Harquahala Mine PA/SI Work Plan

CENE 486C

Prepared for:

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1.0 Project Description

1.1 Project Objectives

The purpose of this project is to investigate the Harquahala mine site and perform a preliminary assessment (PA) and site investigation (SI) to identify potential risks to the environment and public health due to contamination present at the site. Remedial actions for this site will be assessed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) by using data from the PA/SI [1].

1.2 Project Scope

Tasks to be completed for this project include the development of a Sampling and Analysis Plan (SAP), Health and Safety Plan (HASP), soil sampling at the site, x-ray fluorescence (XRF) analysis to determine contaminants of concern and their concentrations and spatial extents, and performance of a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment, which will inform the development of remedial alternatives and final selected remedial design.

1.3 Project Schedule

The total duration of the project will be 142 days, beginning October 22nd, 2023, and ending May 7th, 2024. The site investigation is scheduled for January 19-20th, 2024, so sample processing and analysis will take place from the end of January through February 2024. The risk assessments will be performed throughout March, and in April the remedial action will be developed and designed.

Milestone deliverables for this project are outlined in Table 1.1 below:

Table 1.1 Project deliverables

30% report	February 16, 2024
60% report	March 15, 2024
90% report	April 19, 2024
Final report	May 7, 2024

2.0 Site Background Information

2.1 Site Location

Figure 2.1 shows the Harquahala Mine is located 26 miles south of Salome and 95 miles northwest of Phoenix.

Figure 2.1. Location map of Harquahala Mine in reference to Phoenix, Arizona [2]

Table 2.1 details the site's GPS locators.

Table 2.1. Site location details

Property location	Gila-Salt River Township 004N Range 013W Section 022
Latitude	N 33°40'03"
Longitude	W 113°35'26"

Figure 2.2 shows the road access of the Harquahala Mine from Highway 10 with reference to Salome.

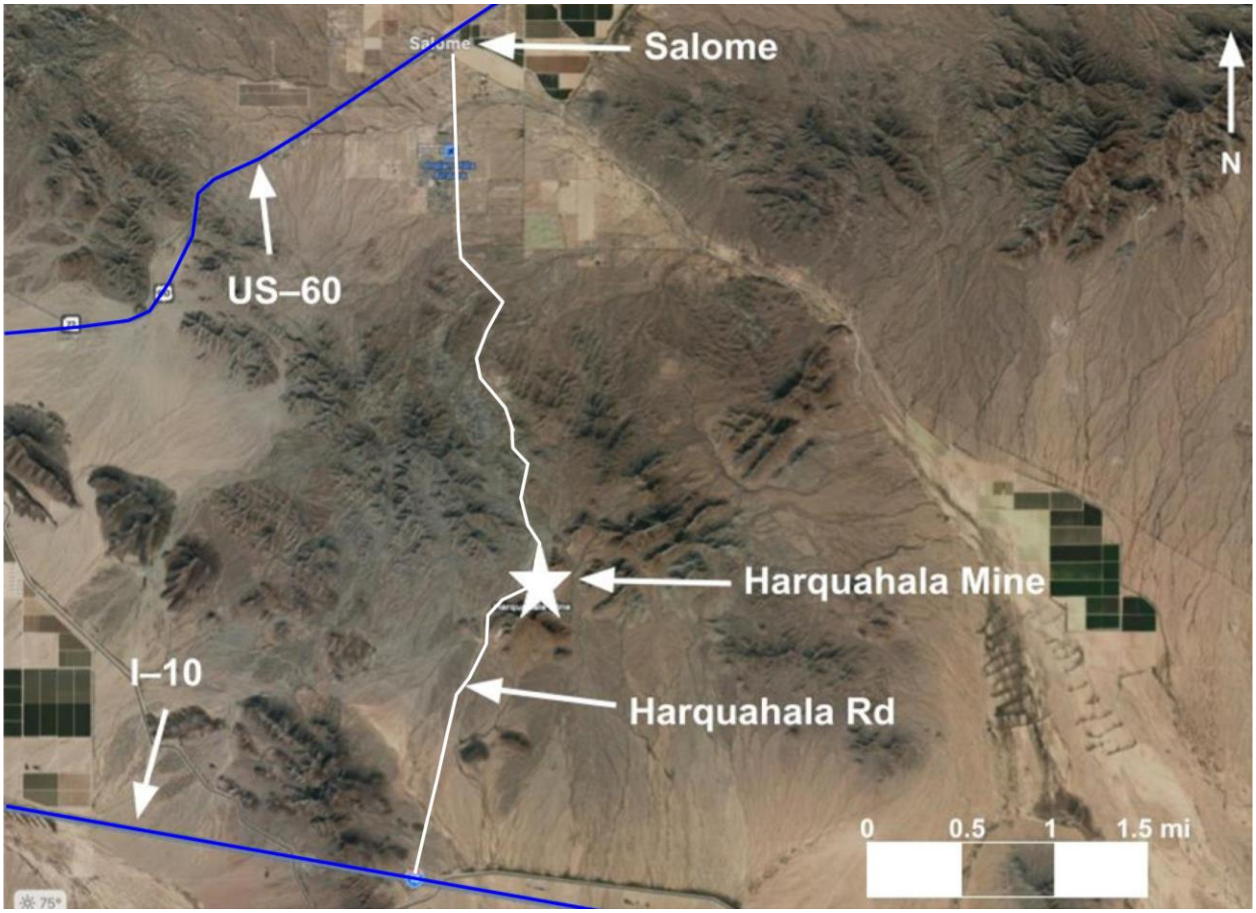

Figure 2.2. Harquahala Mine access road in reference to Salome [2]

Figure 2.3 below shows the site boundary for the project.

