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PROJECT

SIGNAL MILL
WORK PLAN

PURPOSE

CENE 476 - CAPSTONE PREP
TECHNICAL ADVISOR: DR. BERO
GRADING INSTRUCTOR: DR. BERO
NORTHERN ARIZONA UNIVERSITY
FALL 2018

DUE DATE

DECEMBER 10, 2018

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1.0 Introduction

1.1 Project Objectives

The objective of this project is to provide a Preliminary Assessment and Site Investigation report (PA/SI) along with a report outlining the risk associated with the site. This report will contain human risk assessment and ecological risk assessment, determined from the sampling taken on site and analyzed for the PA/SI report that will be provided to the Bureau of Land Management (BLM).

1.2 Project Scope

A list of all the major tasks for the project are provided below:

- **Task 1.** Work Plan
  - **Task 1.1.** Sampling and Analysis Plan (SAP)
  - **Task 1.2.** Health and Safety Plan (HASP)
- **Task 2.** Field Sampling
- **Task 3.** Analysis
  - **Task 3.1.** Dry Sieve Analysis
  - **Task 3.2.** X-Ray Fluorescence Analysis
  - **Task 3.3.** Acid Digestion
  - **Task 3.4.** Flame Atomic Adsorption Spectroscopy (FAAS)w
  - **Task 3.5.** XRF and FAAS Correlation
- **Task 4.** Risk Assessment
  - **Task 4.1.** Human Health Risk Assessment
  - **Task 4.2.** Ecological Risk Assessment
- **Task 5.** Project Impacts
- **Task 6.** Project Management

1.3 Work Plan Schedule

Field sampling is scheduled to occur on the weekend of January 18-20, 2019. In the event of extreme weather, secondary sampling dates were set for February 8-10, 2019. The Sampling and Analysis Plan details the procedures that will be followed during field sampling. The final Preliminary Assessment/ Site Investigation (PA/SI) report will be delivered by May 9th, 2019.

2.0 Project Management

2.1 Project Management Approach

Project management will be upheld through the use of weekly staff meetings, Technical Advisor (TA) meetings, client meetings, correspondence, and schedule management. The following roles have been assigned to each team member:

Angelina Cruse – Secretary
Anna Gorman – Project Manager
Ali Husain – Quality Assurance/ Quality Control Officer
Wyatt La Fave – Safety Officer/ Client Contact

2.2 Project Procedures

Prior to weekly meetings, an agenda will be created outlining discussion items for the meeting. Meetings will be held to discuss the progression of the project as well as to identify upcoming tasks. Meeting minutes will be created at the end of every session and be sent out to all team member within two hours for review. Correspondence will be kept among the team through email, phone, and in-person communication. All scheduling for the team will be kept through a shared Google Calendar.

2.3 Quality Management

To ensure adequate progression of the project meetings amongst the staff will be held on a weekly basis. The documentation of these meetings will be kept in a binder that will be accessible to all team members. The use of Google Calendar as a scheduling tool will aid in planning, as the calendar will be accessible to all team members. All deadlines and Work Plan Schedule items will be emphasized in Google Calendar.

3.0 Site Background Information

3.1 Site Location

Signal Mill is in Arizona, approximately 69 miles southern of Kingman AZ, in Mohave County. See Figure 3.1 below for a general map.

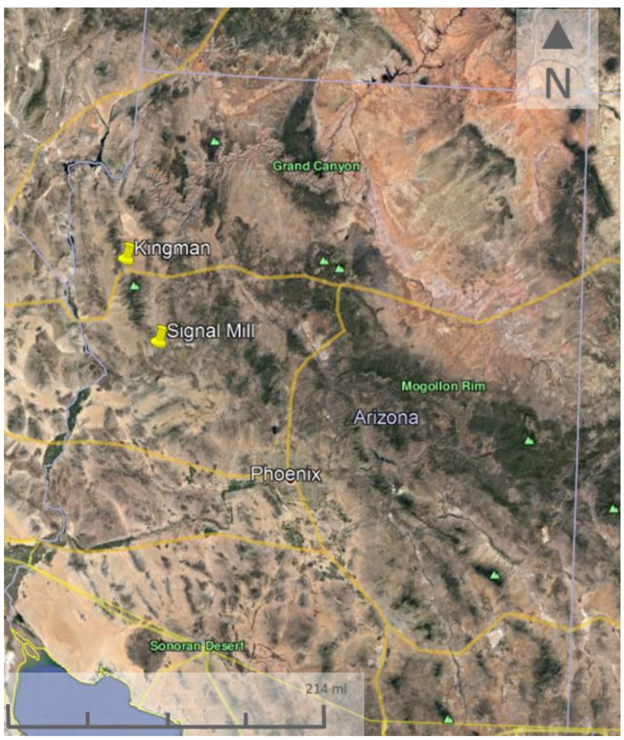

Figure 3.1 Signal Mill in Relation to Kingman

Signal Mill can be accessed most easily by taking Highway 93 through Wikieup. County Road 137 (Signal Rd) is the exit taken off of Highway 93. County Road 137 will be followed approximately 12 miles. After 12 miles a horse corral should be visible, and east of the corral is the road that leads directly to Signal Mill. This route will require crossing the Big Sandy River twice. In the event that the Big Sandy River is flooding and crossing the river with the vehicle presents a potential hazard, an alternate route will be used. The team will need to take the Interstate 40 West from Kingman approximately 26 miles to County Road 15 (Alamo Road) as shown in Figure 3.2. County Road 15 will be followed approximately 38 miles until Country Road 137 is reached. County Road 137 will be followed heading east for 5 miles where the same horse corral should become visible.

