prepare the samples while one member takes extended measurements. If staff is limited then discrete samples may be more efficient by keeping measurement times short allowing more time for preparation. If sample preparation is minimal, potentially leading to inaccurate results, then the maximum allowable concentration by XRF can be lowered as a

conservative cushion. Samples with results exceeding this lowered limit can be sent to a laboratory for accurate assessment but adds to the cost.

This example illustrates some of the considerations involved. For a very large project an initial quick survey may be useful to determine the levels likely to be found. If concentrations fall near the maximum allowed concentration then XRF may not be the best option, especially if background levels are high.

2) If you are doing an initial assessment of a mine site you are likely to encounter everything from rock & coarse gravel to processed fines. Your main objective may be to find the highest levels and locate general areas of concern. The coarse material becomes a hazard to the instrument's window and care must be exercised to avoid rough edges from damaging the window. By not being able to bring the instrument flush with the rock or gravel your accuracy is degraded. You must be aware that the instrument reads only a very small portion of material so that the same piece of sample can give vastly different readings across its surface. Here an experienced geologist can be invaluable in helping to identify suspect material and help interpret the results. The fines are easier to deal with.

Considerations in this example include the need to compare background levels in the area with site samples. The material is naturally occurring and the readings must be placed in context. By necessity the sample preparation for the site samples and background may be different and require interpretation. The elements of concern may be detected only at high concentrations by the instrument. The instrument is set up for soil which is weathered rock containing elements not detected by the instrument, such as, silicon, aluminum, carbon, oxygen, etc. The instrument algorithms may not appropriately compensate for the composition of the coarse material and even the fines, depending on how they were processed. Nontarget elements may interfere with proper measurement of target elements. Acquiring knowledge of the site history, bringing knowledgeable staff and taking numerous measurements may be the most important factors in your success.

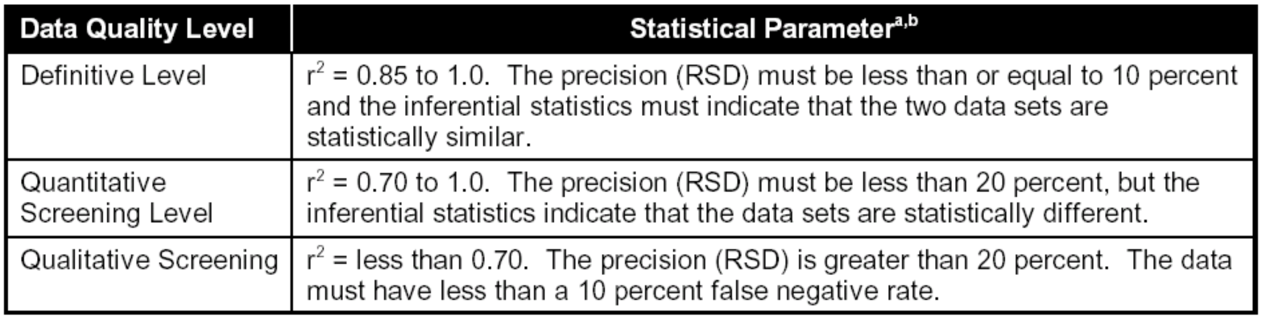
3) If you are conducting a regulatory inspection, it is unlikely that you would use the XRF data alone for enforcement purposes. It does have great potential in identifying materials for sampling since heavy metals frequently are found in hazardous waste. With the exception of spillage onto soil, the samples measured will not be soil-like. Therefore the results will be inaccurate. The relative concentrations between samples of like material should be consistent. In some situations it may be better to switch the instrument out of the bulk soil mode.

The type and number of samples gathered for enforcement purposes are driven by the findings made during the inspection or are based on previous knowledge. Make certain that the instrument can detect the elements of concern at the levels needed. Compare measurements of like materials when selecting samples for laboratory analysis. Use positive results to select samples but do not rule out the gathering of samples when the XRF gives low or negative results. Do not compare site samples with background samples using only the XRF data. For instance, petroleum laden site soil may be biased and not be comparable to background soil samples. Measure at least one standard soil and a blank before and after taking site measurements. Run blank samples often while sampling to ensure there is no cross-contamination between measurements which could discredit your findings. Concentrations at hazardous waste sites can be very high and housekeeping poor. Instrument cleanliness is an important concern.

4) One of the most beneficial uses of an XRF is in determining the thoroughness of a cleanup during the process. Great savings can be achieved by not have to demobilize and later remobilize workers and equipment during a cleanup. If the cleanup concentration is well within the range of the instrument acceptable data is achievable. Many of these site cleanups will have trailers, a portion of which can often be set aside for XRF measurements. Power is frequently available. Since cleanups take days to weeks to accomplish, time is not a critical factor. Confirmation of the results is critical and selected samples should be sent to a laboratory.

As areas are cleaned, the XRF can be used for confirmation sampling using the techniques illustrated in examples 1 through 3, and by using conservative threshold levels. A portion of the samples are sent to a laboratory to verify the accuracy. Always send the same sample measured by the XRF to the laboratory and not a duplicate. Initial results will indicate how close the XRF results are to those of the laboratory. Adjustments can then be made to the sample preparation, number and duration of measurements or to the XRF cleanup level as the activities continue.

Section C, Determining Data Quality



Data Quality Level	Statistical Parameter[a,b]
Definitive Level	r^2 = 0.85 to 1.0. The precision (RSD) must be less than or equal to 10 percent and the inferential statistics must indicate that the two data sets are statistically similar.
Quantitative Screening Level	r^2 = 0.70 to 1.0. The precision (RSD) must be less than 20 percent, but the inferential statistics indicate that the data sets are statistically different.
Qualitative Screening	r^2 = less than 0.70. The precision (RSD) is greater than 20 percent. The data must have less than a 10 percent false negative rate.

Qualitative screening level data indicates the presence or absence of contaminants in a sample matrix, but does not provide reliable concentration estimates. Generally, confirmatory sampling is not required if an analyzer's operation is verified with one or more check samples. If the quality of the data must be known then the above criteria may be used as a guide.

A regression may be performed on raw or log transformed data. The latter is often used when the data spans orders of magnitude and is used to reduce the effect of the highest concentrations relative to the lowest upon the regression. There are five parameters to a regression: the y-intercept, the slope of the regression line, standard error of the estimate, the correlation coefficient (r), and the coefficient of determination (r^2). In linear regression analysis, the r provides a measure of the degree or strength of the correlation between the dependent variable (log10 transformed XRF data), and the independent variable (log10 transformed reference data). The r^2 provides a measure of the fraction of total variation which is accounted for by the regression relation. It is a measure of the scatter about a regression line and, thus, is a measure of the strength of the linear association. Linear regression provides an equation that represents a line:

$Y = mX + b$

where

> *b is the y intercept of the regression line*, *m is the slope of the regression line*, *and Y and X are the log10 transformed dependent and independent variables*, *respectively*.

Values for r vary from 1 to -1, with both extremes indicating a perfect positive or negative correlation between the independent and dependent variables. A positive correlation coefficient indicates that as the independent variable increases, the dependent variable also increases. A negative correlation coefficient indicates an inverse relationship, as the independent variable increases the dependent variable decreases.

An r^2 of 1.0 indicates that the linear equation explains all the variation between the XRF and reference data. As the r^2 departs from 1.0 or -1 and approaches zero, there is more unexplained variation, due to such influences as lack of perfect association with the dependent variable (log10 transformed XRF data), or the influence of other independent variables.

If the regression correlation exhibited an r^2 between 0.85 and 1.0, the XRF data is considered to meet the first requirement for definitive level data classification. The second criteria, precision RSD is then examined and required to be equal to or less than 10 percent to retain the definitive data quality level assignment. [Only raw data may be used to determine RSD not log transformed data.] If either or both of these criteria are not satisfied, certain inferential parameters are then evaluated. As a starting point, the regression line's y-intercept and slope are examined. A slope of 1.0 and a y-intercept of 0.0 would mean that the results of the XRF analyzer matched those of the reference laboratory (log10 XRF = log10 reference). Theoretically, the more the slope and y-intercept differ from the values of 1.0 and 0.0, respectively, the less accurate are the analyzer results. However, a slope or y-intercept can differ slightly from these values without the difference being statistically significant. To determine whether such differences are statistically significant, the Z test statistics for parallelism and for a common intercept is used at the 95 percent confidence level for the comparison. This process is used to assign a data quality level for each analyte.

Slope Test for Significant Differences

$$Z = \frac{m - 1}{\sqrt{SE_m + 0}}$$

where
m is the slope of the regression line, *SE is the standard error of the slope*, *and Z is the normal deviate test statistic*.

Y - intercept Test for Significant Differences

$$Z = \frac{b - 0}{\sqrt{SE_b - 0}}$$

where
b is the y-intercept of the regression line, *SE is the standard error of the intercept*, *and Z is the normal deviate test statistic*.

The matched pairs t-test is also used to evaluate whether the two sets of data (log10 transformed may be used) are significantly different. The paired t-test compares data sets, which are composed of matched pairs of data. The significance of the relationship between two matched-pairs sets of data can be determined by comparing the calculated t-statistic with the critical t-value determined from a standard t-distribution table at the desired level of significance and degrees of freedom. To meet definitive level data quality requirements, both the slope and y-intercept needs to be statistically the same as their ideal values, as defined in the quality assurance plan, and the data must be statistically similar as measured by the t-test. Data (raw or Log10 transformed) meeting these criteria are considered statistically equivalent to the reference data.

[Note: if the data is not normally distributed then the paired t-test is not appropriate. A non-parametric test should be used.]

If the r^2 is between 0.70 and 1, the precision RSD is less than 20 percent, and the slope or intercept are not statistically equivalent to their ideal values, the analyzer is producing quantitative screening level quality data. Results in this case can be mathematically corrected if 10 - 20 percent of the samples are sent to a reference laboratory. Reference laboratory analysis results for a percentage of the samples will provide a basis for determining a correction factor. The regression equation can be used to correct the data.

Data in the qualitative screening level category exhibit r^2 values less than 0.70. These data are not statistically similar to the reference data based on inferential statistics or have a precision RSD greater than 20 percent. An analyzer producing data at this level is considered capable of detecting the presence or lack of contamination, above its detection limit, with at least a 90 percent accuracy rate, but is not considered suitable for reporting of concentrations.

Relative Standard Deviation (RSD) is calculated using 7 to 10 replicate readings of the same sample. The calculated standard deviation is divided by the mean (average) concentration then multiplied by 100%. This is a measure of the instrument's ability to reproduce a measurement. This should not be confused with the relative percent difference (RPD) used to calculate the spread between duplicate samples.

A calculated Z value greater than 1.96 exceeds the 95% confidence level for the slope and y-intercept tests of significant differences in a two-tailed test.

Depending on the specific data quality objectives of the project, the criteria described above need not be applied to the entire data set. If only a specific range of measurements is critical, then only the data in that range need be tested. Measurements near the detection limit will exhibit higher levels of variability and high concentration measurements out of the calibration range of the instrument will be biased. Such measurements will distort the tests used to evaluate the data quality and in most instances may be truncated. Alternatively, each range of data (ex., 10 to 100 ppm; 100 to 1000 ppm, etc.) can be evaluated and reported separately.

Addendum to Niton XLT 793 Standard Operating Procedure

Scope and Application

The purpose of this addendum is to modify the standard operating procedure for the Niton XLT 793 for screening soil samples at abandoned mine sites. Modifications to the SOP are identified below:

Sample Types

Mine Wastes: Mill tailings, Heap leached waste, Waste rock overburden, and Waste rock (mineralized).

Sample Preservation , Containers, Handling and Storage

Samples will be handled in accordance with the sampling plan approved for the specific site.

Soil Samples

Mining wastes can vary in particle size from sand to cobble sized rock. The following steps should be followed:

Fine to sandy grained mine wastes

When samples are dry to slightly moist:

Step 1) Gather and place the sample into a screen and sieve the sample into a large re-closable plastic bag. Discard the matter retained in the screen noting the texture and presence of any stones, pebbles, and extraneous matter that may be of significance.

Step 2) Tightly close the bag and rotate end over end till the contents appear homogenous (approximately ten complete rotations).

Step 3) Transfer the contents into 3' x 4" re-closable plastic bags, tightly close, then obtain a measurement. Be sure to mark the bags and properly dispose of empty plastic bags.

Step 4) If the samples are to be analyzed further, then place filled bags inside 4 oz glass jars and appropriately store. The other samples may be placed back onto the site of origin, if there is no further need for the samples.

When samples are wet or not amenable to homogenizing.