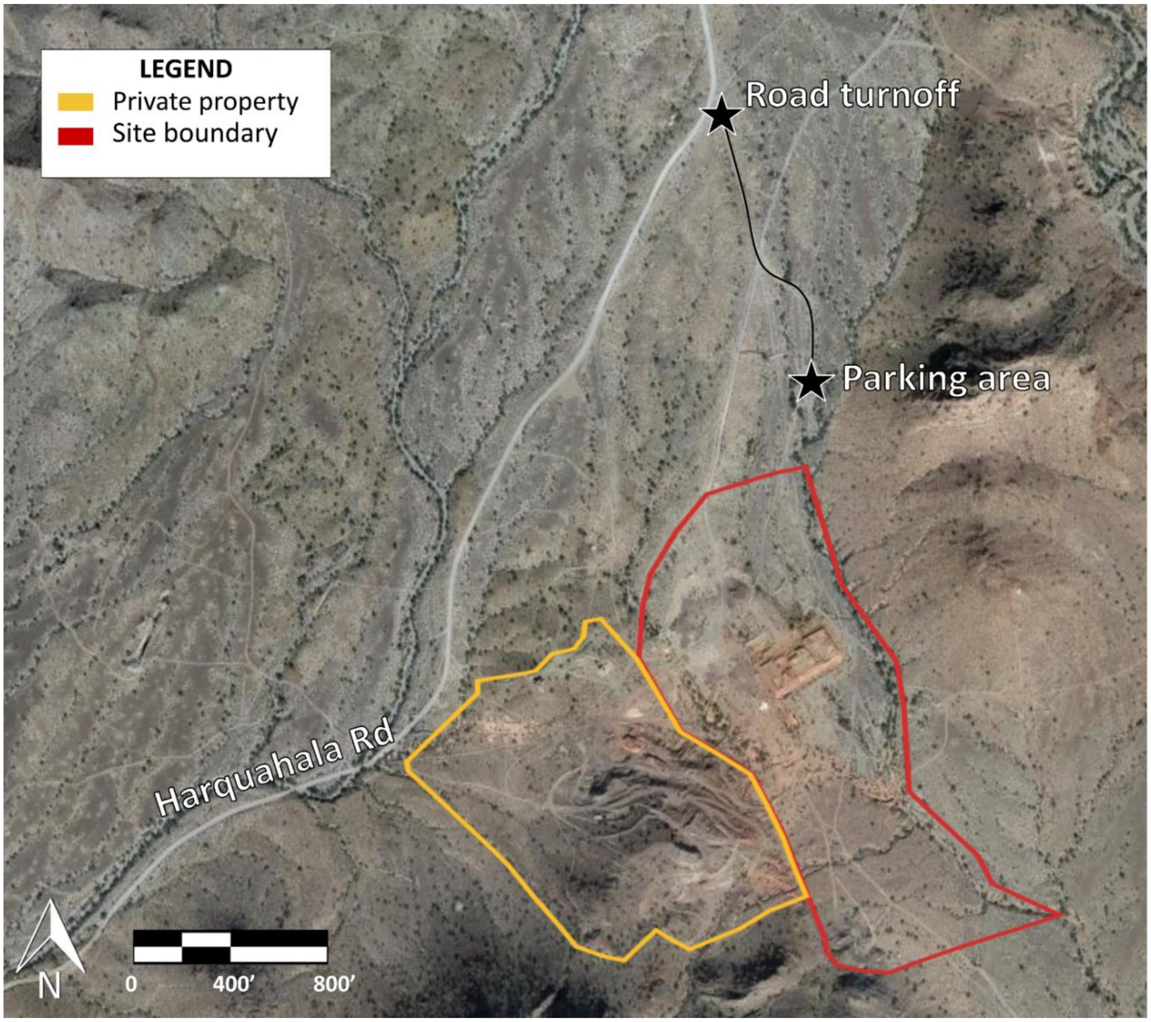

Figure 2.3. Harquahala site summary

2.2 Site Description

As shown in Figure 2.3 above, the site consists of approximately 51 acres of public land adjacent to the privately held land. The private land contains the mine itself plus areas for heap leach operations. A tailings pile is evident on the public land north of the public land. Based upon the location of this tailings pile, it is likely that historic operations at the mine such as stamp milling was performed on the public land.

2.3 Site History

Mining operations began as early as 1888, with sporadic working until the 1980s; The mine was owned by David Oberstine of Golden Eagle Mining Co. during the 1960s [3]. Since 1985 the Bonanza Mining Company (Ray Wreggit) has owned the mine, and currently is performing heap leach operations. The Harquahala Mine was historically mined for gold, silver, lead, and copper using a stamp mill since 1888 and heap leaching since 1896. Approximately 180,000-200,000 ounces of gold have been mined since the late 1800's; the Bonanza Mining Company recovered another 150,000-300,000 ounces of gold with their most recent claim [3]. Most of the contamination at the site occurred in the 1970s and 1980s as cyanide heap leaching operations were common at the time. No documentation of cleanup operations was found.

2.4 Previous Investigations

The most recent field investigation at the Harquahala mine site took place on March 9, 2018, by the BLM. Nine in-situ x-ray fluorescence (XRF) surface soil readings were taken on the tailings pile and surface soils downwash as shown in Figure 2.5

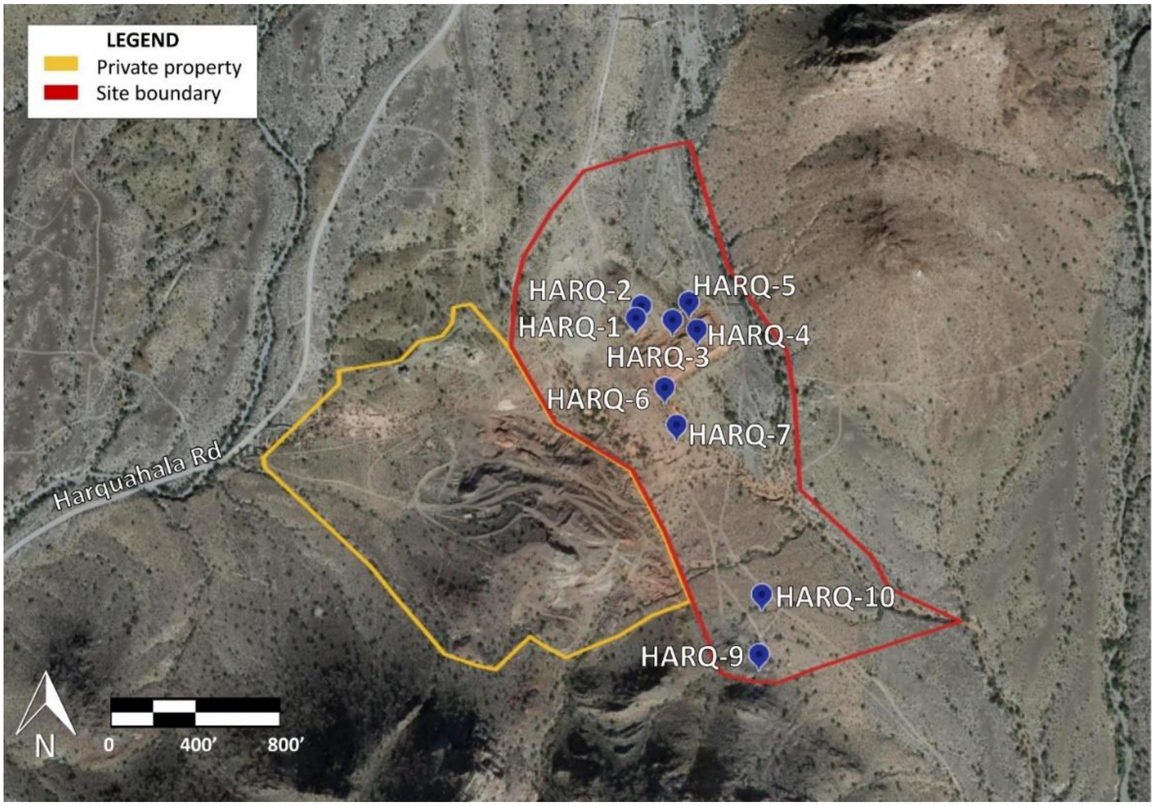

Figure 2.4. XRF sampling locations from 2018 study

The XRF results are shown in Table 2.2 where cells highlighted in red exceed the Arizona non-residential soil remediation standard and those in yellow lie between the Arizona residential and non-residential standards. These results indicate that lead and arsenic are likely contaminants of concern.

Table 2.2. X-ray fluorescence results from 2018 field study [4]

SAMPLE	Units	Latitude	Longitude	Pb	Pb Error	As	As Error	Sb	Sb Error
AZ Remediation Standard (Residential/Non-Residential)				400/800		10/10		31/410	
harq-1	ppm	33.670573	-113.589056	3467.73	132.82	<LOD	148.02	219.02	18.79
harq-2	ppm	33.670424	-113.589009	1228.35	25.93	56.3	19.32	55.24	8.12
harq-3	ppm	33.670291	-113.588466	2519.63	55.18	196.72	41.76	160.96	15.15
harq-4	ppm	33.670428	-113.588136	2517.86	57.9	133.29	43.29	195.47	23.15
harq-5	ppm	33.670774	-113.588257	2522.42	41.9	160.47	31.48	134.11	10.95
harq-6	ppm	33.669696	-113.588618	1764.09	30.04	82.69	22.38	79.5	7.61
harq-7	ppm	33.669225	-113.588437	4578.83	59.46	356.07	44.95	184.39	12.06
harq-9	ppm	33.666342	-113.587199	693.26	20.02	<LOD	22	33.92	8.03
harq-10	ppm	33.667088	-113.587147	1885.54	33.51	99.14	25.05	74.59	8.49

3.0 Project Management

Table 3.1 shows management roles for this project.

Table 3.1. Project Management

Position	Name	Role
Client	Eric Zielske, P.E. (*BLM-State Office*)	Serves as primary BLM contact
Project Manager and Technical Advisor	Dr. Bridget Bero, P.E. (*NAU*)	Manage quality of project deliverables and answer technical questions
Field Geologist	Aaron Jacobsen (*BLM-Field Office*)	Answer questions regarding site conditions and history
Laboratory Manager	Adam Bringhurst (*NAU*)	Oversee all lab safety protocol and lab hazardous waste disposal
QA/QC Officer	Elda Silva (*NAU*)	Organize and maintain all QA/QC protocol throughout SI and in-lab work
Health and Safety Officer	Sierra Binney (*NAU*)	Ensure adherence to all safety protocol throughout SI and in-lab work

4.0 Field Methods & Procedures

The field methods and procedures will follow the Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP), located in Appendices A and B.