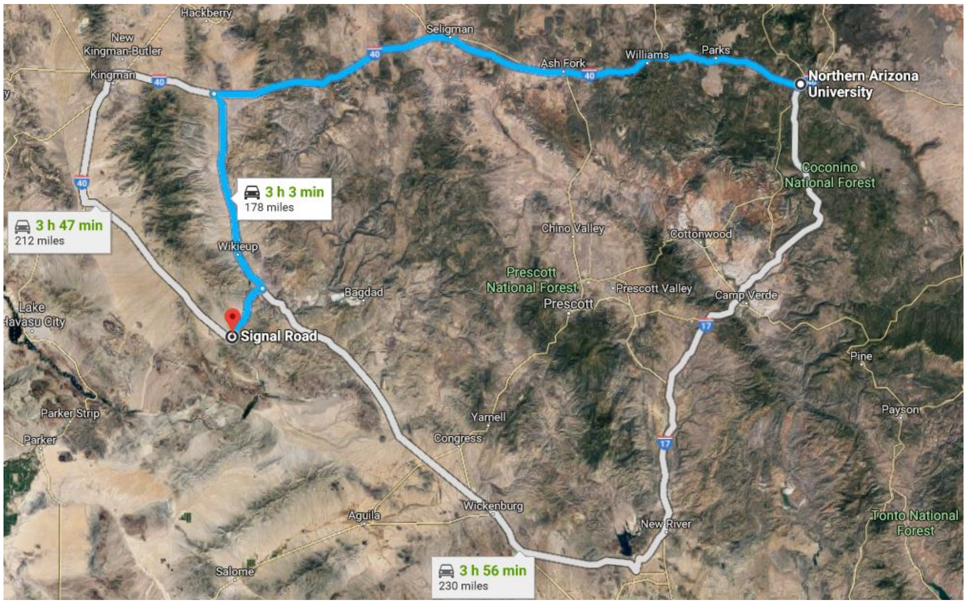

Figure 3.2: Signal Mill in Relation to I-70 and I-40 Roads.

3.2 Site Description

Signal Mill borders the Big Sandy River on the western bank as shown in Figure 3.3 on the following page. Signal Mill was erected by a San Francisco company contracted by McCracken and Owens in 1874. The mill was designed as a 10-stamp mill and later upgraded to a 20-stamp mill in 1884. The mill was setup to take and process ores from the McCracken Mine, most notably lead and silver. The 10-stamp mill later burned down in 1893 and Signal Mill was closed in August of 1902 [1].

3.3 Previous Operations and Investigations

Signal Mill ran intermittently in the 1920's and 1950's. In 1922 the Signal Mines Company took over the property where the mill was run intermittently up until July of 1925, when the property closed. In the late 1950's milling operations began again and was conducted by Ari-Vada Development Corporation. The last indicated operation period of the mill was in 1959. The main cause of the various operation periods is due to the fluctuating price of silver in Arizona [1].

The only data available on Signal Mill is from the Bureau of Land Management site investigation conducted on April 9, 2018 [2]. The data collected from this brief investigation is presented in Table 3.1. The red cells in Table 3.1 represents contaminant concentrations exceeding Arizona Non-Residential Remediation Standards and the yellow cells show contamination levels that are between Arizona Residential Remediation Standards and Arizona Non-Residential Remediation Standards. The most probable contaminants at the site are likely to be those outlined in Table 3.1.

Table 3.1 Signal Mill Site Summary with Contaminants of Concerns [2]

Sample #	Site	Latitude	Longitude	Contaminant Concentration								
				Pb	As	Hg	Zn	Mn	V	Ba	Ag	Sb
1	Signal Mill	34.47222	-113.62476	14542.4	418.59	75.43	31467.29	66259.59	149.13	36968.43	691.41	31.88
2	Signal Mill	34.47237	-113.62471	11690.38	151.58	79.61	36019.4	10559.25	<LOD	1419.24	219.6	55.53
3	Signal Mill	34.47222	-113.62474	4647.22	182.63	47.65	12266.27	13645.8	73.72	1796.12	11.05	<LOD
4	Signal Mill	34.47209	-113.62469	22400.74	394.96	91.45	42378.46	11158.64	37.17	7285.86	131.93	112.61
5	Signal Mill	34.47203	-113.62446	35907.42	<LOD	77.96	40024.83	11134.78	45.07	9430.04	162.84	67.74
6	Signal Mill	34.47169	-113.62437	19471.04	<LOD	37.84	22344.06	9984.22	40.43	7045.68	115.01	28.91
7	Signal Mill	34.47160	-113.62400	26828.93	328.55	308.86	18575.02	18173.51	70.08	10159.31	236.56	73.59
8	Signal Mill	34.47138	-113.62392	12436.05	<LOD	72.47	29018.56	6873.92	<LOD	2186.35	64.33	67.51
9	Signal Mill	34.47076	-113.62399	13371.81	<LOD	62.42	21750.39	4590.7	88.1	10033.01	83.58	59.99
10	Signal Mill	34.47065	-113.62416	24143.39	767.97	1190.53	35907.79	44584.74	186.36	38543.32	213.74	58.58

The data collected in Table 3.1 is visually represented across the site in Figure 3.3. Based on the sampling locations, it is evident that much of the site is contaminated. There is concern that mine tailings located on site have been washed down into the Big Sandy River which borders the area [2].