If the samples can be forced through the screen, then do so. Attempt to homogenize the samples by squeezing and prodding the bag. If the sample can be transferred to the smaller bag, do so. Otherwise analyze the sample using the larger and thicker bag.

Step 3) Take two or more measurements of the sample through the bag but at different locations. Average the result.

Coarse grained mine wastes

Gravel, rocks and even coarse sand (>2 mm) present analytical difficulties for field portable XRF measurements. The void spaces reduce the concentration reported by the instrument. Rocks and gravel can damage the Kapton window, so exercise care when measuring rough surfaces. Nugget effects will occur with these coarse grained materials. A geologist should be onsite to observe the samples being tested and provide advice on the significance of the readings.

Step 1) Select samples that appear to contain analytes of interest. Ideally the samples should be selected and measurements directed by a geologist.

Step 2) Place a mylar or other suitable film across the sample to minimize instrument contamination (if the sample cannot be placed inside of a plastic bag) and obtain a measurement. A representative measurement of the sample may require multiple analyzes of the various portions of the sample. Keep detailed notes on the characteristics of the exact spot analyzed.

Step 3) Samples requiring further analysis should be stored in a suitable glass container. Rocks may require size reduction using a rock hammer.

Quality Assurance/Quality Control

Once the instrument has warmed up and the initial calibration performed, the following measurements should be done prior to initial measurements and at the end of a batch of samples. This should be done each time the instrument is turned on or off.

1) Measure the blank standard. The total time of measurement should be as long as used on the samples. This demonstrates insignificant contamination of the instrument.
2) Measure a standard soil. If there is a concentration of concern or a concentration level used for decision making, select the standard(s) having concentrations nearest to those levels. This demonstrates that the instrument is properly functioning.

APPENDIX 4

XRF Equipment Checklist

List of Sampling Equipment for Using Niton XRF at Mine Sites

Equipment	Person in Charge	Procured	Anticipated Procurement Date	Comments
ARF (analysis request form)				For each shipment
Auger assembly				For taking depth samples
Bucket(s)				carry/clean equip.; catch waste
Camera				documentation
Chain of Custody Forms (SAR)				
Clipboard/Notebook				for written notes on sampling
Coolers				
Computer, laptop				XTRA software installed
Cotton balls				for sample cups
Custody seals				
DI Water				
Drinking water				
Drying boats or coffee filters				
Drying oven				
Fed Ex Shipping Labels				
Film or memory stick				
Film badges				radiation monitoring
Filters (for packing sample cups)				
First Aid Kit				
Flags (various colors)				for marking sampling locations
Hat				
Insect Repellant				as needed
Dry Ice				For methyl mercury samples
Ice				
Liquinox				phosphate free detergent
Maps				mark locations; find site
Marking pens				
Mortar & Pestle				
Mylar film				
Niton accessories with case				
Niton with case				
Packing Material (bubble wrap)				
Packing Material (Absorbent)				
Paper Towels				
Plastic bags to fit buckets				for easy decon
Plastic garbage bags				
Raincoats & boots				as needed

Sample Containers				
Sample cups & parts				
Sample Labels				
Screens with handle & frame				to sift out large particles
Sieves				
Spatula				for filling sample cups
Trowel (cement)				to compress & flatten soil
Trowel (hand)				to gather or homogenize soil
Trowels, disposable				
Sunscreen				
Vehicle(s)				
Water sprayer				
Whiteboard & markers				for photo documentation
Wool socks (for freezing weather)				as needed
Zip Lock bags (gal)				
Zip Lock bags (specimen)				

APPENDIX 5

Health and Safety Plan and Hazard Appraisal and Recognition Plan

Health and Safety Plan
for the Field Sampling Plan
in Support of the Arsenic Bioavailability Study at
Empire Mine State Historic Park
Grass Valley, California

July 27, 2009

Prepared by
California Department of Toxic Substances Control
8810 Cal Center Drive
Sacramento, CA 95826-3200

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of the Field Sampling Plan (FSP) prepared by the California Department of Toxic Substances Control (DTSC) is to provide for the collection of soil and rock samples at selected abandoned mine land (AML) sites (Sites) appropriate for use in a Relative Bio-Availability (RBA) research project. The goal of the RBA research project is to develop an assessment tool that can be used to characterize arsenic at mining sites. To further this goal the RBA research project will collect and analyze soil samples with varying concentrations of arsenic and other characteristics and evaluate how arsenic adsorbs to and desorbs from soil.

The RBA research project is being performed by DTSC with assistance from the United States Geologic Survey (USGS) and several universities. DTSC prepared this Health and Safety Plan (HASP) in conjunction with the FSP for the RBA research project.

All visitors to the site will be required to sign in and out. The sign-in sheet will include the visitor’s name, affiliation, and time in and out (Appendix A Visitor Log). All visitors will also receive a safety briefing to include site hazards and emergency procedures. The project manager or site representative must verify that all visitors have met the minimum level of training required for this site.

1.1 HASP Applicability

The purpose of the HASP is to establish safe work practices for DTSC employees engaged in the implementation of the FSP. It presents the minimum health and safety requirements for establishing and maintaining a safe working environment during the course of work. The HASP was prepared based on regulations and guidelines contained in Title 8, California Code of Regulations Sections 5155, 5192, and 5194, and other applicable federal, state, and local laws, regulations, and statutes. A copy of this HASP will be kept on site during scheduled field activities.

It is the Project Manager’s responsibility to ensure that the health and safety procedures are enforced at the Site. DTSC project personnel shall receive a copy of this HASP and sign the form to indicate acceptance before on-site project activities begin. All contractors are required to develop and implement their own HASP for this project.

DTSC health and safety programs and procedures, including medical monitoring, respiratory protection, hearing conservation, and personal protective equipment (PPE) are documented in the DTSC Health and Safety Policy and Procedures (P&P) found in the DTSC Intranet, Industrial Hygiene webpage. These health and safety procedures are incorporated herein by reference, and DTSC employees will adhere to the procedures specified in the P&Ps.

DTSC is responsible for the safety of its employees but assumes no responsibility for the activities of other contractors, or their subcontractors, who may be working concurrently at the general project location. DTSC will use reasonable degree of care when marking potentially hazardous areas within its project work site and restricting access as appropriate. DTSC will not be responsible for others outside its control who disregard such marked hazards or restricted access. This HASP has been prepared specifically for this project and is intended to address health and safety issues solely with respect to DTSC's work.

1.2 Hazard Appraisal and Recognition Plan

A Hazard Appraisal and Recognition Plan Pre-Site Visit form (Pre-HARP) will be completed before beginning the field activities. A Hazard Appraisal and Recognition Plan Daily Site Visit form (Post-HARP) will be completed at the end of every field day. See Appendix B for examples of the Pre and Post-HARP forms.

2.0 SITE DESCRIPTION

Empire Mine State Historic Park (EMSHP) is located in the Motherload mining region within the Sierra Nevada Mountains, near Grass Valley, California. The Empire Mine is the site of the oldest, largest, and richest gold mine in California. From 1850 to its closing in 1956, it produced 5.8 million ounces of gold. The park is currently operated by California Department of Parks and Recreation (DPR) as a state park with over 845 acres of land and 12 miles of hiking trails.

The park consists of numerous former mining locations and provides elevated concentrations of arsenic within waste rock overburden piles, mineralized ore zones, country rock and mill tailings. The site terrain is hilly and heavily forested in many areas.

3.0 SCOPE OF WORK

Field activities associated with this project will include the collection of approximately 30 soil samples from EMSHP during each of two sampling events. Soil samples will be collected by trenching up to 4 feet below ground surface using a track hoe. Approximately five gallons of soil will be collected into 5 gallon buckets at each sample location. Trenches created during the sampling process will be backfilled as soon as the samples are collected.

Soil samples from each sampling event will be taken to an offsite facility where they will be sieved, split and then prepared for shipment to laboratories for analysis of arsenic.

Each sampling event is expected to last one week or less. It is estimated that the first sampling event will take place sometime in August and the second sampling event a few months after the first event.

If the offsite sieving and splitting is performed at the Holdredge and Kull facility, the remaining soil, consisting primarily of larger dirt particles unsuitable for analysis (greater than 250 µm), will be returned to the respective sampling locations at the EMSHP as inspection derived waste.

4.0 KEY PERSONNEL ROLES & RESPONSIBILITIES

4.1 Project Manager – Perry Myers, P.E.

The Project Manager has the ultimate responsibility for the health and safety of DTSC personnel during field activities. The Project Manager is responsible for:

- Ensuring that the project personnel review and understand the requirements of this HASP;
- Keeping the Project Health and Safety Officer informed of project developments;
- Keeping on-site personnel, including subcontractors and other personnel involve in the project, informed of the expected hazards and appropriate protective measures at the Site; and,
- Providing resources necessary for maintaining a safe and healthy work environment for DTSC personnel.

4.2 Project Health and Safety Officer – Mellan Songco, MPA

The Project Health and Safety Officer is responsible for the review, interpretation, and modification of this HASP. Modifications to this HASP that may result in less stringent precautions cannot be undertaken by the Project Manager or Site Safety Officer (SSO) without the approval of the Project Health and Safety Officer. In addition, the Project Health and Safety Officer has the following responsibilities:

- Advising Project Manager and SSO on matters relating to health and safety on this project;
- Recommending appropriate safe guards and procedures;
- Modifying this HASP, when necessary; and,
- Approving changes in health and safety procedures employed at the Site.

4.3 Site Safety Officer – DTSC Project Manager, or designee

The Site Safety Officer (SSO) is responsible for enforcing the requirements of this HASP once site work begins. The SSO has the authority to immediately correct situations where noncompliance with this HASP is noted and to immediately stop work in cases where an immediate danger to site personnel or the environment or the public is perceived. Responsibilities of the SSO also include:

- Ensure all visitors sign-in on the log sheet and verify all visitors have appropriate training.
- Obtaining and distributing PPE as necessary for this project;
- Limiting access at sampling locations to authorized personnel;
- Communicating unusual or unforeseen conditions at the Site to the Project Manager;
- Supervising and monitoring the safety performance of site personnel to evaluate the effectiveness of health and safety procedures and correct deficiencies;
- Conducting daily tailgate safety meetings before each day's activities begin and ensure all staff that attends signs the tailgate safety meeting log sheet (Appendix C Tailgate Safety Log Sheet); and,
- First Aid/CPR trained.

5.0 CHEMICAL OF CONCERN

The primary chemical of concern at the EMSHP is inorganic arsenic (Appendix D Arsenic Chemical Data Sheet). Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds.

5.1 Health Effects of Arsenic

Breathing high levels of inorganic arsenic can cause sore throats or irritated lungs. Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of “pins and needles” in hands and feet. Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small “corns” or “warts” on the palms, soles, and torso. Skin contact with inorganic arsenic may cause redness and swelling.

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for

Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

5.2 Exposure Criteria for Arsenic

The California Occupational Safety and Health Administration (Cal-OSHA) permissible exposure limit (PEL) for inorganic arsenic is 0.01 milligrams per cubic meter of air (mg/m^3).

Preliminary studies of arsenic in soil at the EMSHP using an x-ray fluorescence (XRF) device indicate that arsenic may be present in the soil at or below 6,000 milligrams per kilogram (mg/kg). See the table in Section 9.2 for the different action levels to be used during the site activities to minimize the potential for inhalation of contaminated materials. When the dust action level is reached, DTSC personnel will stop work and upgrade to level of protection C. In addition, engineering control such as dust suppression will also be implemented. If the engineering control reduced the dust level below the action level, DTSC personnel will downgrade to level of protection D.

Direct skin contact and incidental ingestion of potentially contaminated materials are also a concern during this project. Wearing proper personal protective equipment (such as wearing nitrile gloves), following decontamination procedures listed in Section 9 and good hygiene practices (such as washing hands & face before eating/smoking) can minimize these potential route of exposures.

6.0 PHYSICAL HAZARDS

The following general physical hazards identified for this project:

- Heavy equipment.
- Heat stress.
- Slip, trip, and fall hazards.
- Biological hazards.
- Back injuries from improper lifting procedures.
- Head injuries from falling objects.
- Eye injuries from dusts, flying objects, etc.
- Hand and foot injuries from improper use of hand tools, sharp objects, falling objects, etc.
- High noise levels.
- Trenches.
- Radiation hazard from using XRF.
- Overhead power transmission lines.

The above list of potential physical hazards is not all inclusive. DTSC personnel are required to report all injuries, including minor injuries, to the Site Safety Officer.

6.1 Heavy Equipment

Site activities will include the use of heavy equipment to excavate and transport excavated materials. The potential hazards include vehicular traffic, overhead power transmission lines and noise. DTSC personnel must be aware of movement of equipment and maintain eye contact with operators nearby.