5.0 Deviations from the Work Plan

Any instance related to site operations that deviate from this Work Plan will be authorized either by BLM lead, Eric Zielske, or NAU Technical Advisor, Bridget Bero. Deviations related to laboratory operations will be authorized by the QA/QC Officer. All deviations from the Work Plan will be documented in the field or lab notebooks.

6.0 References

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Appendix A

Harquahala Mine PA/SI
Sampling and Analysis Plan

CENE 486C

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1.0 Introduction

1.1 Responsible Agency

Viperidae Tech will conduct this Sampling and Analysis Plan (SAP) under the guidance of the BLM-Arizona State Office.

1.2 Project Organization Table

People involved in the SAP activities and their roles are included in Table A.1.1. below:

Table A.1.1. Project personnel & roles

Title/Responsibility	Name
Technical Advisor (NAU)	Dr. Bridget Bero, P.E.
Staff Engineer	Jack Priniski
Staff Engineer	Bohao Liu
Staff Engineer, QA/QC Officer	Elda Silva
Staff Engineer, HS Officer	Sierra Binney
Client (BLM)	Eric Zielske, P.E.

1.3 Sampling Overview

At the site a combination of grid, transect, and incremental sampling methodology (ISM) sample types will be conducted, resulting in a total of approximately 60 surface soil samples. Up to ten hotspot samples (surface plus up to three core) and three background samples will be collected.

2.0 Project Data Quality Objectives and QA/AC Methods

2.1 Project Objectives

The Harquahala mine site and adjacent area will be subjected to a site investigation to identify all contaminants of concern. The spatial distribution and migration paths of COCs will be determined via soil sampling. Data from the site investigation will be used to estimate ecological and human health concerns.

2.2 Data Quality Objectives

The Data Quality Objectives (DQOs) procedure is used by the Environmental Protection Agency to identify acceptable types, quality, and quantity of environmental data [5]. The project's DQOs are to obtain estimates of the indicated COC concentrations that are within an acceptable range of uncertainty suitable for screening level data.

2.3 Quality Assurance and Control

The purpose of quality assurance (QA) and quality control (QC) in field and laboratory are to generate data of acceptable quality to support project objectives. The proper methodologies and operational procedures will be employed, as well as QC checks, to maintain recognized and accepted levels of accuracy and precision for each set of data. Field and laboratory QC samples will be used to check data quality. Each type of quality control sample to be taken is described in this section. Chain of Custody documentation will be used to guarantee that all samples are accounted for and correctly recorded. Every bin containing samples will carry a Chain of Custody Record and Seal. Further details on the chain of custody are in section 3.5.3.

2.3.1 Field QA/QC

During the sampling event, approximately 45-55 soil samples will be obtained; a duplicate sample will be collected at 20% for all samples as field quality control samples to evaluate sampling variability. All obtained field QC samples will be noted in the field logbook. Field duplicates are samples obtained from the same source and under the same conditions as the original sample.

To correctly identify where samples will be taken, the GPS location of the starting sampling point will be used. The remainder of the sampling points for grid sampling will be identified from the starting point using a compass and measuring tape. Each sample point will be flagged; any samples that require duplicates will also be marked on the flag. When collecting the sample, each sample site will be documented with its GPS coordinates, photographed, and logged in the Field Notebook.

To ensure that all samples are collected, the QA/QC officer will keep a sample checklist. The QA/QC officer will verify proper sample bag labeling in accordance with the sample naming scheme mentioned in Section 3.4.

The samples will be stored, safeguarded, and tracked in accordance with the procedures outlined in Sections 3.5 and 3.6 below.

Sampling equipment will be decontaminated according to Section 3.6 below.

In-situ XRF readings will be taken using hand-held XRF (Thermo Scientific Nitron XL3) immediately adjacent to the surface soil sample collection location. The XRF instrument undergoes an internal calibration check every time the device is turned on. Results of the calibration checks will be logged in the Field Notebook.

2.4 Laboratory QA/QC

2.4.1 X-ray Fluorescence

The XRF instrument will be maintained and used in accordance with the manufacturer's instructions, EPA Method 6200, and the Science and Ecosystem Support Division (SESD) Operating Procedure for Equipment Inventory and Management (SESDPROC-108) [6].

For XRF laboratory analyses, each sample will be separated into 9 sub-samples. For each COC, the highest and lowest data points will be removed from the data set, and the remaining 7 data points will be averaged. Based on the reported instrument error, two out of three duplicate XRF readings must be within the 95% confidence interval [7].

A number equal to half the detection limit will be utilized for non-detects.

For each COC, a performance check will be performed prior to use using traceable standard reference material from the National Institute of Standards and Technology (NIST). The NIST traceable standards are located within the XRF kit. A second check will be performed using a sand/silica instrument blank sample. The blank will be examined to ensure that the XRF does not produce false positives. Four XRF measurements of the blank sample will be collected to ensure the instrument is reading below its detection limit. The performance check values must be within 20% of the known values of the standards and blank [6]. All calibration check results will be documented in the Lab Notebook. Before using the instrument for analysis, both checks must be performed.

Every time the XRF turned on, the internal calibration is performed. During XRF operation, the reference standards and blank will be also run at the start of each workday, every 4 to 5 hours of analysis time, after the instrument has been turned off for 1 to 2 hours, if the battery has been changed, and before the instrument is turned off at the end of the operating period. For each measurement, the ambient air temperature will be recorded. The instrument will be recalibrated if the temperature varies by more than 10°F during operation [6].

2.4.2 Sample Control in the Lab

All samples will be appropriately labeled and stored in an assigned, secured area in the CENE Soils Lab.

Precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) are data quality indicators (DQIs) [8]. The details of PARCCS are shown below.

2.4.2.1 Precision

Precision is defined as the degree of agreement between independent measurements of the same property [8]. Field duplicates are used to assess the variability of samples' concentration levels and/or collection processes. This is accomplished by calculating the relative percentage difference between the samples. For soil and sediments, the DQO for duplicates is less than 50 RPD [8]. Precision will be presented as a relative percent difference [RPD] between duplicate readings with Equation A.2.1, below.

Equation A.2.1. Precision

$$\%RPD = \frac{2|O_i - D_i|}{(O_i - D_i)}\ x\ 100\%$$

Where:

%RPD = relative percent difference for the compound i

O_i = value of compound i in original sample

D_i = value of compound i in duplicate sample

2.4.2.2 Accuracy

Accuracy is the degree to which a measurement agrees with an actual value [8]. Previous experience has shown that the XRF provides accurate data for Pb concentrations. However, as concentrations are hampered by the overlap of As and Pb fluorescence frequencies. When significant quantities of Pb are present in the sample, arsenic concentrations tend to be biased high. As a result, seven soil samples will be forwarded to an external laboratory for confirmatory ICP or FAA analysis. Using a correlation curve, the XRF data will be correlated with the ICP/FAA results, and all XRF arsenic readings will be corrected.

2.4.2.3 Representativeness

The degree of accuracy and precision in data is known as representativeness [8]. The QA/QC Officer will guarantee that every sample taken is representative of the site conditions. The proposed sampling locations may be changed to ensure representative sampling rather than excessive background sampling occurs because the team has not yet visited the site. Dr. Bero, the technical advisor, will make any modifications to the sampling strategy while at the site.

2.4.2.4 Completeness

Completeness is defined as the percentage of actual usable data acquired vs the amount expected. Unwanted numbers for completeness can result from not collecting all samples, sample loss, instrument failures, technological errors, and so on. Typical targets are in the 75-90% range. The DQO for completeness for this project is 90%.

2.4.2.5 Comparability

Comparability is the level of confidence surrounding one data set compared to another and does not applicable to this project because no two data sets are identical [8].

2.4.2.6 Sensitivity

The method detection limits (MDLs) represent sensitivity. MDLs for both XRF and ICP/FAA data will be obtained, and any non-detects will be given a numerical value equivalent to half of the MDL.

2.4.3 Cross-contamination

2.4.3.1 In Field

To reduce cross-contamination during sample collection, the following precautions will be taken:

- A new pair of nitrile gloves will be used to collect each sample and will be discarded once the sampling equipment has been decontaminated.
- No sampling staff will touch the inside of the sampling bag.
- All sampling equipment used for sample collection must be fully decontaminated before each use.
- The sample bags will be sealed as soon as the sample has been collected.
- Each sample bag will be properly labeled and recorded in a field logbook.
- Sample bags with pinholes will be double bagged.