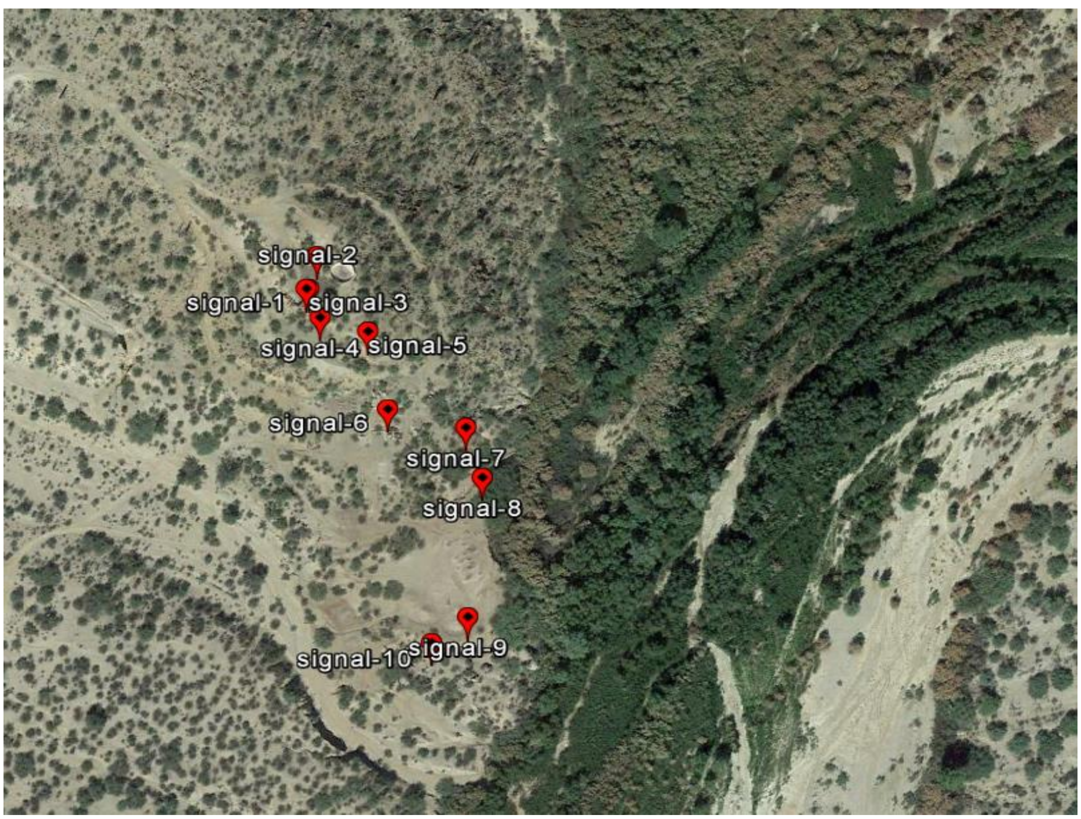

Figure 3.3 Bureau of Land Management Site Investigation Sample Locations [2]

4.0 Investigative Approach

4.1 Site Investigation Objective

The objective of this site investigation is to collect and obtain data that can be used to create a PA/SI report and human health and ecological risk assessments.

4.2 Site Investigation General Approach

On the site, the Sampling and Analysis Plan (SAP) will be followed to collect surface soil samples for analysis. Approximately 80 samples will be obtained through the grid sampling method, as outlined in Figure A3.1 in Section 3.1 of the SAP, while about 20 samples will be reserved for hotspot and background sampling. Hotspot samples will be taken at tailings that are visually present while background samples will be taken in areas that are perceived not to be contaminated.

5.0 Field Investigation Methods and Procedures

This section details the objectives, methods, and rationale for the sampling and analysis procedures with the purpose of providing a template for the project to be completed. The main sections tasks of the SAP are:

- Introduction
- Project Data Quality Objectives
- Sampling Rationale Sampling Analysis Design
- Field Methods and Procedures
- Sample Containers, Preservation, Packaging, and Shipping
- Disposal of Residual Materials
- Sampling Documentation and Shipment
- Deviations from Work Plan

6.0 Investigation-Derived Waste Management

Waste generated during the site investigation is detailed in Section 7.0 of the Sampling and Analysis Plan and Section 7.3 of the Health and Safety Plan (Appendix B).

7.0 Sample Collections Procedures and Analysis

7.1 Sample Containers, Preservations, and Storage

Gallon-sized heavy duty freezer bags will be used to transport and store samples. The detailed process for preservation and storage can be found in Section 6.0 of the Sampling and Analysis Plan (Appendix A).

7.2 Sample Documentation and Shipment

Samples bags will be labeled with a numbering system, each number corresponding to a specific sample. Samples will be logged and transported as outlined in Section 6.0 of the Sampling Analysis Plan (SAP).

7.3 Field Quality Assurance and Quality Control

Measures will be taken to ensure quality assurance and quality control in the field. Quality/Assurance Control Officer will have the responsibility to assure that samples are taken based on the correct procedure of sampling and have the role of counting the entire taken samples. These measures are detailed in Section 2.2.1 of the SAP.

8.0 Deviations from the Work Plan

Any deviations from the Work Plan will be documented in the field log book. Decisions regarding deviations from the Work Plan will be made by the technical advisor (Dr. Bero).

9.0 Preliminary Assessment and Site Investigation Reporting (PA/SI)

The final deliverable for this project will be a Preliminary Assessment and Site Investigation report that outlines the work completed for the project.

10.0 Project Schedule

The following table represents the project duration tasks including the start and end date. For Field Sampling, the team will visit the site and will spend 3 days sampling on the weekend of January 18, 2019 through January 20, 2019. XRF analysis will be applied in CECMEE Environmental Laboratory at Northern Arizona University (NAU). This task will take 7 days duration and will begin on February 2, 2019. From the total collected samples, the team will have 7 days to prepare acid digestion samples. Acid digestion will begin on February 9, 2019. Soil samples and digestate samples will be sent out to Western Technologies and NAU Chemistry Laboratories for 14 days to conduct the remaining analyses. Samples will be shipped on February 17, 2019. Risk assessment will begin on February 10, 2019 and will have a time period of 14 days to be completed. The final Preliminary Assessment/ Site Investigation report will be completed by May 9, 2019.

Table 10.1 Project Schedule

Task Name	Duration (days)	Start date	End date
1.0 Work Plan	44	Tue 10/9/18	Fri 12/7/18
1.1 Sampling and Analysis Plan (SAP)	44	Tue 10/9/18	Fri 12/7/18
1.2 Health and Safety Plan (HASP)	44	Tue 10/9/18	Fri 12/7/18
2.0 Field Sampling	2	Fri 1/18/19	Mon 1/21/19
3.0 Analysis	42	Tue 1/22/19	Wed 3/20/19
3.1 Dry Sieve Analysis	7	Tue 1/22/19	Wed 1/30/19
3.2 X-Ray Fluorescence	7	Tue 2/2/19	Wed 2/9/19
3.3 Acid Digestion	7	Fri 2/9/19	Mon 2/16/19
3.4 Flame Atomic Absorption Spectroscopy Analysis	14	Wed 2/17/19	Mon 3/4/19
3.5 XRF and FAAS Correlation	7	Tue 3/5/19	Wed 3/13/19
4.0 Risk Assessment	14	Thu 2/10/19	Tue 2/24/19
4.1 Human Health Risk Assessment	14	Thu 2/10/19	Tue 2/24/19
4.2 Ecological Risk Assessment	14	Thu 2/10/19	Tue 2/24/19
5.0 Project Impacts	5	Thu 3/14/19	Wed 3/20/19
6.0 Project Management	153	Tue 10/9/18	Thu 5/9/19
6.1 Project Coordination	153	Tue 10/9/18	Thu 5/9/19
6.1.1 Meetings	153	Tue 10/9/18	Thu 5/9/19
6.1.2 Correspondence	153	Tue 10/9/18	Thu 5/9/19
6.1.3 Schedule Management	153	Tue 10/9/18	Thu 5/9/19
6.2 Deliverables	83	Tue 1/15/19	Thu 5/9/19
6.2.1 Website	31	Thu 3/28/19	Thu 5/9/19
6.2.2 Final Presentation	8	Wed 4/17/19	Fri 4/26/19
6.2.3 PA/SI report	78	Tue 1/22/19	Thu 5/9/19
6.2.3.1 30% Deliverable	19	Fri 2/1/19	Wed 2/27/19
6.2.3.2 60% Deliverable	10	Fri 3/1/19	Thu 4/4/19
6.2.3.3 Final PA/SI Report	9	Mon 4/29/19	Thu 5/9/19

11.0 References

[1] B. Bero, "McCrackenMohaveT13NR15WSec25_A," Northern Arizona University, Flagstaff, 2018.