6.2 Heat Stress

Heat stress is a concern when workers are required to wear protective clothing and/or work in hot weather. The average temperature in Grass Valley from July through October ranges from 70 to 93 degrees Fahrenheit (F) with average high temperatures of 80 to 95 degrees F. In Appendix E the Heat Stress Fact Sheet includes guidance for the prevention, recognition, and treatment of heat stress. The SSO will be responsible for observing personnel for performance-related effects of high temperatures, and for making the necessary adjustments in work/rest periods to maintain a safe body temperature. Liquids will be provided for Site workers to hydrate before work and to replace lost body fluids periodically through the work shift.

6.3 Slip, Trip, and Fall Hazards

Slip, Trip, and Fall Hazards are present at the Site. Uneven surfaces and debris may increase the potential for injuries. Site workers shall wear appropriate footwear and be aware of surface obstacles.

6.4 Biological Hazards

Biological hazards include the potential presence of poisonous plants, biting or stinging insects (i.e. black widows and yellow jackets) and poisonous snakes (See Appendix F Biological Hazards Fact Sheet for additional information). Site workers need to be aware of their surroundings and take appropriate precautions such as avoiding contact with these plants and/or animals.

6.5 Back Injuries

DTSC personnel will be required to use proper lifting techniques and buddy system when carrying heavy loads such as soil samples to be sieved.

6.6 Head Hazards

All personnel will be required to wear hard hats while working within restricted and exclusion work areas. Hard hats must be worn properly and not altered in any way that would reduce the degree of protection offered.

6.7 Eye Hazards

Eye protection will be required to prevent eye injuries from contact with chemical or physical agents.

6.8 Hand Hazards

Appropriate hand protection will be required to protect worker's hands from absorbing harmful substances and/or physical hazards such as severe cuts or lacerations or severe abrasion. DTSC personnel will wear nitrile gloves when handling soil such as when collecting and sieving samples. In addition, work gloves such as leather gloves will be available for use so workers hands will be protected from physical hazards.

6.9 Foot Hazards

DTSC personnel will be required to wear safety boots meeting ANSI Standard Z41.1/75 with toe compression ratings when working at the Site.

6.10 High Noise Level Exposure

When noise levels equal or exceed 85 dBA, DTSC personnel must wear hearing protection (i.e. ear plugs or ear muffs). If noise monitoring equipment is unavailable, this noise level is considered to exist when normal speech cannot be distinguished at a distance of two feet.

6.11 Trenching

All trenching activities will be conducted with the use of a small track hoe. The trenches will be no deeper than four feet thus Cal/OSHA Permits will not be required. The following requirements apply when staffs are to enter the trench:

- USA 'Dig Alert' will be notified at least two business days prior to excavation work. NOTE: This is not applicable since all work is on private property in a rural setting with no underground utilities.
- All excavations must be inspected by a competent person. The competent person must indicate there is no potential cave-in hazard, if

staffs are to enter the trench. Entering the trench is defined as breaking the top plane of the trench. (T8 CCR 1541.1)

- A competent person must be onsite to: a) conduct inspections of the excavations, adjacent areas, and protective systems before the start of work; as needed throughout the shift; and daily for potential cave ins, failures, hazardous atmospheres, or other hazards; and, b) take prompt corrective action or remove employees from the hazard.
- A competent person must be able to demonstrate the following: a) the ability to recognize all possible hazards associated with excavation work and to test for hazardous atmospheres; b) knowledge of the current safety orders pertaining to excavation and trenching; c) the ability to analyze and classify soils; d) knowledge of the design and use of protective systems; and e) the authority and ability to take prompt corrective action when conditions change.
- All spoils shall be stored at least two feet from the edge of a trench to be entered.
- If in the vicinity of overhead power transmission lines a spotter will be used and clearances required by the utility company will be maintained.

6.12. Radiation Hazard

DTSC utilizes x-ray fluorescence (XRF) instruments for the identification of hazardous levels of metals in samples. These instruments contain either an x-ray tube or a sealed source. Both types of instruments emit low levels of ionizing radiation. Per the manufacturer, the instrument is safe when used in accordance with the instructions. The manual states that radiation exposure greater than acceptable levels will not occur if the instrument is used according to the manufacturer’s instructions. Prior to using the XRF instrument, DTSC staff must be trained on its proper use.

7.0 JOB HAZARD ANALYSIS

The evaluation of the general hazards is based upon the understanding of the Site background information and anticipated risks posed by the various tasks. A summary of the activities, general hazards and protective measures for the project are as follows:

Activity	Principal Steps	Potential Hazards	Recommended Controls	Minimum PPE	Equipment to be Used
Mobilization	1) Survey the area 2) Screen sampling locations with XRF	1) Slips, trips, falls 2) Biological hazards 3) Heavy Equipment	See Sections 6.1, 6.2, 6.3, 6.4, 6.12	Hard hats; Safety glasses or goggles; Steel-toed boots; Safety vest.	XRF

		4) Heat stress 5) Radiation from XRF			
Observe Soil Excavation	1) Establish exclusion zone	1) Slips, trips, falls 2) Biological hazards 3) Heavy Equipment 4) Heat stress	See Sections 6.1, 6.2, 6.3, 6.4	Hard hats; Safety glasses or goggles; Steel-toed boots; Safety vest;	
	2) Excavate 3) Dust control	5) Above ground utilities 6) Trenching 7) Chemical hazard (inhalation) 8) Noise 9) Eye Hazards	See Sections 5.2, 6.6, 6.7, 6.9, 6.10, 6.11 Conduct air monitoring * (See next column)	Ear plugs or ear muffs (if required); * upgrade to Level C (See Section 9.2), if required	Back-hoe or track excavator MIE Data Ram dust meter
Soil Sampling	1) Collect samples 2) Manually sieve samples using track hoe and hand tools	1) Slips, trips, falls 2) Heat Stress 3) Chemical hazard (contact, inhalation & ingestion) 4) Back injuries 5) Radiation from XRF	See Sections 5.2, 6.2, 6.5, 6.7, 6.8, 6.12 Conduct air monitoring * (See next column) Follow FSP on the proper sieving procedure to minimize dust from becoming airborne	Hard hats; Safety glasses or goggles; Steel-toed boots; Safety vest; Kleenguard (if required) Nitrile gloves * upgrade to Level C (See Section 9.2), if required	Mechanical sieves MIE Data Ram dust meter

8.0 EXPOSURE MONITORING

8.1 X-Ray Fluorescence

Monitoring for arsenic at soil sample locations will be performed using a Niton XLt 793 or a Niton Xl3t field portable x-ray fluorescence instrument. X-ray Fluorescence (XRF) spectroscopy is a nondestructive qualitative and quantitative analytical technique used to determine the chemical composition of samples. Solid and liquid samples can be analyzed for elements Vanadium (V) through Lead (Pb) with the current instrument configuration.

DTSC conducted an ionizing radiation study of the XRF units for just over six months. The study concluded that additional ionizing radiation monitoring is not required.

8.2 Air Monitoring Requirements

A MIE DataRam dust meter will be used to evaluate the concentration of total airborne particulates during any activity that disturbs potentially contaminated soils, including: trenching, sample collection, trench backfilling and soil sieving. The DataRam is a personal monitor that collects discrete readings for total airborne particulates. Dust monitoring will be performed in the vicinity of the site workers performing dust generating activities as well as at the downwind perimeter of the exclusion zone for the sampling activities.

For action levels and required personal protective equipment, refer to section 9.0.

8.3 Sieving Soil Samples

Soil samples from the back-hoe or track excavator will be unloaded directly onto a stacked set of sieves. DTSC personnel will observe at a distance when the track excavator or back-hoe is in operation.

After soil samples have been run through the stacked sieves, the fraction of soil that passes through will be further sieved using hand tools. That fraction that passes through a number 4 sieve (4 openings per inch) will be collected in a plastic container and sealed. The Number 4 sieve will be enclosed with a plastic bag to minimize dust generation. The portion of soil samples passing the No. 4 Sieve will be sent to the Holdrege and Kull soils laboratory or Ohio State University for additional sieving and sample splitting.

If used, the Holdrege and Kull soils laboratory will dry the soil samples and pass them through a No. 60 sieve (250 µm) using a mechanical shaker. The drying and sieving process will be done outside the laboratory in the parking area and will be partially to fully enclosed to minimize dust generation. Note that there are no buildings within 75’ of the parking lot where work will take place. DTSC personnel will be observing upwind and at a distance. Air monitoring will be conducted to ensure that staff dust exposures are minimized. If the samples are sent to the Ohio State University DTSC staff will not be present. Staff at those locations will follow their own health and safety procedures during sieving and splitting.

9.0 PERSONAL PROTECTIVE REQUIREMENTS

9.1 General Personal Protective Equipment Requirements

Personal Protective Equipment to be utilized by on-site personnel during field activities will consist of primarily modified Level D, which will include the following:

- Hard hats;

- Ear plugs or ear muffs (when noise levels exceed 85 dBA);
- Safety glasses or goggles;
- Safety boots;
- Safety vest;
- Kleenguard A30 disposable coveralls (when contact with potentially contaminated soils is anticipated);
- Nitrile or other chemically resistant gloves (when contact with potentially contaminated soils is anticipated).

The site activities at this site will not entail the use of Level of Protection B or A. All site personnel will utilize modified Level D (as described above). If the air monitoring action limit is attained or exceeded, then respiratory protection will be required (see section 9.2 Potential for Respiratory Protection).

9.2 Potential for Respiratory Protection

If airborne total particulate levels, as measured by the DataRam dust meter, exceed the **respiratory action level listed in the table below** (See Appendix C for a calculation sample)**,** site personnel working within the exclusion zone will upgrade to Level C PPE, which will include the items listed above as well as full-face or half-face air-purifying respirators equipped with P100 particulate cartridges. In case dust levels cannot be maintained, a Stop Work Level is also included in the table below (last column). All respirator cartridges will be changed-out when breathing resistance is noticed or at the end of each work day. Site personnel within the exclusion zone will wear respiratory protection until additional engineering controls and work practices are able to maintain airborne total particulate concentrations below that of the action level.

Soil Concentration (mg/kg)	Action Level (mg/m^3) – Don Half-Face APR	Second Action Level (mg/m^3) - upgrade to Full-Face APR	Stop Work Level (mg/m^3)
3000	1.7	8.5	10
6000	0.8	4	10
10000	0.2	1	5
15000	0.1	0.5	2.5

10.0 DECONTAMINATION PROCEDURES

General decontamination procedures will remove contaminants that may accumulate on workers and equipment during Site activities and will prevent contaminants from migrating from the Site.

Decontamination involves the orderly and controlled removal of contaminants. Standard contamination control methods and decontamination sequences are presented in this section. All Site personnel should minimize contact with contaminants in order to limit the need for extensive decontamination.

Contamination control methods include using PPE when appropriate [disposable coveralls (Tyvek or equivalent), gloves (disposable liner, neoprene or nitrile outer), shoe or boot covers; equipment covers (plastic bags or sheets)]; and avoiding direct contact with the contaminated material and surfaces where possible.

10.1 Personnel Decontamination

Preliminary personnel decontamination will be done in the Support Zone. Waste containers, water, plastic sheeting, paper towels and brushes will be available at the site for decontamination. Dry decontamination procedures will be followed by staff including careful removal of personal protective equipment, proper disposal, followed up with washing hands and face with soap and water.

10.2 Equipment/Instruments

Tools and small equipment will be decontaminated, as necessary, at the completion of each task or whenever they require additional cleaning. Prior to cleaning, equipment will be stored on plastic sheets in appropriate places on the trucks. Personnel will wear appropriate clothing during decontamination of equipment equivalent to the Level of Protection required during the use of the equipment.

All possible measures will be taken by personnel to prevent the contamination of any monitoring equipment. Instruments that cannot be easily decontaminated will be placed in a clear, sealable, plastic bag that allows for sample intake and exhaust.

11.0 EMPLOYEE TRAINING AND MEDICAL MONITORING

11. 1 General Health and Safety

All project personnel who will be participating in field activities for this project must have completed formal health and safety training in accordance with California Code of Regulations Title 8 CCR 5192(e)(1). The training shall be, at a minimum:

a. 40-hour minimum hazardous materials safety and health course, and

b. 8 hours of supervised on the job training,

c. An eight (8) hour minimum refresher course if the 40-hour minimum training was acquired more than one year prior to the start of site operations, or

d. Equivalent work experience (which can be documented) demonstrating a knowledge of safety and healthful work practices, or

e. A combination of prior training and work experience (which can be documented), sufficient to satisfy the 40-hour minimum requirement and have completed 8 hours of supervised on the job training.