2.4.3.2 In Lab

Drying containers, sieves, and XRF cups will be decontaminated between samples to eliminate cross-contamination in the lab. Between sample analyses, all lab equipment and surfaces will be properly cleaned. When handling the samples during analysis, new gloves will be worn for each sample. All containers will be securely closed. All equipment will be rinsed in a designated hazardous waste rinse bucket, which will be provided by NAU EHS. After rinsing, the equipment will be thoroughly cleaned in a sink using a scrub brush and soapy water. Washed sieves will be dried using an air compressor. The sieve shaker will be operated outdoors to prevent indoor exposure to particle fines.

2.5 Data Review, Validation, and Management

In-situ XRF readings will be correlated with their respective ex-situ readings.

An evaluation of the laboratory's performance and sample-specific criteria will constitute the data review and validation process. This is done to remove inappropriate data. After examining all the data, the QA/QC Officer will determine the level of satisfaction of the DQOs. All usable data should adhere to the EPA "National Functional Guidelines for Inorganic Superfund Methods Data Review" [9]. The project report will include a summary of each outcome of the quality review and unaccepted data will be noted.

Microsoft Teams will provide a backup of all excel data files. Files will be downloaded as an excel spreadsheet by connecting the XRF to a computer and stored in Microsoft Team for easy access. All revised file versions will be saved with new names to preserve file history. Both a fellow team member and the QA/QC Officer will review each piece of data obtained.

3.0 Field Sampling Protocols

3.1 Soil Sampling

Approximately 45-57 samples, including duplicates, will be collected at the site, of which 12 will be composite ISM samples, approximately 33 will be individual samples from grid, transect, and background sampling, and up to 12 hotspot samples. Samples will be collected at the surface (0-3") unless otherwise stated. Locations of hotspot and background samples will be identified during the site visit.

The site will be divided into five decision units (DUs):

1. Washes (blue lines)
2. Known former tailings pile (blue shaded rectangle)
3. Area of possible migration around the tailings pile (pink)
4. Area of disturbed soil northwest of the tailings (yellow)
5. Area of possible migration southeast of the tailings (green)

A map showing these decision unit areas, the surrounding roads, and the private land (red) is displayed below in Figure A.3.1.

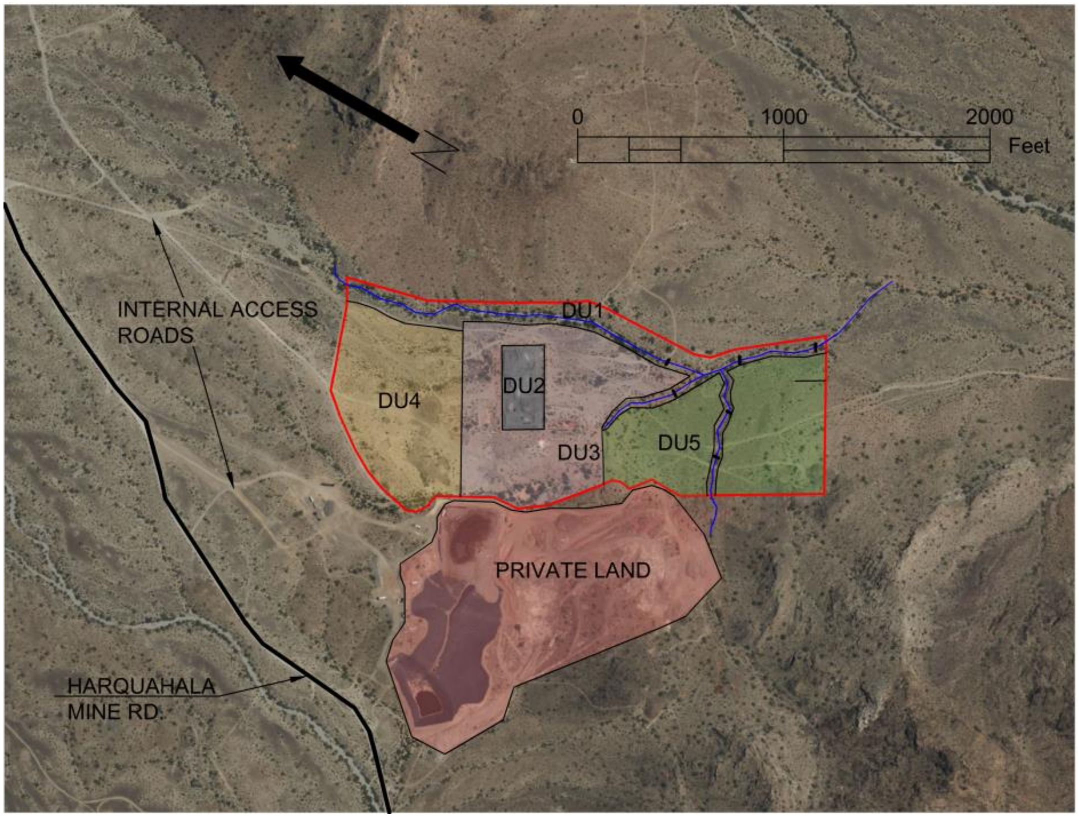

Figure A.3.1. Site Overview

Table A.3.1. DU Sampling Plans

Decision Unit	Sampling Method	# of samples (# of duplicates)
1) Washes	Transect	18 (3)
2) Tailings Pile	Grid	6 (2)
3) Migration around Tailings	ISM	4 (0)
4) Disturbed Soil - NW	ISM	4 (0)
5) Migration - SE	ISM	4 (0)
Background	Random	3 (1)

Approximately 18 transect surface soil samples will be collected in the surrounding washes. The location of the transect wash samples is shown below in Figure A.3.2. Since all washes appear narrow, three samples will be taken: at the right and left banks, and in the thalweg. Should there be a wide section of wash encountered during the site investigation, 4 samples across the transect will be taken and noted. Transects will be approximately 30 feet apart, for a total of 6 transects.

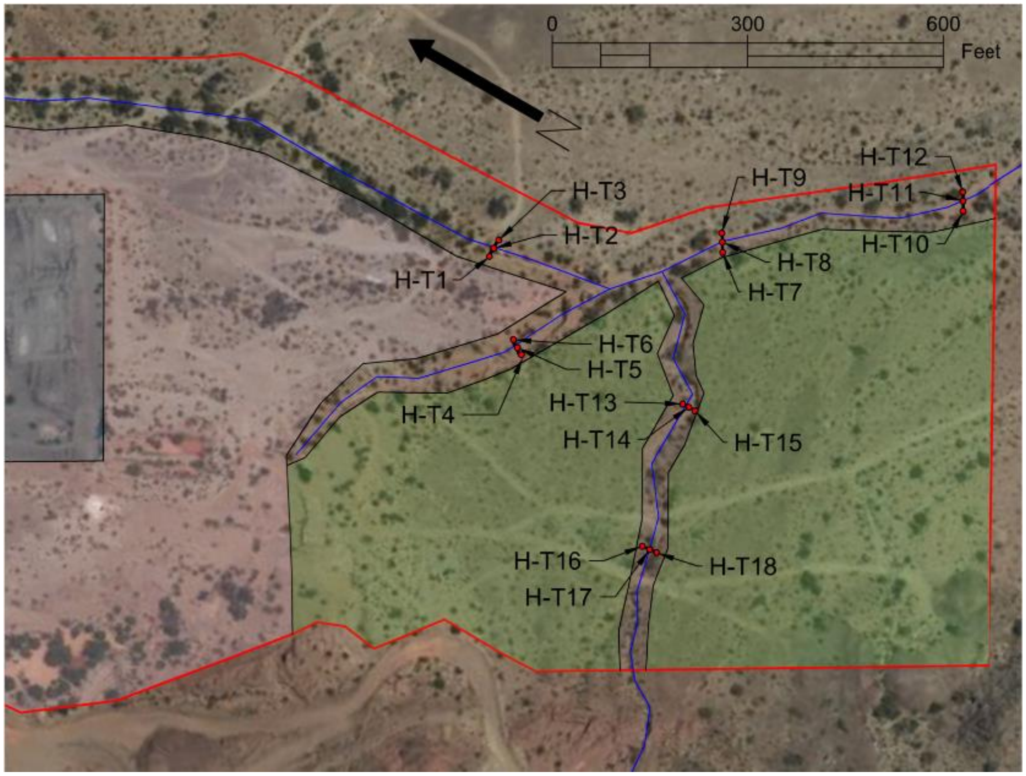

Figure A.3.2. Decision Unit 1 samples

The location of the grid samples that will be taken are defined in Figure A.3.3 and represent DU-2 at the known tailings pile (~170'x350'). The pile will be divided into 6 sections (~85'x175') and a sample will be taken in the center of each grid (~40' from centerline).