[2] Bureau of Land Management, "Signal Mill Site Summary," Bureau of Land Management, 2018.

[3] U.S. EPA. " Method 200.7, revision 4.4: determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry," Washington, DC. 2007

[4]ASTM D6913/D6913M-14 Standard Test Method for Particle-Size Distribution of Soils Using Sieve Analysis, ASTM International, West Conshohocken, PA, 2014, https://doi.org/10.1520/D6913_D6913M-17

[5] U.S. EPA. " SW-846 Test Method 6200: Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment," Washington, DC. 2007

[6] U.S. EPA. "Method 3050B: Acid Digestion of Sediments, Sludges, and Soils," Revision 2. Washington, DC. 1996

[7] U.S. EPA. " SW-846 Test Method 7000B: Flame Atomic Absorption Spectrophotometry," Washington, DC. 2007

Appendix A Sampling and Analysis Plan

1.0 Introduction

The Sampling and Analysis Plan outlines the relevant procedures and best management practices in order to retrieve effective, quality data while ensuring the safety of the team.

1.1 Responsible Agency

The responsible agency for this project is the Bureau of Land Management (BLM), whose office is located at North Central Ave Suite 800, Phoenix, AZ 85004.

1.2 Project Organization Table

An overview of the staffing plan for the project is provided in the table A1.1 below.

Table A1.1. Project Organization Table

Name	Role
Eric Zielske	BLM Client
Bridget Bero	Technical Advisor, NAU
Angelina Cruse	Secretary
Anna Gorman	Project Manager
Ali Husain	Quality Assurance/ Quality Control Officer
Wyatt La Fave	Safety Officer

The Technical Advisor will accompany the team in the field. One additional person (Josue Juarez) will also help the team with the field sampling investigation.

1.3 Sampling Details

The sampling process is outlined in Section 3.0 below.

2.0 Project Data Quality Objectives

2.1 Project Objectives and Problem Definition

The purpose of this project is to identify the composition and location of contaminants at Signal Mill. This information will allow for the creation of ecological and human health risk assessments. All information will be returned to the BLM to allow them to carry out the remediation process.

2.2 Data Quality Objective (DQO) and Quality Control

2.2.1 Field Quality Control

Quality control is an important aspect in the field to ensure the reliability of the data. When the team arrives on site personal protective equipment will be worn. The sampling location will be located as defined in Section 3.0. Once sample collection beings, team members will collect soil samples and label them appropriately following Section 8.2. Logbooks will be kept to document and detail the sampling of the specimen. Photo logs will be kept, documenting the site and each sample. Between each sample team members will decontaminate the equipment used as detailed in Section 7.2 of the Health and Safety Plan. New gloves will be worn between each sample and waste generated during decontamination will be collected in trash bags. This process will be repeated until the team leaves the site for the day. Before leaving the site, the Quality Control Officer will inspect all logged samples to make sure they are accounted for. The Quality Control Officer will also place the completed chain of custody form within the bins holding the samples and seal the bin with the appropriate custody seal. When the team is ready to leave, personal decontamination will occur, following Section 7.1 of the Health and Safety Plan.

2.2.2 XRF Quality Control

In order to ensure quality control during the XRF analysis, a few precautions will be followed. Before use, the machine must be calibrated to verify that it is working properly. Additionally, the battery life must be monitored. The device should be charged every night so that it doesn't run out of battery during use. It is also important to track which sample is being tested to record the data correctly. Therefore, good organization is required. All data will be recorded in a lab notebook and any computer generated charts will be saved to the team file on Google Drive. Furthermore, the data will be backed up on an external flash drive in case any files are accidentally lost.

2.2.3 Data Analysis Quality Control

Once the data has been collected, it can be analyzed. This will be done in a careful fashion, relying on the attention of at least two team members to avoid error and to check each other's work. A two-person check system will be utilized to provide quality control. Data will be entered in Excel for organization. Furthermore, the values obtained will be compared to the previous data taken at Signal Mill to check for accuracy. The data results will be saved to the team file as well as backed up in a flash drive to avoid losing critical files.

2.2.4 Correlating Samples (XRF and FAAS)

After the XRF and FAAS analyses, a correlation will be drawn between the results in order to check for accuracy of the XRF data. Data will be correlated using Levene's test for equality of variances. This method will examine the variances between the XRF and FAAS analysis. This statistical method will provide a p-value indicating the strength of the correlation. The XRF data will then be corrected based on the correlations provided

2.2.5 Cross-contamination Precautions

Cross-contamination is a source of potential error. This would mostly affect the accuracy of the contaminant migration analysis, rather than the composition of contaminants. In the field, cross-contamination will be avoided by decontaminating the equipment used and by completing the bagging of one sample before beginning another, along with properly labeling bags. Cross-contamination will be avoided in the lab by keeping adequate space between samples and using separate bags. Any vessels or sieves that are to be reused for another sample will be cleaned between uses.

2.3 Data Review, Validation and Management

Data will be checked for accuracy and error among the team with the help of Dr. Bridget Bero as the technical advisor for the project on behalf of BLM. Any errors encountered will be documented.

3.0 Sampling Rationale

3.1 Soil Sampling

3.1.1 Grid Sampling Overview and Rationale

Eighty samples will be taken from a grid pattern, which is provided in Figure A3.1 on the following page. The sampling grid covers the areas where contaminated is expected. The milling area is covered by the grid in the northwest section of the map, while the expected contaminant migration is expected to flow downwards in elevation through the Big Sandy River, shown in the southeastern grid. The old operating site of Signal Mill is outlined by the blue oval. Sample collection will begin at the western edge of the circular structure surrounded between sampling points 7 and 8 in Figure A3.1. From the western edge of the round structure a 200-foot tape measure will be utilized to measure 15 feet west to position the team on sampling point 7. A surveying flag will be placed to mark the location of sampling point seven. Grid marks are spaced approximately 50 feet apart in the northern portion of the site. To find other sampling points a distance of 50 feet can be measured in either the north, south, west, or east direction to locate other sampling locations on the grid. Identified sampling locations will be marked with a surveying flag. To get to sampling point 50 from sampling point 51, the team can use the 200-foot tape measure and measure 215 feet south of point 50 to reach point 51. The grid spacing within the Big Sandy River is 100 feet. The same method for finding grid points within the Big Sandy River can be utilized to mark sample locations.