11.2 Site-Specific Training

On-site personnel will be made aware of the chemicals that may be encountered during field operations. All field personnel shall be trained on the hazards of arsenic including potential routes of exposure, protective clothing to be worn and precautionary measures to be taken. Personnel will also be informed of the signs and symptoms of chemical exposure and heat stress.

Site specific training will include arsenic hazards and Wilderness First-Aid (for at least one staff member). Traveling to the sites required the use of all-terrain vehicles. Any staff member utilizing these vehicles must receive specific training prior to operation.

Prior to working at the Site, a pre-work meeting will be held to discuss the content of this plan, specific Site requirements and responsibilities of Site members.

11.3 Medical Monitoring

All field staff shall undergo baseline and annual medical monitoring by a licensed physician knowledgeable in occupational medicine in accordance with Title 8 CCR 5192(f). Medical examinations include, but are not limited to, overall physical assessment, spirometry, hearing and vision evaluation, body measurements, complete blood panel, blood lead and cholinesterase, and EKG. All medical monitoring examinations within DTSC are performed at contract medical facilities. All questions regarding medical monitoring should be directed to medicalmonitoring@dtsc.ca.gov.

Specialized biological monitoring may be performed on an as needed basis.

DTSC shall maintain all medical records for a minimum of 30 years in accordance with T8 CCR 3204(d).

12.0 SITE CONTROL

12.1. Exclusion Zone

The exclusion zone is where the field work related to the preliminary site investigation for the Arsenic Relative Bioavailability Study and the area of potential contamination. All personnel entering this zone must wear appropriate protective clothing to include nitrile and/or leather gloves when handling soil and equipment of which soil has touched, steel-toed boots, long pants, and hard hats. The excavation operations will be contained within an exclusion zone set up to prevent any unauthorized personnel from coming in contact with any part of the operation.

12.2 Support Zone

The support zone requires no personal protective equipment. This zone will be used for staging and rest breaks.

13.0 SANITATION

The site is in a public park where restroom facilities are readily available. Potable water is also available. Drinking water will be provided in the support zone.

14.0 CONFINED SPACE

This site will not involve any confined space entry.

15.0 EMERGENCY RESPONSE/CONTINGENCY PLAN

This section describes general contingency and emergency planning procedures for workers during the sampling activities. All project-related emergency incidents will be reported immediately to the Site Safety Officer.

15.1 Pre-Emergency Planning

All staff will be briefed on the provisions of the Site Health and Safety Plan during the daily tailgate meetings. This general Health and Safety Plan will be reviewed and revised, as necessary, to ensure that it is adequate and consistent with daily Site conditions.

15.2 Personnel Roles and Lines of Authority

The Site Safety Officer (DTSC designee) has primary responsibility for responding to and correcting emergency situations and for taking appropriate measures to ensure the safety of Site personnel. Possible actions may involve evacuation of personnel from the Site area, or the shut down of operations. The Site Safety Officer is additionally responsible for ensuring that corrective measures have been implemented, appropriate authorities notified, and follow-up reports completed. The Site Safety Officer will direct responses to any medical emergency.

15.3 Evacuation Routes and Procedures

In the event of an emergency that necessitates an evacuation of the Site, personnel will be expected to mobilize to a safe distance from the emergency. Personnel will remain at that area until an authorized individual provides further instructions. The route of evacuation and designated assembly point will be discussed at the daily tailgate meeting. Appendix G includes a map and written directions highlighting the primary route to the nearest hospital from the Site.

15.4 Emergency Contacts/Notification

In the event of an on-site emergency, personnel will take direction from the Site Safety Officer.

Project-related emergency events and procedures are summarized below.

Emergency Medical Treatment Procedures

Any person who becomes ill or injured must be decontaminated as appropriate to the maximum extent possible. First aid will be administered while awaiting an ambulance or paramedics or during transport as necessary. All injuries, illnesses will be immediately reported to the DPR and DTSC as appropriate. Any person transported to a medical clinic or hospital for treatment will take information related to the hazards at the site

Any vehicle used to transport contaminated personnel will be cleaned as necessary.

A Hospital route map and directions are in Appendix G.

Weather Related Emergencies

Sampling shall not be conducted during severe weather accompanied by high winds or lightning. In the event of severe weather, work will be stopped, equipment will be secured (i.e., the excavator arms will be lowered) and personnel will leave the Site.

15.5 First Aid and Emergency Equipment

The Site Safety Officer will maintain the following first aid and emergency equipment:

1. First aid kit.
2. Emergency eye wash kit.
3. Fire extinguisher.
4. Potable water.

15.6 Emergency Phone Numbers

Emergency Services (Police/Fire Department/Ambulance):	911
National Response Center:	(800) 424-8802
Poison Control Center:	(800) 876-4766 or (800) 222-1222
CHEMTREC:	(800) 424-9300
DTSC Project Health and Safety Officer (Mellan Songco):	(916) 255-3590
(Jennifer Bailey):	(916) 255-6650
DTSC Project Manager (Perry Myers):	(916) 255-3708
DTSC Project Site Safety Officer (Rick Fears):	(916) 255-3802
Nearby Hospital:	(530) 274-6000

Sierra Nevada Memorial Hospital
155 Glasson Way
Grass Valley, CA 95945

16.0 PARK VISITORS

The excavation work activities will be conducted on trails and immediately adjacent to open park trails. To minimize dust, hudsen sprayers or a similar device will be utilized as needed to dampen the air and reduce airborne dust.

17.0 STANDARD OPERATING PROCEDURES

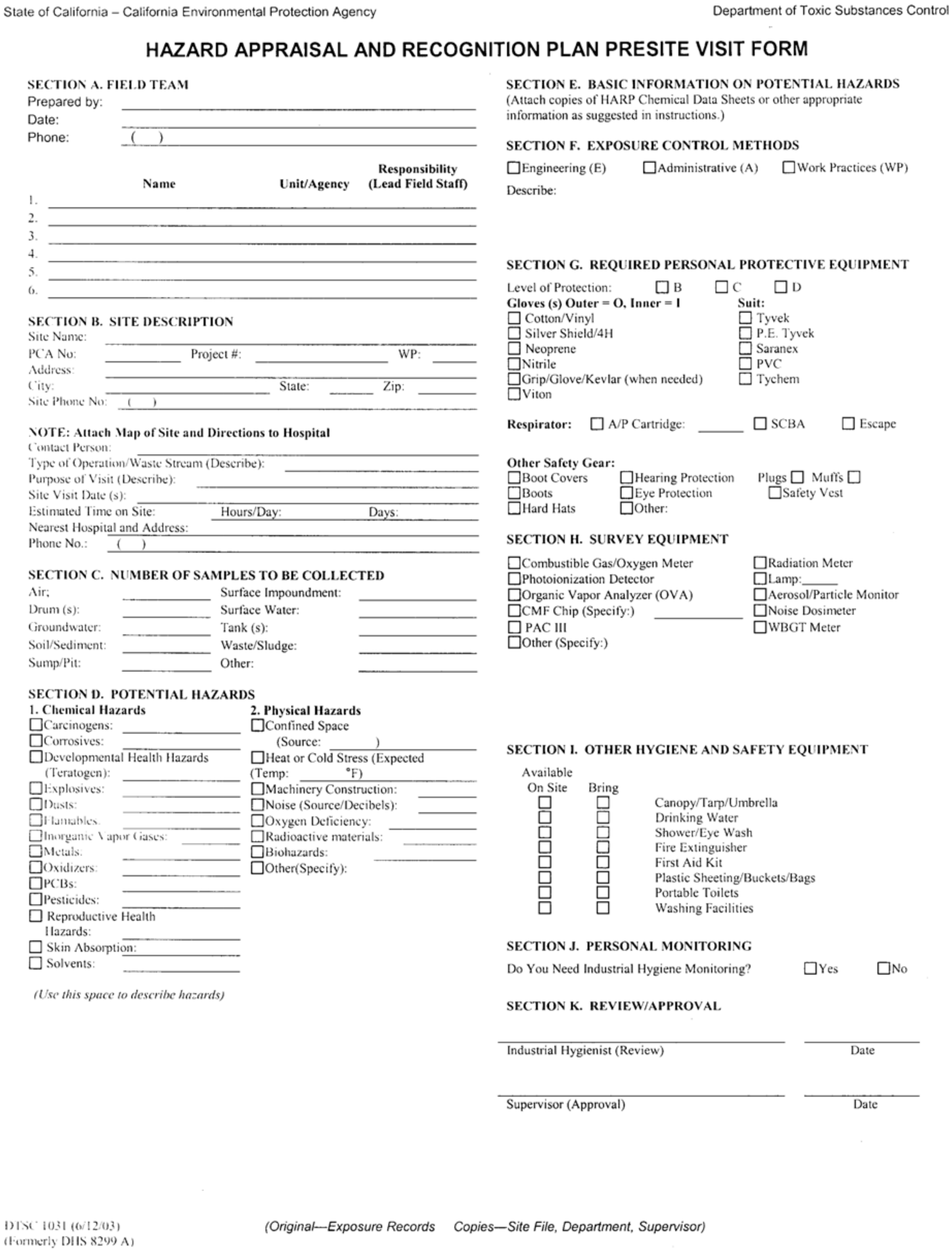
See Appendix H for the Site Safety Standard Operating Procedures.

Appendix A
VISITOR LOG

The undersigned have read this Health and Safety Plan, have met the minimum level of training required for this site, understand the potential hazards and are wearing the required PPE.

NAME	**SIGNATURE**	**DATE**	**TIME IN**	**TIME OUT**	**COMPANY**

Appendix B
Pre HARP and Post HARP Forms



State of California – California Environmental Protection Agency
Department of Toxic Substances Control

HAZARD APPRAISAL AND RECOGNITION PLAN PRESITE VISIT FORM

SECTION A. FIELD TEAM

Prepared by: ____________________
Date: ____________________
Phone: ( ) ____________________

	Name	Unit/Agency	Responsibility (Lead Field Staff)
1.			
2.			
3.			
4.			
5.			
6.			

SECTION B. SITE DESCRIPTION

Site Name: ____________________
PCA No: __________ Project #: __________ WP: __________
Address: ____________________
City: __________ State: ______ Zip: ______
Site Phone No: ( ) ____________________

NOTE: Attach Map of Site and Directions to Hospital

Contact Person: ____________________
Type of Operation/Waste Stream (Describe): ____________________
Purpose of Visit (Describe): ____________________
Site Visit Date (s): ____________________
Estimated Time on Site: Hours/Day: __________ Days: __________
Nearest Hospital and Address: ____________________
Phone No.: ( ) ____________________

SECTION C. NUMBER OF SAMPLES TO BE COLLECTED

Air;	______	Surface Impoundment:	______
Drum (s):	______	Surface Water:	______
Groundwater:	______	Tank (s):	______
Soil/Sediment:	______	Waste/Sludge:	______
Sump/Pit:	______	Other:	______

SECTION D. POTENTIAL HAZARDS

1. Chemical Hazards

☐ Carcinogens: ______
☐ Corrosives: ______
☐ Developmental Health Hazards (Teratogen): ______
☐ Explosives: ______
☐ Dusts: ______
☐ Flamables: ______
☐ Inorganic Vapor Gases: ______
☐ Metals: ______
☐ Oxidizers: ______
☐ PCBs: ______
☐ Pesticides: ______
☐ Reproductive Health Hazards: ______
☐ Skin Absorption: ______
☐ Solvents: ______

2. Physical Hazards

☐ Confined Space (Source: ______)
☐ Heat or Cold Stress (Expected (Temp: ______ °F)
☐ Machinery Construction: ______
☐ Noise (Source/Decibels): ______
☐ Oxygen Deficiency: ______
☐ Radioactive materials: ______
☐ Biohazards: ______
☐ Other(Specify):

(Use this space to describe hazards)

SECTION E. BASIC INFORMATION ON POTENTIAL HAZARDS

(Attach copies of HARP Chemical Data Sheets or other appropriate information as suggested in instructions.)