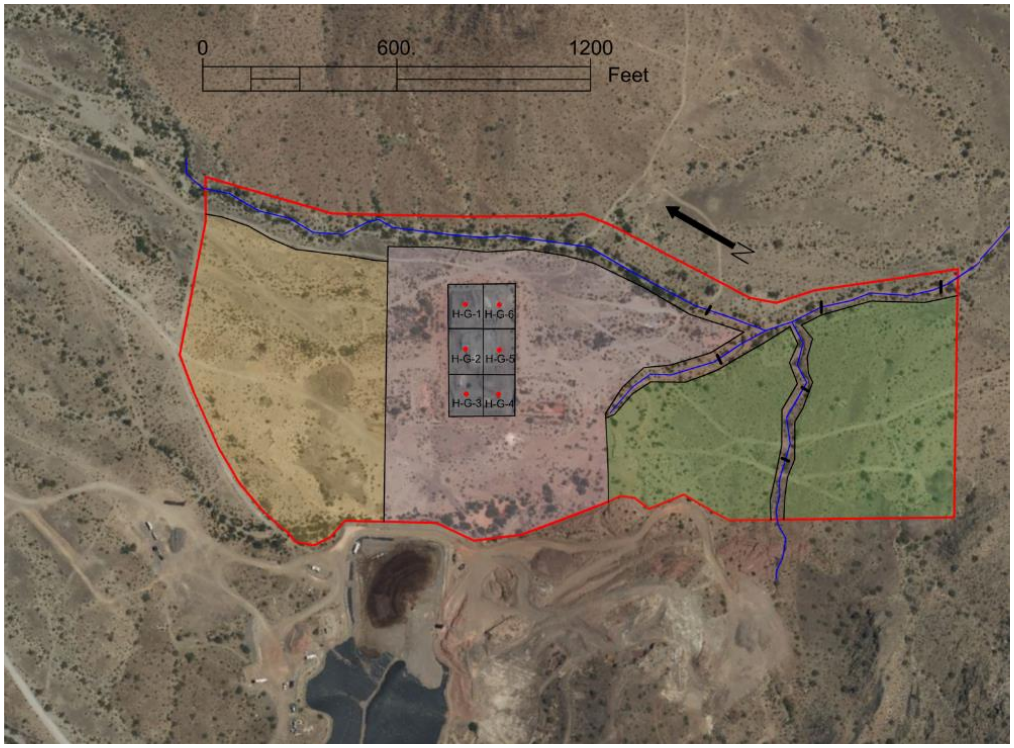

Figure A.3.3. Decision Unit 2 samples

ISM samples in DU-3 around the tailings pile are shown in Figure A.3.4. The DU area is approximately 850 feet east to west by 950 feet north to south. The wash is not considered part of the DU; washes will be sampled as part of DU1. The DU will first be divided into 30 sections of approximately equal area (~120' x 150'). Four sub-samples will be taken in each section, each being combined to ultimately have four total samples for the decision unit.

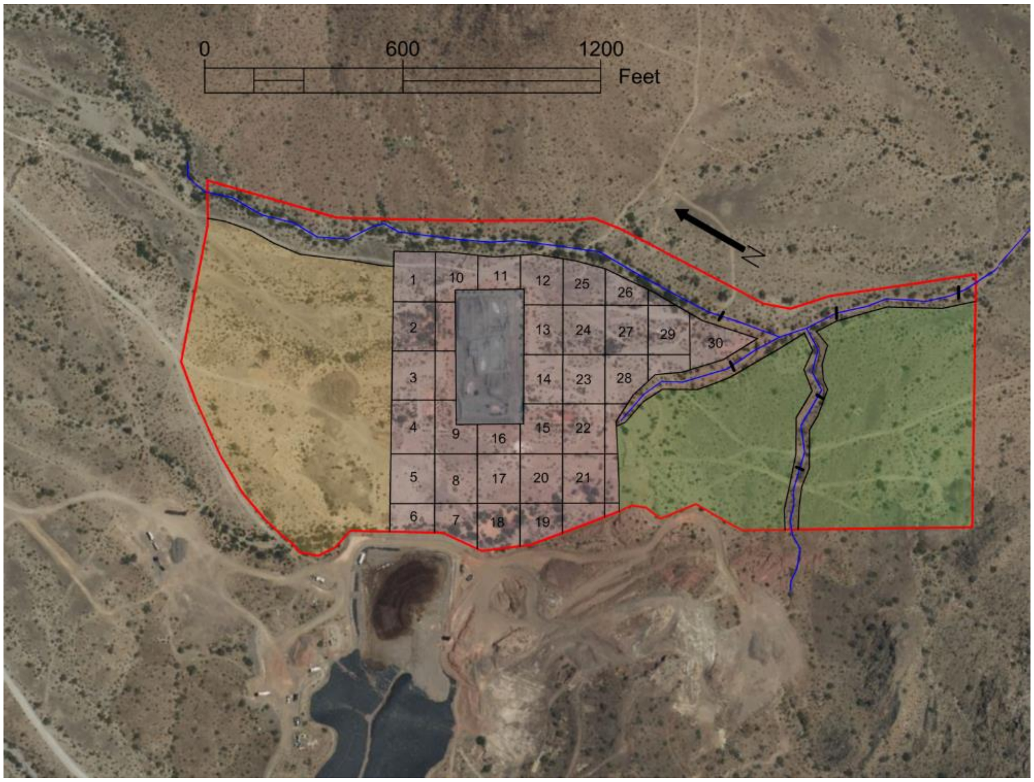

Figure A.3.4. Decision Unit 3 samples

ISM samples in DU4, the disturbed soil area northwest of the tailings, approximately 580 feet by 900 feet, are displayed in Figure A.3.5. The wash dividing the DU is not considered part of the DU; washes will be sampled as part of DU1. Similar to DU3, 30 (~ 145' x 155') sections will be flagged, and four homogenous samples will be collected from this decision unit.

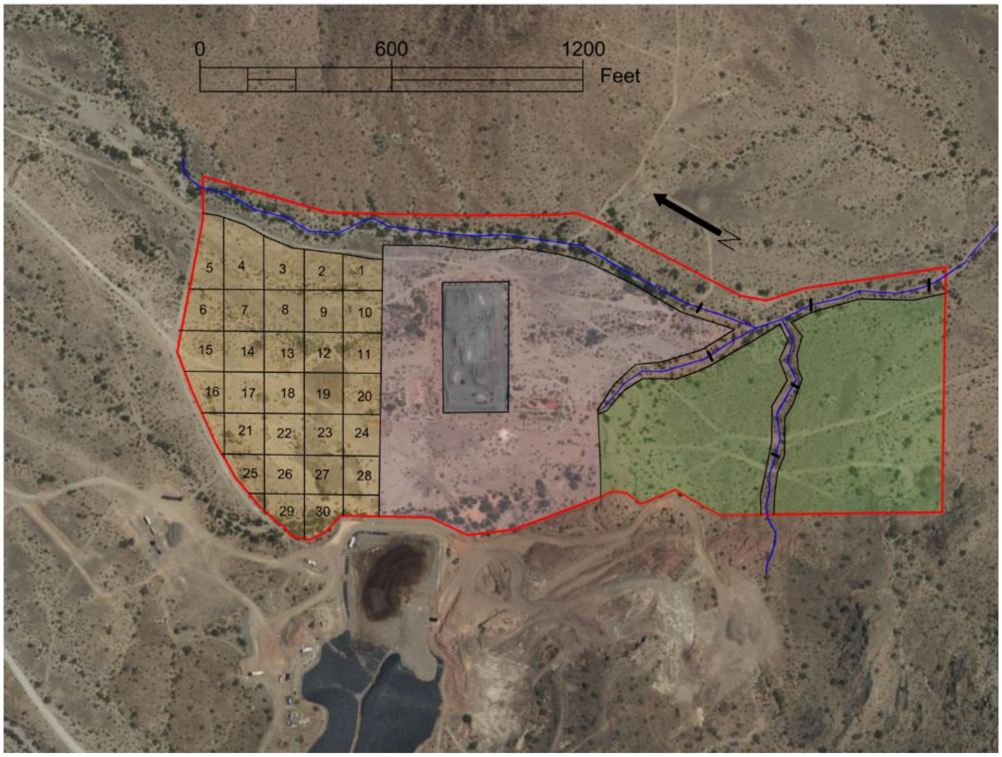

Figure A.3.5. Decision Unit 4 samples

ISM samples in DU5, area east of DU2 is shown in Figure A.3.6 and is approximately 1000 feet by 680 feet. Similar to DU3, 31 (140' x 160') sections will be flagged, and four homogenous samples will be collected from this decision unit.