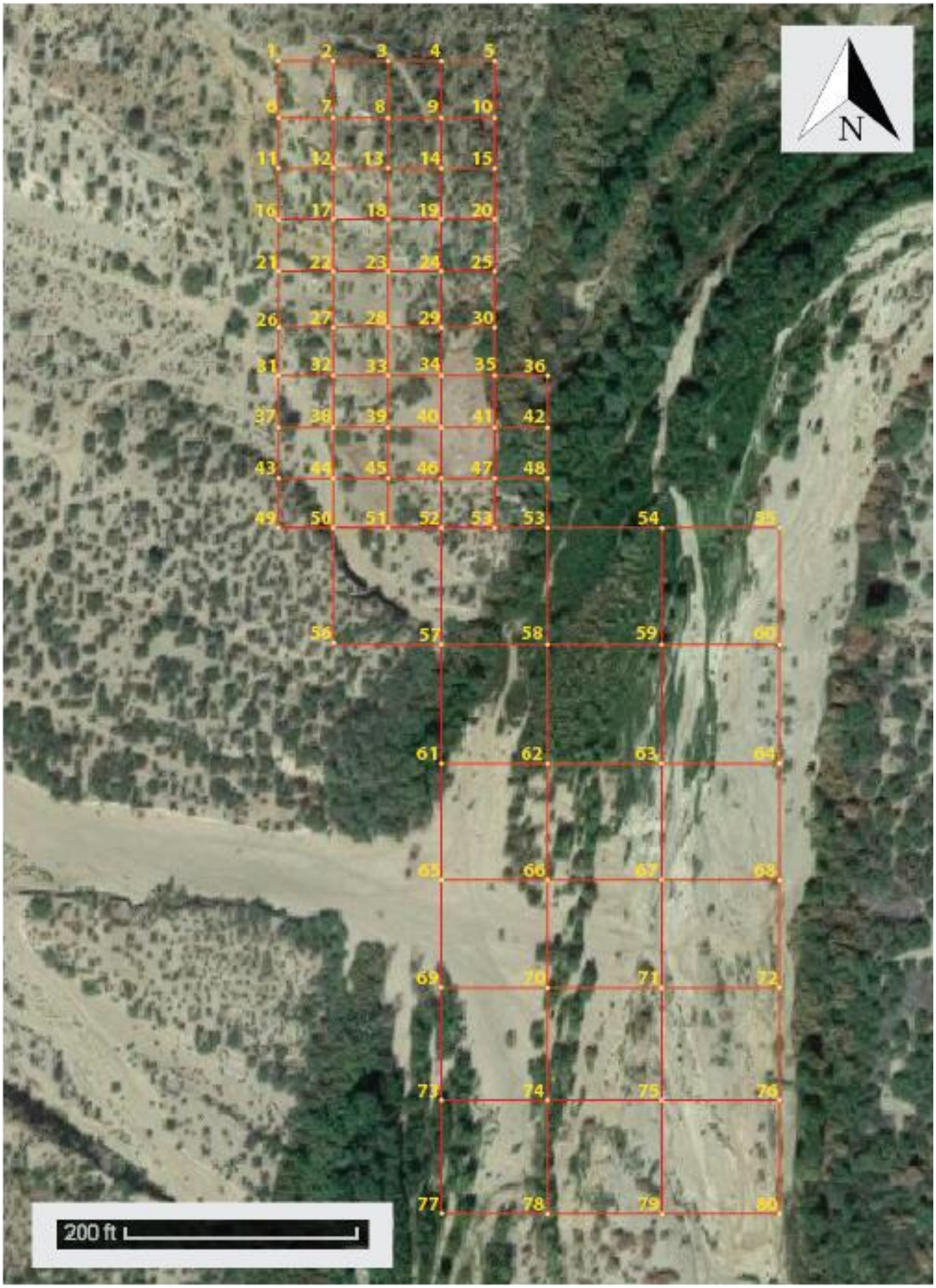

Figure A3.1 Sampling Grid Overview

3.1.2 Hot Spot Sampling Overview and Rationale

In addition to the grid sampling, about 10 hotspot samples will be taken from places where obvious contamination exists. If the team sees tailings, these will be sampled.

3.1.3 Background Sampling Overview and Rationale

Three to five background samples will be taken from places where no contamination is expected to occur. The purpose of these samples is to determine concentrations of contaminants of concern in undisturbed areas showing native vegetation.

3.1.4 Field Decision Criteria

In the field, the Technical Advisor will identify samples that may need to be eliminated based on the following conditions:

- The sample location is physically inaccessible.
- Obtaining the sample poses a risk to health and safety.
- Technical Advisor on site deems the sample unnecessary.

4.0 Sample Analysis Design

4.1 Sample Drying and Sieving-EPA Method 200.7 + ASTM D6913

All soil samples need to be dried before the sieve analysis can begin. EPA Method 200.7 Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry will be followed for drying procedures. This method suggests drying samples at 60℃ to prevent loss of mercury and other possible volatile metallic compounds [3]. ASTM D6913 Standard Test Method for Particle-Size Distribution of Soils Using Sieve Analysis is the standard method for a dry soil sieve analysis. This will be used to obtain soil samples that are sieved to the No. 60 sieve. The materials required to complete this analysis include a mechanical shaker and drying oven [4]. Sieve stacks will be utilized to prevent overloading limits for the sieve set. The maximum mass retained on an eight-inch sieve for the No. 60 sieve is 60 grams. The sieve analysis will be conducted at Northern Arizona University CECMEE Soils Lab.