SECTION F. EXPOSURE CONTROL METHODS

☐ Engineering (E) ☐ Administrative (A) ☐ Work Practices (WP)

Describe:

SECTION G. REQUIRED PERSONAL PROTECTIVE EQUIPMENT

Level of Protection: ☐ B ☐ C ☐ D

Gloves (s) Outer = O, Inner = I

☐ Cotton/Vinyl
☐ Silver Shield/4H
☐ Neoprene
☐ Nitrile
☐ Grip/Glove/Kevlar (when needed)
☐ Viton

Suit:

☐ Tyvek
☐ P.E. Tyvek
☐ Saranex
☐ PVC
☐ Tychem

Respirator: ☐ A/P Cartridge: ______ ☐ SCBA ☐ Escape

Other Safety Gear:

☐ Boot Covers
☐ Boots
☐ Hard Hats
☐ Hearing Protection
☐ Eye Protection
☐ Other:
Plugs ☐ Muffs ☐
☐ Safety Vest

SECTION H. SURVEY EQUIPMENT

☐ Combustible Gas/Oxygen Meter
☐ Photoionization Detector
☐ Organic Vapor Analyzer (OVA)
☐ CMF Chip (Specify:) ______
☐ PAC III
☐ Other (Specify:)
☐ Radiation Meter
☐ Lamp: ______
☐ Aerosol/Particle Monitor
☐ Noise Dosimeter
☐ WBGT Meter

SECTION I. OTHER HYGIENE AND SAFETY EQUIPMENT

Available On Site	Bring	
☐	☐	Canopy/Tarp/Umbrella
☐	☐	Drinking Water
☐	☐	Shower/Eye Wash
☐	☐	Fire Extinguisher
☐	☐	First Aid Kit
☐	☐	Plastic Sheeting/Buckets/Bags
☐	☐	Portable Toilets
☐	☐	Washing Facilities

SECTION J. PERSONAL MONITORING

Do You Need Industrial Hygiene Monitoring? ☐ Yes ☐ No

SECTION K. REVIEW/APPROVAL

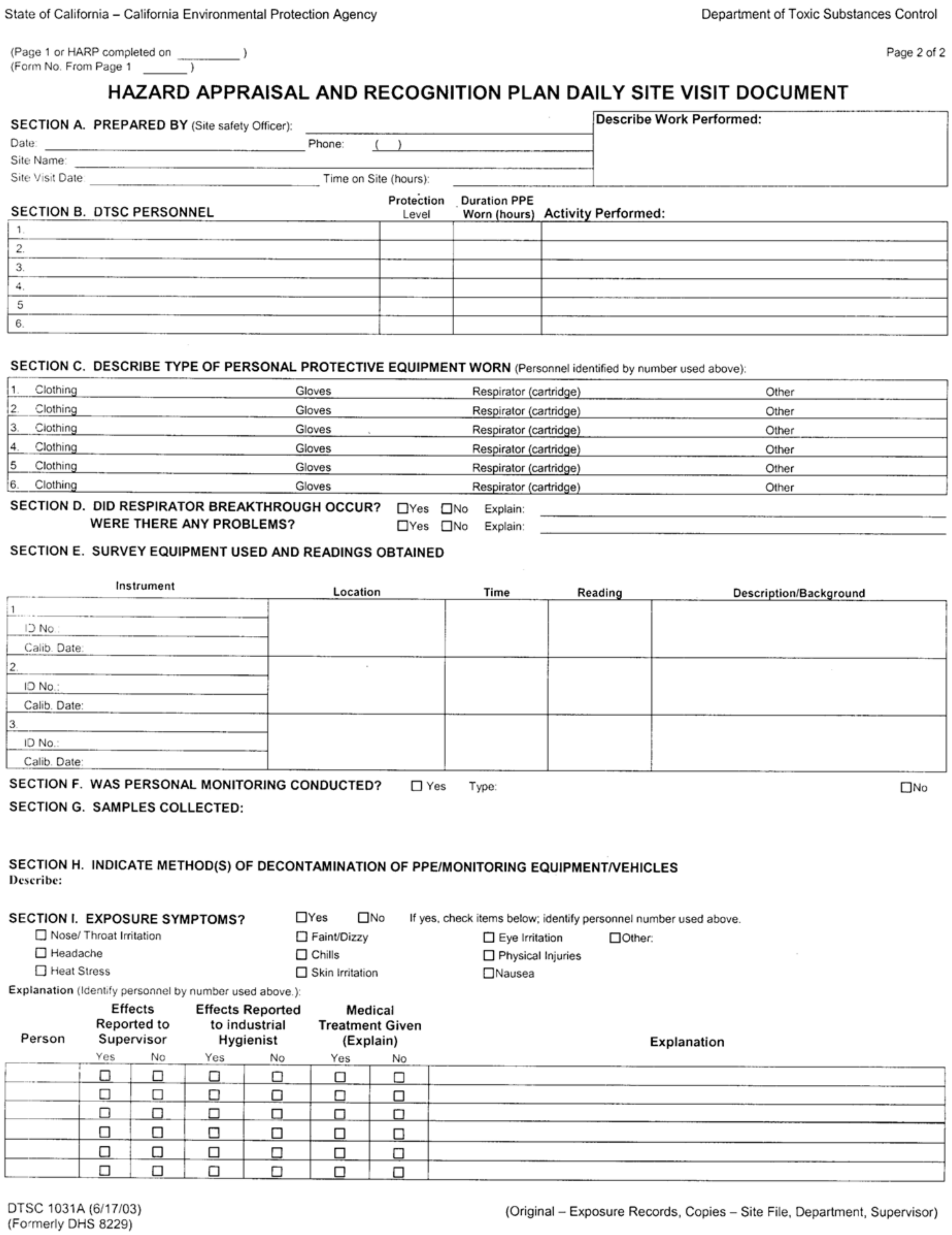
____________________ ______
Industrial Hygienist (Review) Date

____________________ ______
Supervisor (Approval) Date

DTSC 1031 (6/12/03)
(Formerly DHS 8299 A)

(Original—Exposure Records Copies—Site File, Department, Supervisor)

Appendix B
Pre HARP and Post HARP Forms



State of California – California Environmental Protection Agency

Department of Toxic Substances Control

(Page 1 or HARP completed on __________)
(Form No. From Page 1 _______)

Page 2 of 2

HAZARD APPRAISAL AND RECOGNITION PLAN DAILY SITE VISIT DOCUMENT

SECTION A. PREPARED BY (Site safety Officer): ____________________

Date: ____________________ Phone: ( ) ____________________

Site Name: ____________________

Site Visit Date: ____________________ Time on Site (hours): __________

Describe Work Performed:

SECTION B. DTSC PERSONNEL	**Protection** Level	**Duration PPE Worn (hours)**	**Activity Performed:**
1.			
2.			
3.			
4.			
5			
6.			

SECTION C. DESCRIBE TYPE OF PERSONAL PROTECTIVE EQUIPMENT WORN (Personnel identified by number used above):

1. Clothing	Gloves	Respirator (cartridge)	Other
2. Clothing	Gloves	Respirator (cartridge)	Other
3. Clothing	Gloves	Respirator (cartridge)	Other
4. Clothing	Gloves	Respirator (cartridge)	Other
5 Clothing	Gloves	Respirator (cartridge)	Other
6. Clothing	Gloves	Respirator (cartridge)	Other

SECTION D. DID RESPIRATOR BREAKTHROUGH OCCUR? ☐Yes ☐No Explain: ____________________
WERE THERE ANY PROBLEMS? ☐Yes ☐No Explain: ____________________

SECTION E. SURVEY EQUIPMENT USED AND READINGS OBTAINED

Instrument	**Location**	**Time**	**Reading**	**Description/Background**
1 ID No.: Calib. Date:				
2. ID No.: Calib. Date:				
3. ID No.: Calib. Date:				

SECTION F. WAS PERSONAL MONITORING CONDUCTED? ☐ Yes Type: ☐No

SECTION G. SAMPLES COLLECTED:

SECTION H. INDICATE METHOD(S) OF DECONTAMINATION OF PPE/MONITORING EQUIPMENT/VEHICLES
Describe:

SECTION I. EXPOSURE SYMPTOMS? ☐Yes ☐No If yes, check items below; identify personnel number used above.

☐ Nose/ Throat Irritation
☐ Headache
☐ Heat Stress
☐ Faint/Dizzy
☐ Chills
☐ Skin Irritation
☐ Eye Irritation
☐ Physical Injuries
☐Nausea
☐Other:

Explanation (Identify personnel by number used above.):

Person	**Effects Reported to Supervisor**		**Effects Reported to industrial Hygienist**		**Medical Treatment Given (Explain)**		**Explanation**
	Yes	No	Yes	No	Yes	No	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	

DTSC 1031A (6/17/03)
(Formerly DHS 8229)

(Original – Exposure Records, Copies – Site File, Department, Supervisor)

Appendix C
TAILGATE SAFETY MEETING LOG

Date: ____________________________

Location: ____________________________

Presented by: ____________________________

Topics Covered:

HEALTH AND SAFETY PLAN

- Hazardous/Toxic Substances
- On-Site Organization and Coordination
- Emergency Medical Care and Procedures
- Contingency Plan
- Additional Controls for Complex/Hazardous Jobs

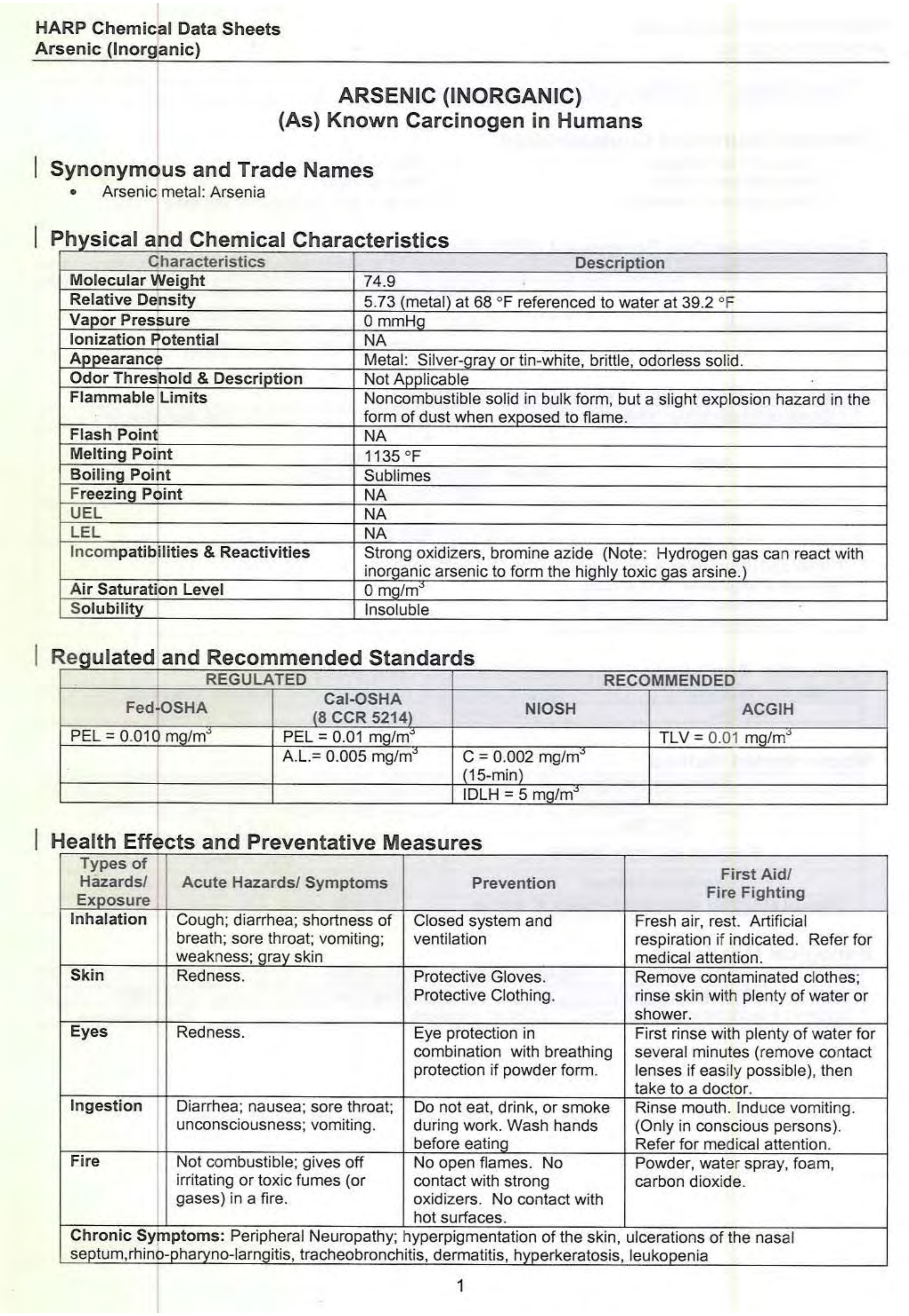
SPECIFIC PRECAUTIONS FOR DAY'S ACTIVITIES

OTHER: ____________________________________

ATTENDEE LIST

Print Name	Signature
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

Appendix D
ARSENIC CHEMICAL DATA SHEET & DUST EXPOSURE CALCULATION



ARSENIC (INORGANIC)
(As) Known Carcinogen in Humans

Synonymous and Trade Names

- Arsenic metal: Arsenia

Physical and Chemical Characteristics

Characteristics	Description
Molecular Weight	74.9
Relative Density	5.73 (metal) at 68 °F referenced to water at 39.2 °F
Vapor Pressure	0 mmHg
Ionization Potential	NA
Appearance	Metal: Silver-gray or tin-white, brittle, odorless solid.
Odor Threshold & Description	Not Applicable
Flammable Limits	Noncombustible solid in bulk form, but a slight explosion hazard in the form of dust when exposed to flame.
Flash Point	NA
Melting Point	1135 °F
Boiling Point	Sublimes
Freezing Point	NA
UEL	NA
LEL	NA
Incompatibilities & Reactivities	Strong oxidizers, bromine azide (Note: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.)
Air Saturation Level	0 mg/m^3
Solubility	Insoluble