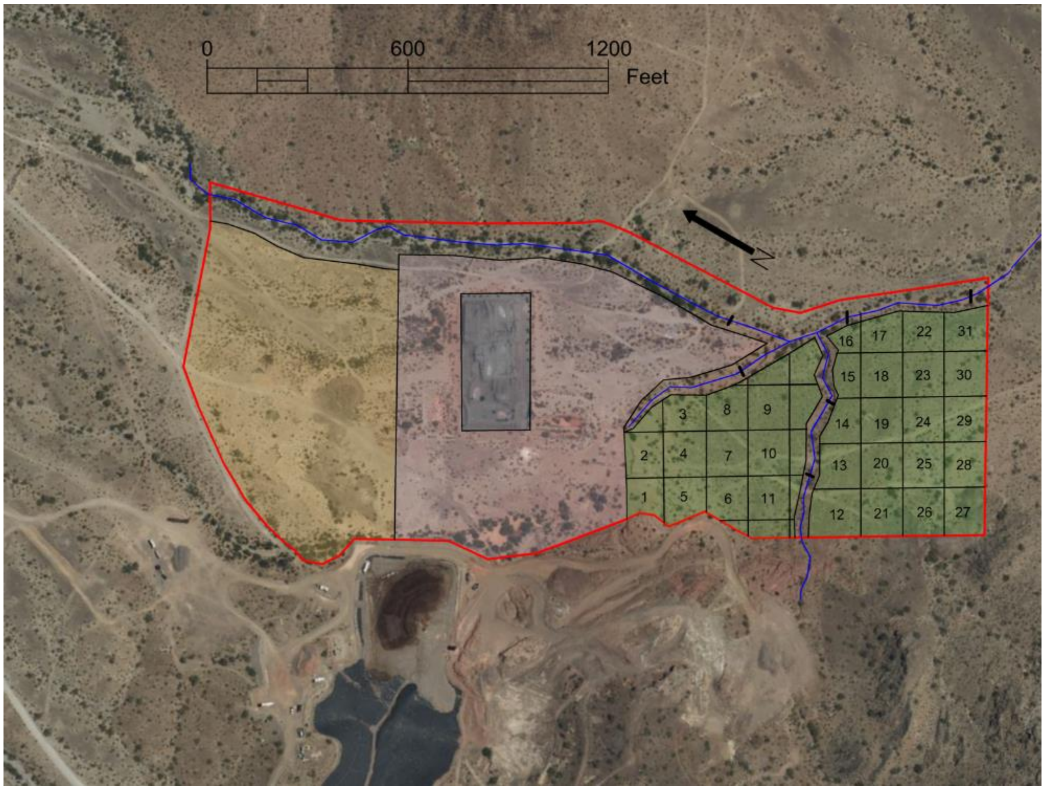

Figure A.3.6. Decision Unit 5 samples

Three background samples will be taken, as well as up to ten hot-spot samples where visible or elevated contamination may be found. The locations of the hotspot and background will be determined during the site investigation. The sample identification scheme for all samples is discussed in Section 3.4.

3.2 Soil Collection

Surface Soil samples will be collected approximately 0-3 inches below the existing surface. Surface litter (vegetation, rocks, gravel, etc.) around the sample area will be removed with a trowel prior to sample collection. A clean stainless-steel trowel will be used to collect the respective amount of sample for each sampling method. The sample will be placed into a gallon sized heavy-duty Ziploc (freezer) bag and properly labeled as outlined in Section 3.4. Weather permitting, an in-situ XRF reading at the sample location will be conducted after surface litter is removed.

3.2.1 Background Soil Samples

Three background samples will be collected using methods described in Section 3.1.1. The location of the background samples will be determined on-site during the site investigation. Their locations will be selected from native/non-disturbed soils unlikely to be influenced by wind migration of contaminated soils.

3.2.2 Hot-Spot Soil Collection

Up to ten hot-spot samples have been allotted and will be collected where high levels of contamination are suspected during the site investigation (such as visible tailings in a wash). These samples will be collected using the methods described in 3.1.1.

3.2.3 Field Equipment & Calibration

Necessary equipment for surface soil samples collection include a stainless-steel trowel, heavy-duty gallon sized Ziploc bags, 5-gallon buckets, marking flags, measuring tapes, and a handheld GPS. Core samples will be taken using a hand-auger with plastic sleeve inserts. Field notebooks, pens/markers, and a camera will be used for documentation of field work. Sampling equipment will be cleaned after each sample using wash water, dish soap, and a scrub brush (see Section 3.6).

The XRF device will be used to take in-situ reading immediately adjacent to where the surface samples are collected. The internal calibration will be run each time the unit is turned on.

3.2.4 Sample Containers

Samples containers will be gallon sized heavy duty freezer Ziploc bags from a new, unopened package for sterility. The bags will be sealed and placed in large plastic bins for storage and transport.

3.2.5 Sample Labeling

The samples will be named according to the site, sample location, and sampling method used.

- Grid samples will be labeled using the nomenclature H-G1 through H-G6.
- ISM samples will be named H-A3, B3, C3, and D4 for the respective sub-sample of each section within Decision Unit 3; H-A4, B4, C4, and D4 for Decision Unit 4; and H-A5, B5, C5, and D5 for Decision Unit 5.
- Transect samples taken in the washes will be named H-T1 through H-T18.
- Background samples will be named H-B-# and hotspot samples will be named H-HS-#.
- Duplicates will be labeled with the same label as the initial sample plus “-1” added to the label (e.g., H-G1-1 is the duplicate for H-G1).

In-situ XRF samples will be labeled in the XRF instrument with the leading H- removed (e.g., G1). In-situ XRF will not occur for any ISM samples. After drying and sieving, samples will retain their original sample number as the original sample will no longer exist and sieved samples are visually obvious.

3.3 Sample Preservation, Packaging, and Shipping

Sample preservation is not required. The samples will be placed in a plastic bin for transport.

For samples sent to subcontracted laboratories, 5 grams of soil will be placed in a labeled glass vial and placed in styrofoam vial shipping containers. The packaged samples intended for subcontracted analysis will be delivered by a team member ensuring that the samples are kept at standard conditions with no extreme temperatures or excess moisture.

3.4 Equipment Decontamination Procedures

Trowels and hand auger will be decontaminated after each sample is taken in the field to prevent cross contamination and ensure the sample is representative of the desired location. The equipment will be cleaned using dish soap and a scrubbing brush with water in a 5-gallon wash bucket. Equipment will be rinsed in a 5-gallon rinse bucket. Decontaminated samples will be stored in a separate, clean 5-gallon bucket.

3.5 Documentation

3.5.1 Field Notes & Logbooks

Each team member will keep a logbook documenting project name, location, each team member's full name, and pertinent information. Any deviations from the Work Plan in addition to field observations, data and necessary calculations will be recorded in each logbook with pen. Maps and sketches will be included in the logbook where necessary, and page numbers will be labeled as "x of y," where "y" is the total number of pages. For each sample collected, the date and time of collection, sample location (GPS coordinates), sample ID, sampling collection method, description of sample, and whether an XRF reading was taken will be recorded in the field logbooks.