4.2 XRF Spectrophotometry

X-Ray Fluorescence (XRF) analysis is used to obtain a preliminary quantitative and qualitative analysis of contaminants present in a soil sample. EPA Method 6200 Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment will be followed for quality control and calibration. The XRF device will be utilized on sieved soil samples. Soil samples will be in thin gallon plastic bags, where a three by three grid will be drawn over the bag. Using the XRF device measurements will be taken in each grid. A sketch of the grid is available below in Figure A4.1. High and low outliers from the XRF analysis on a single sample will be disregarded, after an average of the readings will be taken and used as the contaminant concentration. The required materials to complete this analysis method include Field Portable X-Ray Fluorescence (FPXRF) device, X-ray window film, sieves, and plastics bags [5]. XRF analysis will be conducted in CECMEE Environmental

Engineering Lab at Northern Arizona University. This analysis will provide the COC's from the Signal Mill site.

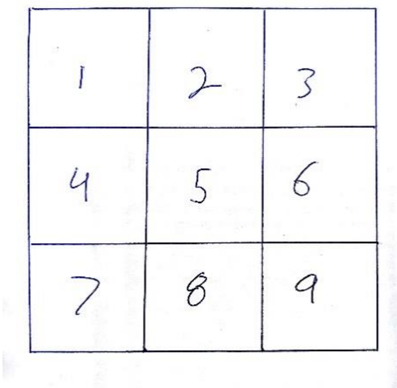

Figure A4.1 Sketch of XRF Soil Analysis Layout

4.3 Acid Digestion

Acid digestion is used to prepare soil samples for Flame Atomic Absorption Spectroscopy or Inductively Coupled Plasma analysis. EPA Method 3050B Acid Digestion of Sediments, Sludges, and Soils will be followed initially until full extent of contamination is understood. EPA Method 3050B works for the elements outlined in Table A4.1. In Table A4.1 the known contaminants of concern at the site are highlighted. The potential Contaminant of Concern will be Arsenic, Argon, Barium, Lead, Magnesium, Mercury, Vanadium and Zinc. The materials required to complete the analysis include 250 mL digestion vessels, vapor recovery device, drying oven, thermometer, filter paper (Whatman No. 41 or equivalent), centrifuge, centrifuge tubes, analytical balance, hot plate, funnel, graduated cylinder, and 100 mL volumetric flasks. Reagents required for testing include concentrated hydrochloric acid, nitric acid, and hydrogen peroxide (30%) [6]. Twenty samples will be selected for the analysis. Samples will be chosen to reflect a wide range of contaminant concentration. Acid digestion will be completed in the CECMEE Environmental Engineering Lab at Northern Arizona University.

Table A4.1 Elements Suitable for EPA Method 3050B [6]

FLAA/ICP-AES		GFAA/ICP-MS
Aluminum	Magnesium	Arsenic
Antimony	Manganese	Beryllium
Barium	Molybdenum	Cadmium
Beryllium	Nickel	Chromium
Cadmium	Potassium	Cobalt
Calcium	Silver	Iron
Chromium	Sodium	Lead
Cobalt	Thallium	Molybdenum
Copper	Vanadium	Selenium
Iron	Zinc	Thallium
Lead		
Vanadium		

4.4 Flame Atomic Absorption Spectrophotometry

EPA Method 7000B Flame Atomic Absorption Spectrophotometry (FAAS) will be followed to determine contaminant concentrations. The materials required to complete the analysis include atomic absorption spectrophotometer, burner, hollow cathode lamps, graphical display and recorder, pipets, pressure reducing valves, and volumetric flasks. Reagents required for analysis include fuel and oxidant, stock standard metal solutions, calibration blank, and method blank [7]. Samples taken for (FAAS) analysis will be subcontracted out to Western Technologies for arsenic testing while the other subsamples will be analyzed of at the Northern Arizona University Chemistry Laboratory.

5.0 Field Methods and Procedures

5.1 Field Equipment

The equipment used in the field is identified below in Table A5.1. The GPS is used to locate the sampling points at the site. Locations of hotspot and background samples will be identified on-site. Surveying flags will be utilized to mark sample locations. Trowels will be utilized to collect soil surface samples. Heavy duty freezer gallon sized bags will be used for sample storage. The 200-foot tape measure will be utilized to measure distance between sampling points.

Table A5.1 Field Equipment

Equipment	Quantity
GPS	2
Survey Flags	100
Heavy Duty Freezer Plastic Bags (One Gallon)	150
Trowels	6
200-foot Tape Measure	2
Water for decontamination (Gallons)	15
5 Gallon Buckets	4
Paper Towel (Rolls)	10
Dish Soap (20 fluid ounce bottles)	2
Glove Cartons (100 per carton)	4
Log Book	2
Pens (20 count box)	1
Batteries (backup pair)	2
Scrubbing Brushes	2
Trash Bags (30 gallon trash bags)	25
Storage Bins	3
Permanent Markers	6
Compass	2

5.1.1 Calibration of Field Equipment

The GPS tracking device will be calibrated before taking it out in the field to ensure that it functions properly and doesn't fail in the field. In the event of failure, additional batteries will be kept in the vehicle or if necessary the second GPS will be used.

5.2 Surface Soil Sampling Methods to be Used

5.2.1 Containers

The samples will be collected on-site in heavy duty freezer gallon-sized plastic bags. All sample information will be recorded in the logbook. For labeling samples refer to Section 8.2.

5.2.2 Sample Locations

The sampler will take a soil surface sample sufficient enough to fill a one-gallon bag using a trowel at sample locations identified in Figure A3.1. The assistant to the sampler will provide geographical coordinates for recordkeeping and sample labeling. Sample bags will be labeled according to Section 8.2. All sample information will be additionally recorded in the logbook.

6.0 Sample Containers, Preservation, Packaging and Shipping

Outlined below are the methods that will be utilized to store and ship soil samples taken during the investigation.

6.1 Soil Samples

Soil samples will be collected in one-gallon plastic bags and will be sealed within a bin with the appropriate chain of custody form. Samples will be kept in labeled bins and will not be unsealed until they have been transported to Northern Arizona University. Samples will be stored at the Northern Arizona CECMEE Environmental Engineering Lab. When the bins are unsealed, it will be documented on the appropriate chain of custody form. Once work is completed with a soil sample, the bin will be resealed with the chain of custody form in the bin. The lab is secured so that only authorized persons may enter.

6.2 Packaging and Shipping

20 soil samples will be shipped to Western Technologies Inc. for arsenic testing. These samples will be sealed in small Ziploc bags and placed in a manila folder with a chain of custody form and delivered by vehicle. Additionally, 20 digestates will be sent to the NAU Chemistry Department for Flame Atomic Adsorption Spectroscopy (FAAS) testing. These digestates will be delivered to NAU chemistry laboratories by hand.