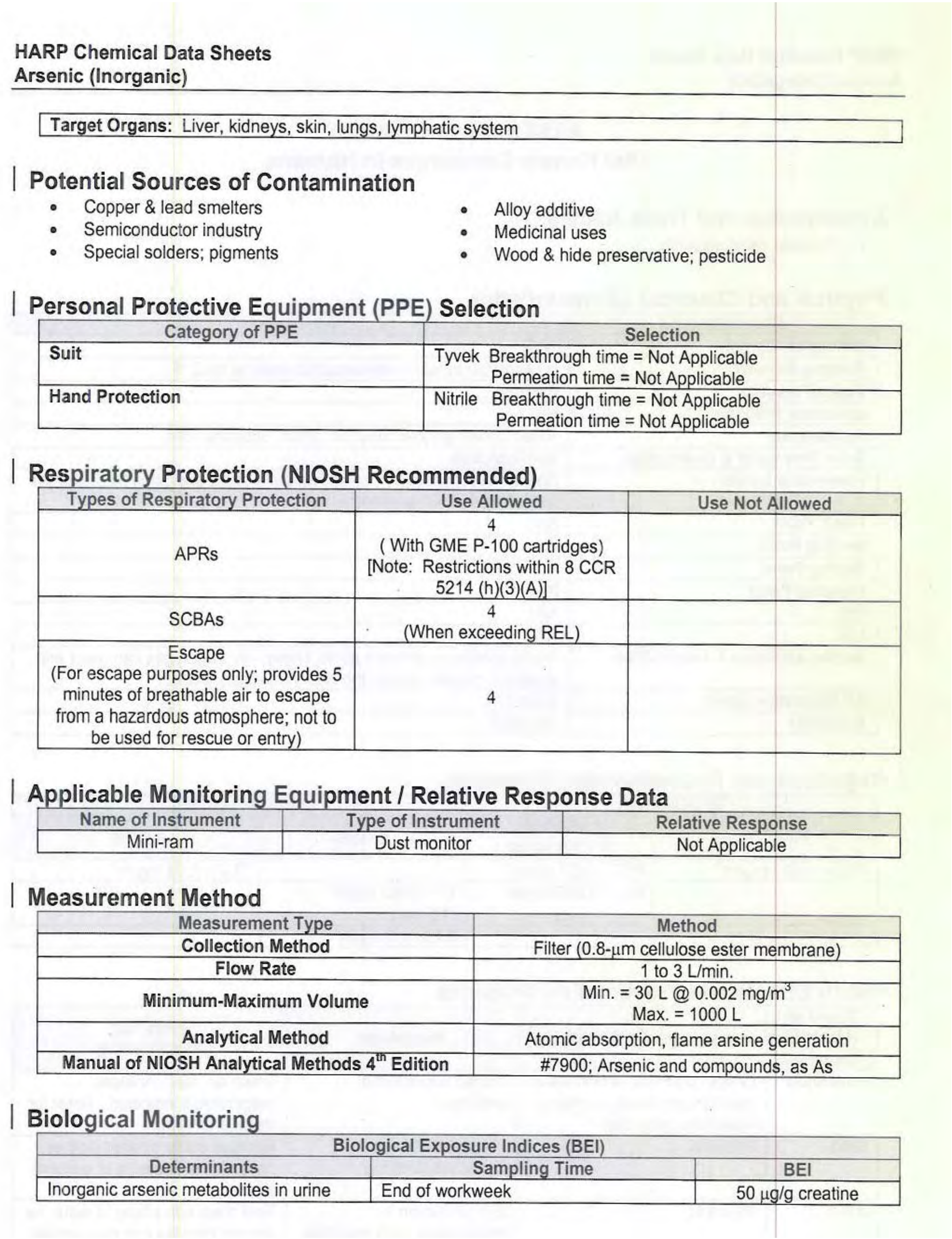
Regulated and Recommended Standards

REGULATED		RECOMMENDED	
Fed-OSHA	**Cal-OSHA (8 CCR 5214)**	**NIOSH**	**ACGIH**
PEL = 0.010 mg/m^3	PEL = 0.01 mg/m^3		TLV = 0.01 mg/m^3
	A.L.= 0.005 mg/m^3	C = 0.002 mg/m^3 (15-min)	
		IDLH = 5 mg/m^3	

Health Effects and Preventative Measures

Types of Hazards/ Exposure	Acute Hazards/ Symptoms	Prevention	First Aid/ Fire Fighting
Inhalation	Cough; diarrhea; shortness of breath; sore throat; vomiting; weakness; gray skin	Closed system and ventilation	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
Skin	Redness.	Protective Gloves. Protective Clothing.	Remove contaminated clothes; rinse skin with plenty of water or shower.
Eyes	Redness.	Eye protection in combination with breathing protection if powder form.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Diarrhea; nausea; sore throat; unconsciousness; vomiting.	Do not eat, drink, or smoke during work. Wash hands before eating	Rinse mouth. Induce vomiting. (Only in conscious persons). Refer for medical attention.
Fire	Not combustible; gives off irritating or toxic fumes (or gases) in a fire.	No open flames. No contact with strong oxidizers. No contact with hot surfaces.	Powder, water spray, foam, carbon dioxide.
Chronic Symptoms: Peripheral Neuropathy; hyperpigmentation of the skin, ulcerations of the nasal septum,rhino-pharyno-larngitis, tracheobronchitis, dermatitis, hyperkeratosis, leukopenia			

Appendix D
ARSENIC CHEMICAL DATA SHEET & DUST EXPOSURE CALCULATION



HARP Chemical Data Sheets
Arsenic (Inorganic)

Target Organs: Liver, kidneys, skin, lungs, lymphatic system

Potential Sources of Contamination

- Copper & lead smelters
- Semiconductor industry
- Special solders; pigments
- Alloy additive
- Medicinal uses
- Wood & hide preservative; pesticide

Personal Protective Equipment (PPE) Selection

Category of PPE	Selection
Suit	Tyvek Breakthrough time = Not Applicable Permeation time = Not Applicable
Hand Protection	Nitrile Breakthrough time = Not Applicable Permeation time = Not Applicable

Respiratory Protection (NIOSH Recommended)

Types of Respiratory Protection	Use Allowed	Use Not Allowed
APRs	4 (With GME P-100 cartridges) [Note: Restrictions within 8 CCR 5214 (h)(3)(A)]	
SCBAs	4 (When exceeding REL)	
Escape (For escape purposes only; provides 5 minutes of breathable air to escape from a hazardous atmosphere; not to be used for rescue or entry)	4	

Applicable Monitoring Equipment / Relative Response Data

Name of Instrument	Type of Instrument	Relative Response
Mini-ram	Dust monitor	Not Applicable

Measurement Method

Measurement Type	Method
Collection Method	Filter (0.8-μm cellulose ester membrane)
Flow Rate	1 to 3 L/min.
Minimum-Maximum Volume	Min. = 30 L @ 0.002 mg/m^3 Max. = 1000 L
Analytical Method	Atomic absorption, flame arsine generation
Manual of NIOSH Analytical Methods 4th Edition	#7900; Arsenic and compounds, as As

Biological Monitoring

Biological Exposure Indices (BEI)		
Determinants	**Sampling Time**	**BEI**
Inorganic arsenic metabolites in urine	End of workweek	50 μg/g creatine

Appendix D
ARSENIC CHEMICAL DATA SHEET & DUST EXPOSURE CALCULATION

Permissible Exposure Limit for Arsenic = 0.01 mg/m^3

Soil Concentration (mg/kg)	Safety Factor*	Action Level (mg/m^3) – Donn APR	Second Action Level (mg/m^3) - upgrade to Full-Face APR	Stop Work Level (mg/m^3)
3000	2	1.7	8.5	10
6000	2	0.8	4	10
10000	5	0.2	1	5
15000	5	0.1	0.5	2.5

*Safety Factor- based on confidence of the data. Pre-sampling soil concentration data indicated soil concentrations at or less than 6000 PPM. If soil concentrations are above this level, the confidence of the data is lower.

Protection Factor for a half face APR = 10
Protection Factor for a full face APR = 100

For example at 6000 mg/kg soil concentration:

$$\text{Total Dust Level (mg/m}^3\text{)} = \frac{\text{(Exposure Limit mg/m}^3\text{) (10}^6\text{ mg/kg)}}{\text{(Conc. Mg/kg) (Safety Factor)}}$$

$$= \frac{(0.01\text{ mg/m}^3)(10^6\text{ kg/mg})}{(6000\text{ mg/kg})(2)}$$

$$= 0.8\text{ mg/m}^3$$

Appendix E
HEAT STRESS FACT SHEET

DTSC
HEAT STRESS FACT SHEET

HAZWOPER 08/09

DEPARTMENT OF TOXIC SUBSTANCES CONTROL

HEAT STRESS

Heat Stress is "the health hazards created by the cumulative adverse effects of physical activity, personal clothing, and environmental factors which include air temperature, air movement, relative humidity and radiant heat exchange". Staff may develop heat-related illness at relatively low ambient temperatures when staff are utilizing impermeable protective clothing, or performing extensive physical activity.

KEY TERM

"Environmental risk factors for heat illness" means working conditions that create the possibility that heat illness could occur, including air temperature, relative humidity, radiant heat from the sun and other sources, conductive heat sources such as the ground, air movement, workload severity and duration, protective clothing and personal protective equipment worn by employees.

A PROGRESSIVE CONDITION

Employees should be encouraged never to discount any discomfort or symptoms they are experiencing when working in heat, after work or before the next workday. Heat illness symptoms can occur even after work has stopped.

Heat stress risk is based on personal risk factors. One person can be fine, while the other person is experiencing heat stroke.

WATER

SHADE

ACCLIMATIZATION

HEAT WAVE

Taking extra measures during a Heat Wave

Heat Waves increase risk of heat illness

TRAINING

EMERGENCY RESPONSE

SMART TIPS

- **Recognize Symptoms Early**
- **Staying in contact with your employees**

WRITTEN PROCEDURES

- **Drinking Water**
- **Cooling**
- **Breaks**
- **Recovery Periods**
- **Acclimatization**
- **Emergency Response**
- **Training**

For more Information see the **DTSC Heat Stress Prevention P&P,** available on the DTSC Intranet and www.dir.ca.gov.

CAL/OSHA 2006 STUDY on Heat Illness in Workplaces

Cal/OSHA investigations showed that in 2006, in workplaces where heat illness occurred:
- 92 % did not address all the required training elements of the Cal/OSHA Heat Illness Prevention Standard
- 75% did not have training on acclimatization
- 57 % of supervisors were not trained (in fatal cases that occurred)
- 35% of supervisors were not trained (in non-fatal cases that occurred)
- A lack of training on early signs and symptoms (e.g., weakness, nausea, muscle cramps) lead to delayed recognition and reporting of heat illness.

This caused:
progression to more serious symptoms (e.g., fainting, seizures, disorientation, high internal body temperatures), increased difficulty in reversing the damage to the body from heat, and the need for immediate medical attention and treatment .

COOLING VESTS

Cooling vest utilize specially designed ice packs to keep the torso cool.

EZ UP SHELTER

These are shelters to provide a shady place for breaks.

KEY TERM

"Personal risk factors for heat illness" means factors such as an individual's age, degree of acclimatization, health, water consumption, alcohol consumption, caffeine consumption, and use of prescription medications that affect the body's water retention or other physiological responses to heat.