Laboratory logbooks will be completed using the NAU Laboratory Project Activity Log sheets, and will include the team member names, date and start/end times of each project activity, activity description, and project name. The lab activities include sample preparation, sample analysis, and equipment checks. For laboratory analysis, the following items must be documented in the lab logbooks: Date and time of analysis, sample ID, instrument name and serial number, calibration records, ID of preparation equipment, if necessary, reagents/standards used, if necessary, units, measurement results, and disposal and decontamination procedures used (see Appendix B).

3.5.2 Photographs

The team will use their cellphones to photograph and document the site conditions. Photographs will include clear images of each sample taken, the flora and fauna in the area, and any disturbed soil or visible tailings on site. The photographs will be compiled in a shared drive and on a flash drive.

3.5.3 Chain of Custody

The Chain of Custody Form is the documentation that is used for tracking the movement of samples from their collection, handling and transport, analysis, and ultimately disposal. The record must include the location of the samples and the names of who is in possession of the samples each time the samples undergo a change in custody. See Figure A.3.6 for the Chain of Custody form.

CHAIN OF CUSTODY RECORD *Viperidae Tech* Harquahala Mine PA/SI			
Date of transfer: **Type of samples:** **Name of person relinquishing:** **Signature of person relinquishing:** **Name of person accepting:** **Signature of person accepting:** **Date of transfer:**		**Sample ID#s:** *Add lines based on how many samples you have*	

Figure A.3.7. Chain of Custody Form

The Chain of Custody form is to remain with the samples at all times. The form for each sample will be checked at each change of custody to ensure consistency and responsibility between the transportation. The person relinquishing/accepting the sample will sign the form.

3.6 Custody Seals

A Chain of Custody Seal will be used to seal the lid of each bin containing samples. The Custody Seal to be used is shown below in Figure A.3.7.

Chain of Custody Seal

Viperidae Tech

Storage Conditions: ______________________ **Site Name:** ___________________________

Bucket #: _______________ **Sample Type:** ______________________________

Date Sealed: ____________ **Sealed By:** ______________________________________

Sample Range Included:____

Figure A.3.8. Chain of Custody Seal

4.0 Laboratory Analyses

4.1 Sample Drying

Samples will be dried in the NAU Soils Lab using ASTM Method D2216 [10]. After drying, if soils are clumped (such as clays), they will be broken up with a pestle to assure each soil particle will be correctly sieved.

4.2 Sample Sieving

As heavy metals tend to adhere to fine soil particles, the removal of larger soil particles results in a more uniform XRF reading. The process of soil sieving will be conducted following the guidelines outlined in ASTM Method D6913 [11]. Sieving of soils will be performed using multiple sieves, the smallest being the #60 sieve with a pore size of less than 250 µm. After every sieved sample, the sieves will be washed and dried using compressed air. Any oversize materials will be disposed of as solid waste.

4.3 XRF

XRF analysis will be performed in accordance with EPA Method 6200 [12]. Each individual sample will be divided into nine polyethylene XRF sample cups. Each sub-sample will undergo XRF analysis for 90 seconds, resulting in nine distinct XRF measurements for each sample. All collected data will be transferred to a spreadsheet. The highest and lowest values for each metal within the sample will be excluded. Table A.4.1 shows the detection limits and screening levels for the COCs using the NITON XL3t 600 XRF instrument [13].

Table A.4.1 XRF Detection limits and screening levels

COC	Detection Limit (mg/kg)	AZSRS – Non-Residential (mg/kg)	AZSRS – Residential (mg/kg)
As	11	10	10
Pb	13	800	400
Sb	-	410	31
Sr	-	610,000	47,000
Zn	-	310,000	23,000
Cu	-	41,000	3,100
Ni	-	20,000	1,600
Mn	-	32,000	3,300
Cr (III)	-	4,500	2,100
V	-	1,000	78
Ti	-	1,000,000	310,000
Sn	-	610,000	47,000
Cd	-	510	39
Ag	-	5,100	390

4.4 Acid Digestion and FAAS/ICP Confirmatory Testing

Since arsenic and lead are present at the site, and lead in known to bias arsenic XRF results, confirmatory arsenic analyses will be conducted by an external laboratory. This analysis involves acid digestion of the soil (EPA Method 3050B) followed by either ICP-OES or FAAS (EPA Methods 7000B and 6010B , respectively) [14] [15] [16].

5.0 Disposal of Residual Materials

5.1 Field Disposal

The wash and rinse water after equipment decontamination will be disposed of onsite (ie, poured onto site soils). Gloves, paper towels wipes, flags, and other disposable items will be collected in a trash bag and disposed of as solid waste at NAU.

5.2 Laboratory Waste Disposal

Any hazardous chemical must be appropriately disposed of in the lab. Liquid hazardous waste and soil hazardous waste will be treated differently. Soil waste will be sealed in a "Hazardous Waste" container provided by the Environmental Health and Safety (EHS) department, who will assure proper disposal of the waste.

The sieving process's "overs" are considered nonhazardous (contaminants tend to sorb to fines) and will be disposed of as solid waste. Liquid waste from decontamination efforts that is deemed hazardous will be placed in a container labeled "Hazardous Waste" and allowed to evaporate; any remaining solid material will be placed with the solid hazardous waste.

Appendix B

Harquahala Mine PA/SI
Hazards and Safety Plan

CENE 486C

Prepared for:

Eric Zielske
Bureau of Land Management Arizona State Office
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Submitted by:

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1.0 Job Name and Location

A Preliminary Assessment and Site Investigation of Harquahala mine will be conducted. The site is located 26 miles south of Salome and 95 miles northwest of Phoenix.

2.0 Safety and Health Administration

Sierra Binney, the Viperidae Health and Safety (HS) Officer for the project, will oversee all safety aspects in both field and laboratory operations. The HS Officer's duties include disseminating safety protocols for field activities and overseeing adherence to them. Moreover, the HS Officer is tasked with distributing the emergency response strategy which encompasses, among other details, the contact information for the nearest emergency services, site management, and emergency contacts for everyone involved in the field work.

3.0 Hazard Assessment & Required PPE

Tables B.3.1 and B.3.2 below outline potential hazards to be encountered in the field and in the laboratory, respectively, and ways to minimize risks associated with each hazard. In both settings, no one is permitted to work alone; all work in the field and lab must be accompanied by another personnel.

Table B.3.1. Potential field hazards

Potential hazard	Level of risk	Recommended mitigations
Physical		
Sun exposure	Moderate	Wear sunscreen and sun protection; drink water consistently; find shade if physical symptoms arise.
Temperature exposure	Moderate	Check the weather forecast; dress appropriately for the temperature; wear/bring layers.
Weather event	Low	Check the weather forecast; dress appropriately; stay aware of evolving weather, desert climates change quickly.
Falls, scrapes	Low	Look before stepping; wear sturdy shoes.
Chemical		
Dermal exposure to COC’s	Low	Wear long clothing and gloves; tie or cover long hair; remove exposed clothing after use and store in a bag.
Ingestion exposure to COC’s	Low	Thoroughly wash hands after field work.
Inhalation exposure to COC’s	Low	If windy onsite, wear a mask over the mouth and nose.
Biological		
Contact with dangerous animals	Low	Be aware of surroundings; do not approach any potentially venomous or protective animals.
Contact with hazardous plants	Low	Be aware of surroundings; do not step backwards.
Radiological		
X-ray exposure	Moderate	Use XRF instrument at arm’s length, leaning forward to keep device as far as possible from torso.

Table B.3.2. Potential laboratory hazards

Potential hazard	Level of risk	Recommended mitigations
Physical		
Burns	Low	Wear thermal gloves when interacting with the drying oven.
Falls, scrapes	Low	Be aware of surroundings; have caution when handling glassware.
Chemical		
Dermal exposure to COC's	Low	Wear long clothing and closed-toed shoes; tie or cover long hair; wear any additionally required PPE for the laboratory.
Ingestion exposure to COC's	Low	Thoroughly wash hands after work.
Inhalation exposure to COC's	Low	Work outdoors or under a fume hood when handling toxic chemicals.
Biological		
N/A	N/A	N/A
Radiological		
X-ray exposure	Moderate	Use XRF instrument only in containment apparatus.

4.0 Training Requirements

4.1 NAU Lab Safety

All project personnel are required to complete Northern Arizona University's Chemical Hygiene Training. Training completion certificates will be provided by all project personnel.