7.0 Disposal of Residual Materials

EPA regulations and procedures will be followed for the disposal of contaminated material generated on site and in the lab.

7.1 IDW Disposal Procedures for Sites with Low Levels of Contamination

The EPA has specific regulations for the disposal of Investigation Derived Waste (IDW). The waste from the investigation may be disposed of on the site of original if it does not further endanger human health or the environment in the process. Water used for contaminated equipment will be disposed of on site.

7.2 Laboratory Waste Disposal

Any of the left-over soil collected from the sieve analysis that is not contaminated will be disposed of in the regular solid waste trash disposal service in the CECMEE Environmental Engineering Lab. What is known to be contaminated and hazardous will be disposed of as hazardous waste, and the proper procedures will be taken according to NAU's Environmental Health and Safety. In Title 40 Subpart K of the Code of Federal Regulations (CFR), specific requirements and procedures are outlined for the disposal of hazardous waste generated from academic laboratories. All waste must be removed from the lab within 12 months of the date it started accumulating. If the laboratory waste bucket is full before scheduled removal, these containers must be sealed and labeled properly and removed within 10 days of exceeding bucket capacity. The bucket capacity under EPA regulations is a 55-gallon bucket. Field waste collected on site will be disposed of off-site through municipal waste collections systems.

8.0 Sampling Documentation and Shipment

8.1 Field Notes

8.1.1 Field Logbooks

Field logbooks will be kept to describe each sampling procedure. Logbooks will detail when a sample was taken, identifying the location of the sample and the time it was taken. General observations of the site will be documented in the logbook. Logbooks will be completed in blue or black pen. Any errors shall be corrected by crossing out the error with a singular line and initialed by the documenter. A table of contents shall be provided on the first two pages of the logbook with page numbers labeled on the bottom right corner of the page. The weather conditions present at the site should be noted along with the names of samplers. Equipment used in the field will be documented. A flora and fauna survey will be conducted during the site investigation and all observed flora and fauna will be logged in the logbooks.

8.1.2 Photographs

Photographs of the site and every sample location will be taken. General site photos will indicate the current condition of the site and present notable features found at the site. All flora and fauna on site will be documented with a photograph.

8.2 Labeling

8.2.1 Labeling System

An example label that will be used out in the field during sampling is shown as follows, “SM-G5”. This label will be indicated on the sample heavy duty freezer gallon bag written in permanent marker.

The labels used on each sample should include the following identifiers:

1. The abbreviation “SM” to indicate the sample came from Signal Mill.
2. Unique sample identifier depending on the type of sample: B should be labeled for background samples, H for hotspot samples, and G for grid samples.
3. The number of the sample taken for each type of sample.

Sample labels should be written directly on plastic bags with a permanent marker. Samples that have been dried and sieved will follow the same labeling system above. An example would be as follows, “SM-G5 S”. The sieved samples will maintain the samples unique identifier and once it has been sieved the data label will written with an S to indicate it has been sieved. An example label for soils samples that go through XRF analysis is as follows: “SM G5 XRF 1”. XRF samples should be labeled with the unique identifier given in the field. It should then be followed by the abbreviation XRF to indicate the XRF analysis. Since a three by three grid is utilized for XRF analysis, the grid will be labeled 1-9 as shown in Figure A4.1. This labeling method will be used to for data collection, the sample does not need to be relabeled after XRF analysis. Digestates from the acid digestion will be labeled as follows: “SM-G5S- D”. The digestates will use the unique identifier given in the after sieving followed by a D to indicate it has gone through acid digestion.

8.3 Sample Chain-of-Custody Forms and Custody Seals

Figure A8.1 is an example of the Chain of Custody form the will be used over the course of the investigation.

CHAIN OF CUSTODY RECORD	
Project Title	**Organization**
	Contact
	Address

Sample ID	**Collection**		**Sampler's Initials**	**Sample Specific Comments**
	Date	**Time**		

Shipping Container No.	**Field Sampler:** *(Signature and Printed Name)* **Date:** **Time:**
Relinquished by: *(Signature and Printed Name)* **Date:** **Time:**	**Received by:** *(Signature and Printed Name)* **Date:** **Time:**
Relinquished by: *(Signature and Printed Name)* **Date:** **Time:**	**Received by:** *(Signature and Printed Name)* **Date:** **Time:**
Relinquished by: *(Signature and Printed Name)* **Date:** **Time:**	**Received by:** *(Signature and Printed Name)* **Date:** **Time:**

Figure A8.1 Sample Chain of Custody Form

Below in Figure A8.2 is the custody seal that will be placed on containers used for storing samples. Custody seals will be placed on containers with clear tape. A break in the tape will provide visual evidence if the seal has been broken or has been tampered with.

	Custody Seal Date ______________________________ Sampler ____________________________ Signature __________________________

Figure A8.2 Chain of Custody Seal

9.0 Deviations from Work Plan

Any deviations from the Work Plan will be documented in the field log book. Decisions regarding deviations from the Work Plan will be made by the technical advisor (Dr. Bero) with rationale and justification documented in the logbook.

Appendix B Health and Safety Plan

1.0 Job Name and Location

This project is the Signal Mill Preliminary Assessment/Site Investigation. Signal Mill is located in Arizona, approximately 22 miles south of Wikieup in Mohave County and 178 miles from Flagstaff in Coconino County. Signal Mill borders the Big Sandy River on the western bank. A map to the site is provided below in Figure B1.1. From Northern Arizona University the team will take I-40 westbound towards Los Angeles. This road will be followed for approximately 123 miles where exit 71 for US-93 south towards Wickenburg will be taken. After 41 miles the team will exit onto Signal Road and continue for 12.5 miles where the site will be on the right on Signal Road.

Figure B1.1 Map from Northern Arizona University to Signal Mill.

2.0 Safety and Health Administration

The Safety Officer for the investigation is Wyatt La Fave. The responsibilities of the Safety Officer are to ensure compliance with standards outlined in the following sections.

3.0 Hazard Assessment

Hazards that may be encountered out in the field and during analysis are outlined below and separated between physical and chemical hazards.

3.1 Physical Hazards

All the physical hazardous will be outlined in NAU Field Safety Checklist along with mitigation efforts. The NAU Field Safety Checklist is provided below in Figure B3.1.