KEY TERM

"Preventative recovery period" means a period of time to recover from the heat in order to prevent heat illness.

Appendix E
HEAT STRESS FACT SHEET

DTSC HEAT STRESS CONTROL METHODS

1. Hydration. Try to consume approximately 1 cup of fluids every 15-20 minutes. Individuals should drink about 500 mL (about 17 oz) of Athletic Replenishment Fluid (ARF) about 2 hours before working in hot environments. Roughly, 600-1200 mL of ARF should be consumed per hour.

2. Prepare a standard work procedure to prevent heat stress including emergency and intervention procedures. This should include: staying in the shade, drinking plenty of fluids, scheduling work in the early morning or evening hours (canceling work), setting up a tent and cooling the rest area, having two or more crews work on alternate shifts, reducing the work shift, reducing the number of samples or field activities, and avoiding unnecessary physical activity.

3. The methods of controlling or reducing heat stress hazards, such as air temperature, increasing air movement, shielding the employee from radiant heat sources, limiting or modifying the duration of exposure time, reducing the metabolic physical activity component of the total heat load.

4. Ensure staff consume small light meals throughout the field work. Consuming too few calories or too many increases the chance of a heat-related disorder.

5. Acclimatization and physical conditioning; medical screening of employees to identify individuals with low heat tolerance and/or physical fitness; and,

6. Recognize the effects of non-occupational factors such as drugs, alcohol and obesity on tolerance to heat stress.

KEY TERM

"**Shade**" means blockage of direct sunlight. Canopies, umbrellas and other temporary structures or devices may be used to provide shade. One indicator that blockage is sufficient is when objects do not cast a shadow in the area of blocked sunlight. Shade is not adequate when heat in the area of shade defeats the purpose of shade.

SKIN TURGOR TEST

A decrease in skin turgor is indicated when the skin does not return to its original state, which is a late sign of dehydration.

Skin with decreased turgor remains elevated after being pulled up and released

KEY TERM

"**Acclimatization**" means temporary adaptation of the body to work in the heat that occurs gradually when a person is exposed to it. Acclimatization peaks in most people within four to fourteen days of regular work for at least two hours per day in the heat. This is especially important in the prevention of heat related illnesses.

Heat Wave

Heat waves are a sudden and temporary rise of temperature above the seasonal average for a particular region, period last for which lasts a prolonged period of time.

WBGT

The WBGT is a field instrument that measures different types of environmental risk factors for heat stress and calculates the heat load on an individual in permeable clothing.

Heat Disorder	Symptoms	Treatment
Heat Rash	Skin remains wet Sweat ducts become plugged Rash develops	Relocate to cool shady area Regularly dry the skin
Heat Cramps	Cramping of legs and abdominal muscles Heavy sweating and water loss	Relocate to cool shady area Rest the cramping muscle Drink fluids to replace water loss (Cold water is recommended. Avoid drinking alcoholic and caffeinated drinks.)
Heat Exhaustion	Pale, clammy skin Heavy sweating Large pupils Rapid, shallow breathing	Relocate to cool shady area Remove PPE Treat for shock Give fluids if conscious Seek medical attention if disorientation, vomiting, or fainting occur
Heat Stroke	Red, flushed Very hot and dry skin, no perspiration (old sweat may be present) Confusion and delirium May become unconscious Body temperature is 104 °F or higher	Seek medical attention immediately! Relocate to cool shady area Monitor breathing Remove PPE Immediately cool with cold water and fan Treat for shock

Appendix F
BIOLOGICAL HAZARDS FACT SHEET

DTSC
BIOLOGICAL HAZARDS FACT SHEET

DEPARTMENT OF TOXIC SUBSTANCES CONTROL

DTSC field staff have the potential to encounter a variety of biological hazards during the performance of various field activities. This fact sheet was developed to assist DTSC field staff with recognizing, avoiding and providing first aid for some of the common biological hazards present in California.

Ways to Recognize Poison Oak

"Leaves of Three, Leave it Be; Berries White, Poisonous Site"

Poison oak typically has groupings of three leaves (occasionally five). It may exist as a woody shrub or may climb, vine-like up the sides of trees.

Poison Oak is a bright green color in the spring, often with white berries and yellow-white flowers. The leaves gradually turn red during the summer and become dry and fall off during the fall.

In the winter, the bushes typically do not have leaves, but branches may still be covered in Urushiol that can transfer to your skin.

SNAKES

Avoidance Methods

- Wear appropriate shoes outdoors, preferably boots that cover the ankles.
- Avoid stepping or placing hands where you cannot see.
- Do not handle any snake, even one suspected to be dead.
- Wear snake gaiters when walking through tall grasses or in other areas where snakes may be encountered.

First Aid For Poisonous Snakes

- If not sure whether snake is poisonous, treat as such.
- Keep the victim calm.
- Remove restrictive clothing, shoes, or jewelry from bitten body part.
- Wash wound with soap and water.
- Follow general first aid for bleeding/puncture wounds, except **DO NOT apply an ice pack or cold pack to the wound.**
- Keep the bite at or below the level of the heart.
- DO NOT cut into the wound or try to suck out the venom with your mouth.
- DO NOT apply a tourniquet to the wound.
- Seek professional medical attention as soon as possible.

POISON OAK

Poison Oak is common throughout California below elevations of 5,000 ft. Poison oak produces an oil, called Urushiol, that can cause an allergic reaction in most people. The oil typically causes an irritating and sometimes painful rash and sometimes blistering of the skin. The rash may not appear for several days after the exposure to the oil.

Avoidance Methods

- Be on the look-out for and avoid performing work near poison oak plants
- Wear long pants and sleeves if work tasks have the potential for contact with poison oak
- Wash skin, clothes, shoes and other items that may come in contact with poison oak.
- The oil may stay active on surfaces for up to 5 years.
- Avoid touching face with hands that may be contaminated with Urushiol.
- Wash hands regularly in the field
- After field work in areas with poison oak, take a cold shower and thoroughly wash skin. DO NOT take baths.
- Wash potentially contaminated clothing separately

Seek medical attention for rashes that are severe or are located near the eyes.

MOSQUITOES

Mosquitoes can transmit West Nile Virus, which can lead to serious and potentially fatal illnesses. Mosquitoes are likely to be present in areas with standing water.

Avoidance Methods

- Avoid field work at dusk or dawn when mosquitoes are more active.
- Use an insect repellant with DEET when outdoors.
- Wear long sleeves and pants to limit exposed skin.

Insect Repellant, Snake Gaiters, Urushiol Removing Wipes & Poison Oak pre-contact towelettes are available from the DTSC HSP staff.

Appendix F
BIOLOGICAL HAZARDS FACT SHEET

Stinging Insects

Stinging insects include bees, wasps, and hornets. For most people, stings will cause discomfort or pain at the sting site, and possibly swelling. For people allergic to the venom, a sting can cause a severe, potentially life-threatening reaction.

Avoidance Methods

- Be observant of work area and pay attention to potential nest sites. Insects may be more aggressive near nests.
- Do not wear perfume, cologne, scented lotions or brightly colored clothing when working outdoors, which may attract insects.
- Do not swat at insects that fly near you.
- Keeps lids on beverages outdoors.
- Do not attempt to remove nests. Call a professional.

First Aid for Stings

- For bee stings, remove the stinger as soon as possible.
- Remove jewelry or constrictive clothing near the sting site in case of swelling.
- Wash the sting site with soap and water, treat with disinfectant.
- Watch for signs of an allergic reaction: difficulty breathing, dizziness, severe swelling. Seek Medical Attention.

POISONOUS SPIDERS

Black widow spiders are located throughout California. Their venom is a systemic venom that can cause various symptoms including severe muscle pain and cramps, weakness, sweating, headache, itching, nausea, difficulty breathing and high blood pressure. Black widow spiders generally prefer dark, quiet places, such as well boxes, electrical boxes, and storage sheds.

The brown recluse spider is not found in California, but its cousin, the **desert recluse spider,** can be found in the desert regions of southern California. Bites from recluse spiders typically produce little or no pain at first, but can lead to the development of a slow healing, necrotic lesion. In severe cases, tissue surrounding the bite site can dies.

First Aid for Spider Bites

- Wash the bite site.
- Apply a cold compress to the area.
- Remove any jewelry near the bite site in case swelling occurs.
- Seek medical attention and anti-venom for black widow bites.
- Seek medical attention if the bite victim experiences nausea, vomiting, fever, chills, or difficulty breathing.

Mountain Lions

If you encounter a mountain lion, **do not run.** Instead face the animal, wave your arms to make yourself appear larger and make lots of noise.

Avoid crouching or bent positions that may make you appear like a deer to mountain lions looking for food.

TICKS

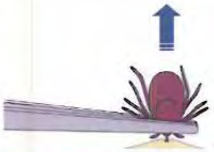
Ticks carry a bacterium in there stomach that can cause Lyme Disease. The bacteria may be transmitted during a tick bite.

Avoidance Methods

- Avoid areas that ticks prefer such as wooded or bushy areas with high grass and a lot of leaf litter.
- Use an insect repellant with DEET.
- Wear sleeves and long pants to keep ticks off skin. Tuck pants into socks.
- Wear a hat to cover your head in wooded areas.
- Check yourself and your coworkers for ticks after leaving wooded or bushy areas.
- Wear light colored clothing to make ticks more visible.
- Remove observed ticks as soon as possible.

Embedded Tick Removal

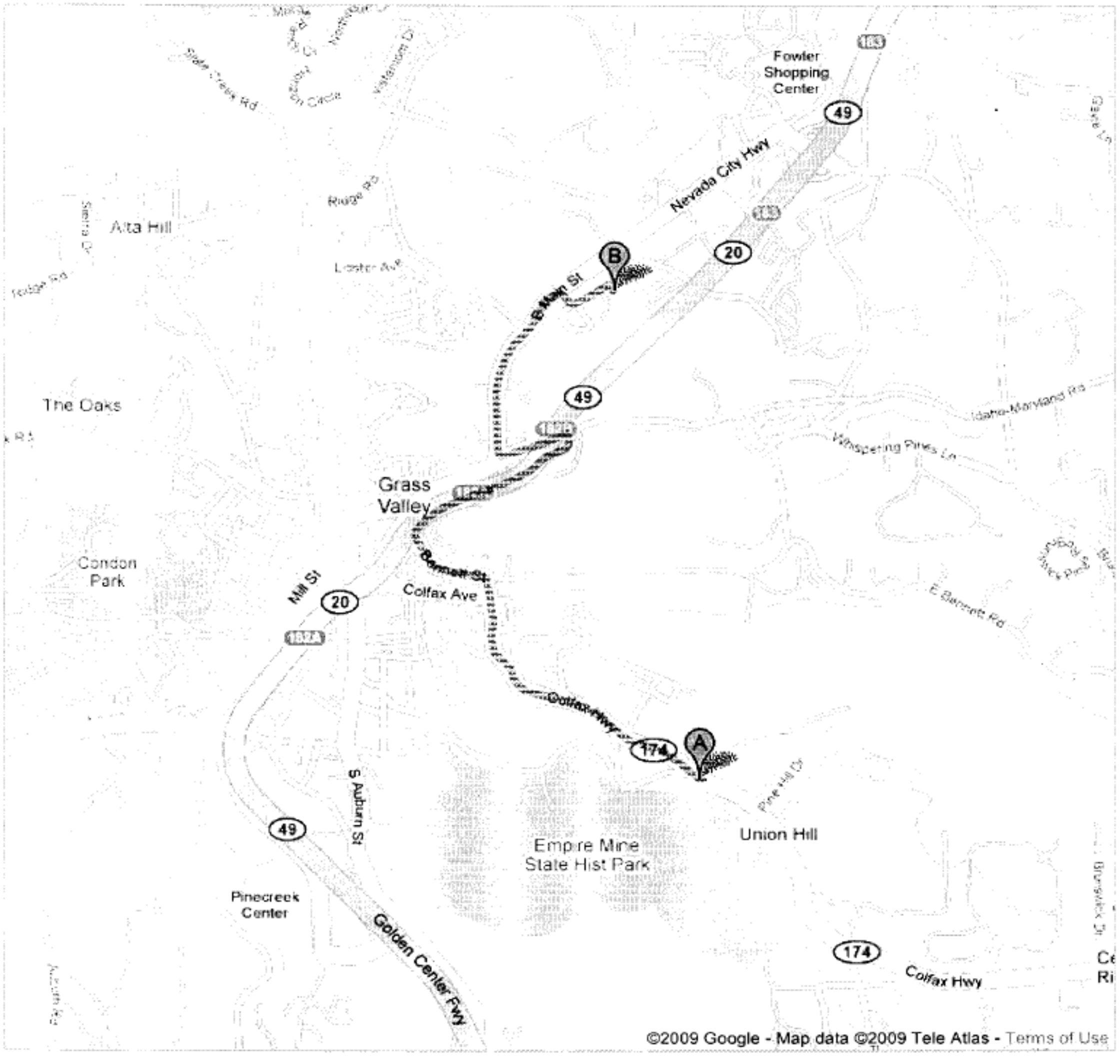
- Using blunt forceps or tweezers, grasp the tick as close to the skin as possible and gently pull.
- If possible, save the tick in a bag or jar and take to doctor.
- Avoid crushing the tick's body.
- Do not twist or jerk the tick out, which can cause the head to remain imbedded.
- DO NOT use matches, flames, gasoline, petroleum jelly, nail polish or similar products.
- Clean the bite site thoroughly.