4.2 X-ray Fluorescence

Each member of the project team will receive training from an experienced NAU graduate student operator, Claire Griffiths (EIT), to ensure they are proficient in the correct operation of the XRF instrument. Additionally, project personnel are expected to review the XRF training manual and use it as a reference whenever necessary.

5.0 Operating Procedures

5.1 Field

The operational and site management protocols will adhere to the OSHA 1910 General Industry Subpart H: Guidelines for Hazardous Waste. These guidelines stipulate that a site diagram, designated work areas on the site, the implementation of a partner system, communications on-site, emergency protocols and responses, as well as safe working methods must be included [17]. The specifics of these procedures will be elaborated on in subsequent sections.

5.2 Lab

The same requirements for fieldwork apply in the laboratory. In addition, a minimum of two individuals must be present for all laboratory activities, as solitary work in the lab is strictly forbidden.

6.0 Personal Decontamination Procedures

6.1 Field

OSHA guidelines place particular emphasis on the following protocols for field operations and underscore preventive actions against contamination [18]:

- Avoid traversing through contaminated zones and refrain from direct contact with potentially dangerous materials.
- Ensure that monitoring and sampling equipment is safeguarded by appropriately bagging them.
- When necessary, utilize disposable outer clothing and equipment to minimize the risk of contamination.

6.2 Lab

A specific workspace will be allocated for laboratory activities. In accordance with the NAU chemical hygiene plan [19], the PPE will be removed and deposited in an appropriately labeled container as part of decontamination before exiting the facility.

6.3 Waste Disposal

NAU EHS will dispose of hazardous waste; anything deemed non-hazardous will be solid waste.

7.0 Emergency Response Procedures

All field personnel will carry a cellphone on them in case emergency medical services are needed. Telephone numbers for emergency response services are listed in Section 7.2. First aid supplies will be provided and accessible. All kits are checked before being sent out to the field, and all used items are replaced beforehand.

7.1 Closest Medical Facility

The closest medical center to the site is La Paz Regional Hospital & Clinic, which is 66 miles or 75 minutes away from Harquahala Mine. La Paz Regional Hospital & Clinic has full-services emergency department.

La Paz Regional Hospital & Clinic
Address: 1200 West Mohave Road, Parker, Arizona
Phone Number: 928-699-9201

Because the hospital is located so far from the site, HS Officer Sierra Binney will provide the team a first-aid kit and and take the lead in first aid, should the need arise, as she is CPR/First Aid certified by the Red Cross.

Figure B.7.1. Distance from site to La Paz Regional Hospital & Clinic

The closest medical center to the NAU lab is Flagstaff Medical Center, which is 2.5 miles away from the NAU campus laboratory. Flagstaff Medical Center has a full-service emergency department open 24/7.

Flagstaff Medical Center
Address: 1200 N. Beaver Street, Flagstaff, Arizona
Phone Number: 928-773-2113

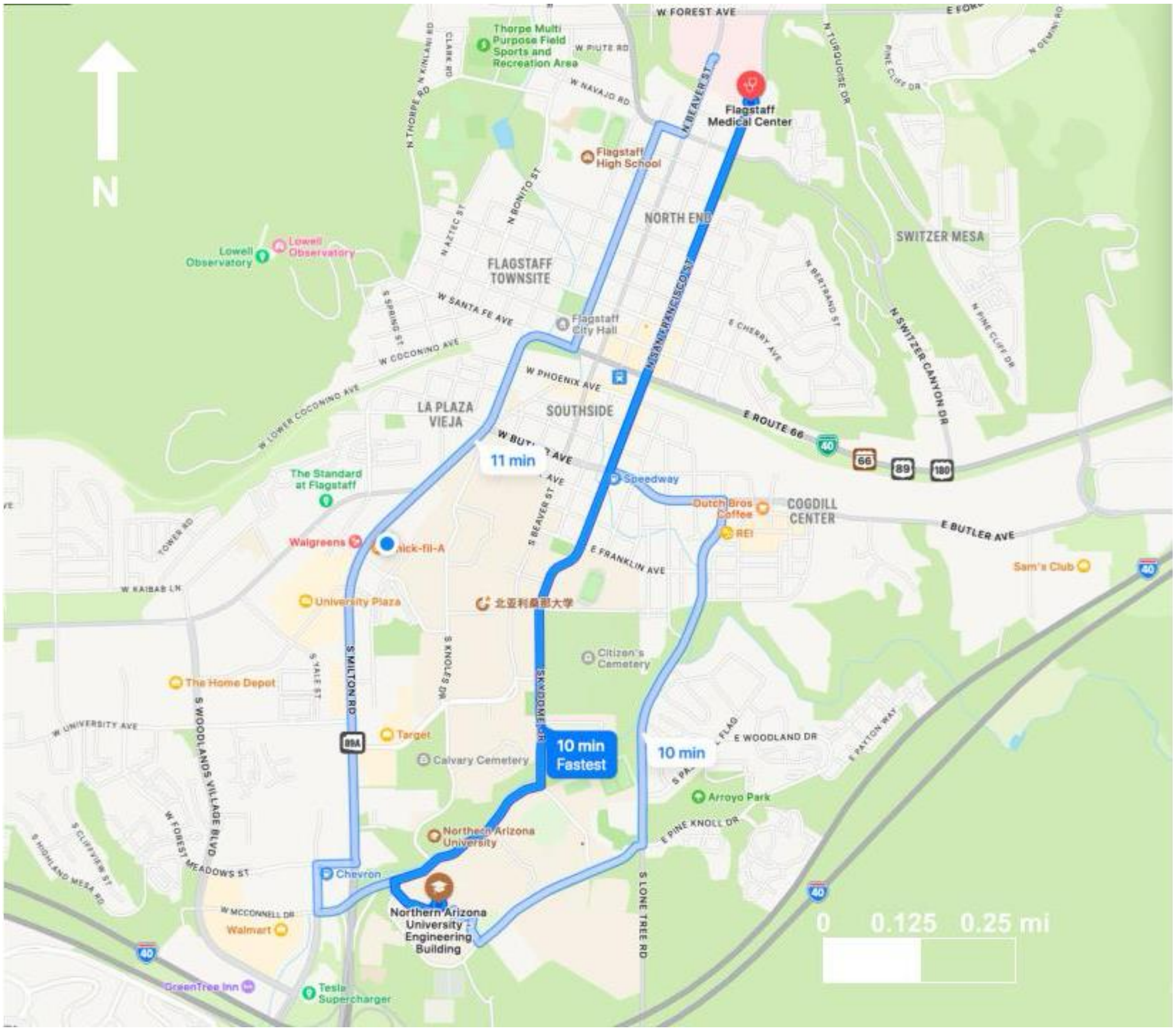

Figure B.7.2. Route from NAU lab to Flagstaff Medical Center

7.2 Contact List

In case of an emergency, use the following table to contact the proper authorities and aid services:

Table B.7.1. Project emergency contacts list

Emergency Contact	Phone Number	Address
La Paz Regional Hospital & Clinic	928-699-9201	1200 West Mohave Road, Parker, Arizona 85344
Salome Police Station	928-859-3318	38238 Salome Rd Salome, AZ 85348
NAU Engineering Department	928-523-2704	2112 S Huffer Ln Flagstaff, AZ 86011
BLM Arizona State Office	602-417-9223	One North Central Ave, Ste. 800 Phoenix, Arizona 85004
Eric Zielske	602-533-6283	-
Flagstaff Medical Center	928-773-2113	1200 N. Beaver St., Flagstaff, 86001

Personal emergency contacts for all site visit personnel are given in the table below.

Table B.7.2 Personnel emergency contact list

Name	Phone Number	Emergency Contact	Relationship to personnel	Contact's Phone Number
Dr. Bridget Bero	928-607-2516	Charles Beadles	Spouse	928-607-8688
Bohao Liu	928-266-3398	Beizhe Shen	Friend	928-679-5837
Elda Silva	480-512-2891	Edgar Avila-Mendoza	Partner	214-430-0940
Jack Priniski	602-363-2588	Jenny Priniski	Mother	602-300-9041
Sierra Binney	805-910-5457	Chloe Cramer	Friend	928-693-9205