Directions to Sierra Nevada Memorial Hospital

155 Glasson Way, Grass Valley, CA 95945 - (530) 274-6000

2.8 mi – about **7 mins**



A Empire Mine State Historic Park
10791 E Empire St, Grass Valley, CA 95945 - (530) 273-8522

	1. Head **east** on **E Empire St** toward **Honeysuckle Ln**	go 85 ft total 85 ft
(174)	2. Sharp **left** at **CA-174/Colfax Ave** About 3 mins	go 1.0 mi total 1.0 mi
↰	3. Turn **left** at **E Bennett St/Union Hill Rd** About 1 min	go 0.3 mi total 1.3 mi
(20)	4. Turn **right** to merge onto **CA-20 E/CA-49 N**	go 0.3 mi total 1.6 mi
	5. Take exit **182B** for **Idaho Maryland Rd**	go 0.2 mi total 1.8 mi
↰	6. Turn **left** at **Idaho Maryland Rd** About 1 min	go 0.2 mi total 2.0 mi
↱	7. Turn **right** at **E Main St** About 1 min	go 0.6 mi total 2.6 mi
↱	8. Turn **right** at **Presley Way**	go 315 ft total 2.7 mi
↰	9. Turn **left** at **Catherine Ln**	go 0.1 mi total 2.8 mi
↱	10. Turn **right** at **Glasson Way**	go 128 ft total 2.8 mi

B Sierra Nevada Memorial Hospital
155 Glasson Way, Grass Valley, CA 95945 - (530) 274-6000

SITE SAFETY STANDARD
OPERATING PROCEDURES

To prevent injuries and health effects, the following safe work practices are to be followed when dealing with site hazards. These practices establish a pattern of general precautions and measures for reducing the risks associated with the established scope of work. This list is not inclusive and shall be amended as necessary.

1. Eating, drinking, chewing gum or tobacco, taking medications, and smoking are prohibited in contaminated or potentially contaminated areas, or where the possibility for the transfer of contamination exists.

2. Upon leaving contaminated or suspected contaminated areas, hands and face must be thoroughly washed. A thorough shower and washing must be taken should excessive body contamination occur.

3. Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling on the ground or leaning or sitting on drums, equipment, or the ground. Do not place monitoring equipment on potentially contaminated surfaces.

4. No beard or facial hair may be worn which interferes with a satisfactory respirator fit test.

5. Be familiar, knowledgeable, and adhere to all instructions in the Health and Safety Plan. A safety meeting shall be held at the start of each project to discuss this plan. Additional meetings shall be held, as necessary to address new or continuing safety and health concerns.

6. Be aware of the location of emergency phone numbers.

7. Personnel going on-site shall be briefed on the anticipated hazards, equipment requirements, safety practices, emergency procedures, and communication methods.

8. Entrance and exit routes should be planned, and emergency escape routes delineated.

9. Unfamiliar operations should be rehearsed prior to implementation.

10. Whenever respiratory protective equipment is in use, the buddy system must be used. Buddies should prearrange hand signals or other means of emergency communication in case of lack of radios or radio breakdown.

11. Visual contact must be maintained between pairs on-site with the team members remaining in close proximity in order to assist each other in case of emergencies.

12. The number of personnel and equipment in the contaminated area should be minimized consistent with site operations.

13. Appropriate work areas should be established for support and exclusion areas.

14. Establish appropriate decontamination procedures for leaving the site.

15. Report all injuries or illnesses, unsafe conditions, practices or equipment immediately to the site safety officer.

APPENDIX 6

Site Sampling Schedule

Site Sampling Schedule

First Sampling Event:

- Late summer - Collect and sample approximately 10 locations. Approximately four days of field effort.

Second Sampling Event:

- Fall - Collect and sample approximately 5 locations. Approximately two days of field effort.

APPENDIX 7

Forms

State of California – California Environmental Protection Agency
Department of Toxic Substances Control

HAZARD APPRAISAL AND RECOGNITION PLAN PRESITE VISIT FORM

SECTION A. FIELD TEAM

Prepared by: ____________________
Date: ____________________
Phone: (   ) ____________________

	Name	Unit/Agency	Responsibility (Lead Field Staff)
1.			
2.			
3.			
4.			
5.			
6.			

SECTION B. SITE DESCRIPTION

Site Name: ____________________
PCA No: ________ Project #: ____________ WP: ______
Address: ____________________
City: ____________ State: ______ Zip: ______
Site Phone No: (   ) ____________________

NOTE: Attach Map of Site and Directions to Hospital

Contact Person: ____________________
Type of Operation/Waste Stream (Describe): ____________________
Purpose of Visit (Describe): ____________________
Site Visit Date (s): ____________________
Estimated Time on Site: Hours/Day: ________ Days: ________
Nearest Hospital and Address: ____________________
Phone No.: (   ) ____________________

SECTION C. NUMBER OF SAMPLES TO BE COLLECTED

Air; ________
Drum (s): ________
Groundwater: ________
Soil/Sediment: ________
Sump/Pit: ________
Surface Impoundment: ________
Surface Water: ________
Tank (s): ________
Waste/Sludge: ________
Other: ________

SECTION D. POTENTIAL HAZARDS

1. Chemical Hazards

☐ Carcinogens: ________
☐ Corrosives: ________
☐ Developmental Health Hazards (Teratogen): ________
☐ Explosives: ________
☐ Dusts: ________
☐ Flamables: ________
☐ Inorganic Vapor Gases: ________
☐ Metals: ________
☐ Oxidizers: ________
☐ PCBs: ________
☐ Pesticides: ________
☐ Reproductive Health Hazards: ________
☐ Skin Absorption: ________
☐ Solvents: ________

2. Physical Hazards

☐ Confined Space (Source: ________)
☐ Heat or Cold Stress (Expected (Temp: ____ °F)
☐ Machinery Construction: ________
☐ Noise (Source/Decibels): ________
☐ Oxygen Deficiency: ________
☐ Radioactive materials: ________
☐ Biohazards: ________
☐ Other(Specify):

(Use this space to describe hazards)

SECTION E. BASIC INFORMATION ON POTENTIAL HAZARDS

(Attach copies of HARP Chemical Data Sheets or other appropriate information as suggested in instructions.)

SECTION F. EXPOSURE CONTROL METHODS

☐ Engineering (E) ☐ Administrative (A) ☐ Work Practices (WP)

Describe:

SECTION G. REQUIRED PERSONAL PROTECTIVE EQUIPMENT

Level of Protection: ☐ B ☐ C ☐ D

Gloves (s) Outer = O, Inner = I

☐ Cotton/Vinyl
☐ Silver Shield/4H
☐ Neoprene
☐ Nitrile
☐ Grip/Glove/Kevlar (when needed)
☐ Viton

Suit:

☐ Tyvek
☐ P.E. Tyvek
☐ Saranex
☐ PVC
☐ Tychem

Respirator: ☐ A/P Cartridge: ______ ☐ SCBA ☐ Escape

Other Safety Gear:

☐ Boot Covers
☐ Boots
☐ Hard Hats
☐ Hearing Protection
☐ Eye Protection
☐ Other:
Plugs ☐ Muffs ☐
☐ Safety Vest

SECTION H. SURVEY EQUIPMENT

☐ Combustible Gas/Oxygen Meter
☐ Photoionization Detector
☐ Organic Vapor Analyzer (OVA)
☐ CMF Chip (Specify:) ________
☐ PAC III
☐ Other (Specify:)
☐ Radiation Meter
☐ Lamp: ______
☐ Aerosol/Particle Monitor
☐ Noise Dosimeter
☐ WBGT Meter

SECTION I. OTHER HYGIENE AND SAFETY EQUIPMENT

Available On Site	Bring	
☐	☐	Canopy/Tarp/Umbrella
☐	☐	Drinking Water
☐	☐	Shower/Eye Wash
☐	☐	Fire Extinguisher
☐	☐	First Aid Kit
☐	☐	Plastic Sheeting/Buckets/Bags
☐	☐	Portable Toilets
☐	☐	Washing Facilities

SECTION J. PERSONAL MONITORING

Do You Need Industrial Hygiene Monitoring? ☐ Yes ☐ No

SECTION K. REVIEW/APPROVAL

____________________ ________
Industrial Hygienist (Review) Date

____________________ ________
Supervisor (Approval) Date

DTSC 1031 (6/12/03)
(Formerly DHS 8299 A)

(Original—Exposure Records Copies—Site File, Department, Supervisor)

(Page 1 or HARP completed on __________)
(Form No. From Page 1 _______)

HAZARD APPRAISAL AND RECOGNITION PLAN DAILY SITE VISIT DOCUMENT

SECTION A. PREPARED BY (Site safety Officer): ____________________

Date: ____________________ Phone: ( )

Site Name: ____________________

Site Visit Date: ____________________ Time on Site (hours): ____________________

Describe Work Performed:

SECTION B. DTSC PERSONNEL	**Protection Level**	**Duration PPE Worn (hours)**	**Activity Performed:**
1.			
2.			
3.			
4.			
5			
6.			

SECTION C. DESCRIBE TYPE OF PERSONAL PROTECTIVE EQUIPMENT WORN (Personnel identified by number used above):

1. Clothing	Gloves	Respirator (cartridge)	Other
2. Clothing	Gloves	Respirator (cartridge)	Other
3. Clothing	Gloves	Respirator (cartridge)	Other
4. Clothing	Gloves	Respirator (cartridge)	Other
5 Clothing	Gloves	Respirator (cartridge)	Other
6. Clothing	Gloves	Respirator (cartridge)	Other

SECTION D. DID RESPIRATOR BREAKTHROUGH OCCUR? ☐Yes ☐No Explain: ____________________
WERE THERE ANY PROBLEMS? ☐Yes ☐No Explain: ____________________

SECTION E. SURVEY EQUIPMENT USED AND READINGS OBTAINED

Instrument	**Location**	**Time**	**Reading**	**Description/Background**
1.				
ID No.:				
Calib. Date:				
2.				
ID No.:				
Calib. Date:				
3.				
ID No.:				
Calib. Date:				

SECTION F. WAS PERSONAL MONITORING CONDUCTED? ☐ Yes Type: ☐No

SECTION G. SAMPLES COLLECTED:

SECTION H. INDICATE METHOD(S) OF DECONTAMINATION OF PPE/MONITORING EQUIPMENT/VEHICLES
Describe:

SECTION I. EXPOSURE SYMPTOMS? ☐Yes ☐No If yes, check items below; identify personnel number used above.

- ☐ Nose/ Throat Irritation
- ☐ Headache
- ☐ Heat Stress
- ☐ Faint/Dizzy
- ☐ Chills
- ☐ Skin Irritation
- ☐ Eye Irritation
- ☐ Physical Injuries
- ☐Nausea
- ☐Other:

Explanation (Identify personnel by number used above.):

Person	**Effects Reported to Supervisor**		**Effects Reported to industrial Hygienist**		**Medical Treatment Given (Explain)**		**Explanation**
	Yes	No	Yes	No	Yes	No	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	

(Original – Exposure Records, Copies – Site File, Department, Supervisor)

XRF SAMPLE LOG

Site:			Date:	Page:
Reading #	Sample #	Fe	As	

PHOTO LOG

Site:	Date:	Page:

Photo #	Sample #	Description

Alternate photo log

Report Photo Log

Site Name:	
Photo #	
Address:	
Date:	
Investigator:	
Samples taken: Y / N #________	

Description:

Site Name:	
Photo #	
Address:	
Date:	
Investigator:	
Samples taken: Y / N #_________	

Description:

TRENCH LOG

SITE: ______________________ DATE: ______________

TRENCH ID: ______________________ TIME: ______________

SAMPLER: ______________________ WEATHER: ______________

TRENCH MAP: MAP SCALE: ______________

FIELD_NOTES