NORTHERN ARIZONA UNIVERSITY

NAU Field Safety Checklist

This form may be used by the Principal Investigator (PI), or Supervisor, to assist with the planning of field work. **The completed checklist must be shared with all the members of the field team and a copy must be kept on file on campus.** Multiple trips to the same location can be covered by a single checklist. The checklist should be revised whenever a significant change to the location or scope of field work occurs. NAU's Regulatory Compliance groups are available to review these plans, and will conduct periodic reviews of departmental checklists.

Before you go:

☐This checklist must be completed, and a copied maintained on campus, prior to departure for any field work. ☐Prepare first aid kit and manual

☐Assemble and check safety provisions

☐Check to assure all required immunizations are current for all team members

☐Check to assure all emergency health care and insurance requirements have been met.

Principal Investigator/Supervisor: Dr. Bridget Bero

Phone Number: (929) 523-2051

Dates of Travel: January 18-20, 2018

Location of Field Work:

Country: USA Geographical Site: Signal Mill

Nearest City: Wikieup Distance from Site: 24 miles north

Nearest Hospital: Kingman Regional Medical Center Distance from Site*: 74 miles

Field Work: About 100 surface soil samples will be taken around the remnants of Signal Mill.

Emergency Procedures: Refer to Section 8.0 for emergency procedures.

University Contact (Name/ Phone): Dr. Bero (928) 523-2051

Local Field Contact (Name/ Phone): Dr. Bero (928) 523-2051

Special Medical Requirements: (bee sting kits, insulin, etc.)

NA

First Aid Training: (Please list any team members who are first aid trained and the type of training they have).

Angelina Cruse is first aid certified.

Physical Demands:

(Please list any physical demands required for this field work, e.g., Diving, Climbing, Temperature Extremes, High Altitude).

Driving to and from site, low temperatures, carrying heavy weight of samples.

Risk Assessment: Please list identified risks associated with the activity or the physical environment (e.g., extreme heat or cold, chemical use, wild animals, endemic diseases, firearms, explosives, violence). List appropriate measures to be taken to reduce the risks; *Include a separate sheet if necessary. Attach Safety Data Sheets (SDSs) and training documentation for any chemicals that will be used.*	
Identified Risk	*Control of Risk*
See attached risk assessment	

Field Team Membership Name/ Phone number
Angelina Cruse (602) 653-4265
Anna Gorman (805) 602-2681
Ali Husain (267) 237-7957
Wyatt La Fave (520) 400-8339
Dr. Bero (928) 607-2516 (Field Leader)
Josue Juarez (928) 580-1985

Animal Studies: A field study is defined as any study conducted on free living wild animals that does not involve an invasive procedure or materially alter the behavior of the animal under study. In order to help you determine if your study fits this criteria, please answer the following questions.

Does Your Study?

1. **Greatly disturb the animals under study?** Yes ___ No _X_
   (ex. testing predator vocalization, supplemental feeding, nest manipulation)
2. **Involve an invasive procedure?** Yes ___ No _X_
   (ex. blood sampling, tagging)
3. **Cause potential harm/injury to the animal?** Yes ___ No _X_
   (ex. net and trap capture, bagging)

If you answered **YES to any** of these questions, your study involves invasive procedures or materially alters the behavior of the animal under study. Please fill out the full IACUC protocol application form. http://www.research.nau.edu/compliance/iacuc/

If you answered **NO to all three** of these questions and your study will only involve observation of free ranging animals, then an IACUC protocol is not required.

Table 1. Risk Assessment

Identified Risk	Control of Risk
Venomous desert animals (snakes, spiders, scorpions, etc.)	Team members will take care of be aware of their surroundings, inspecting the ground thoroughly before picking anything up. If a venomous animal is encountered in close proximity, the individual should back away slowly, taking care not to trip over anything.
Chemicals on site (lead, arsenic, mercury, zinc, manganese, vanadium, antimony, silver, barium)	Personal protective equipment will be worn by all team members, including a Tyvek coverall suit, nitrile gloves, safety glasses, and closed-toed shoes. Additionally, personal decontamination procedures will be followed, as provided in section 7.1.
Uneven terrain	Team members will watch carefully where they are walking to avoid falling down on uneven terrain and loose, gravelly surfaces. If terrain appears unsafe, an alternative path will be identified.
Extreme cold	Team members will dress appropriately for the weather. In the likely event of extreme cold weather, all individuals will wear adequate warm clothing.

Figure B3.1 NAU Field Safety Checklist

3.2 Chemical Hazard

Chemical hazards the may be encountered in the field area identified in Figure B3.1 NAU Field Safety Checklist. In the lab, chemical hazards that could occur is during the handling of the necessary chemicals for acid digestion procedures. Hazardous chemical being handled during acid digestion include hydrochloric acid and nitric acid. Mitigation of chemical handling can be reduced by following proper lab procedures and wearing personal protective equipment such as lab coats, goggles, and nitrile gloves. In the event of a spill, Safety Data Sheets for the chemical should be followed.

4.0 Training Requirements

4.1 HAZWOPER

Team members must complete an online 40-hour HAZWOPER training course provided by Hazardous Waste Operations and Emergency Response under OSHA 29 CFR part 1910.120. The training course helps to protect team members involved with hazardous waste materials.

4.2 NAU Safety Training

Team members are also required to follow NAU safety training online course available at: https://www5.nau.edu/its/mytraining/tutorial/tutorial5.aspx?id=6442503287. This training is required to access the CECMEE Environmental Engineering Lab and to conduct field work.

4.3 XRF Training

Team members will have completed XRF training for safe usage of the device as well as to provide quality data and to ensure the correctness of following the procedure when analyzing the samples.

5.0 Personal Protective Equipment

The personal protective equipment (PPE) used during the investigation will protect all members from dermal contact, inhalation, and ingestion exposure routes. PPE must be worn during the course of the investigation.

5.1 Safety Equipment List

The following list outlines all PPE that sampling members must wear during the investigation.

- Tyvek Coverall Suit
- Nitrile Gloves
- Safety Glasses
- Closed Toed Shoes (preferably boots)

6.0 Site Control and Operating Procedures

To ensure quality assurance and quality control during the site investigation, no person will be left alone during the investigation. During physical sampling of soils, two people will be required to ensure adequacy of the sampling procedure. Additionally, two persons should always be together in the event of an injury. In the event of an injury, the transportation vehicle will have a first aid kit and additional drinking water. The vehicle will be parked once on site and will be considered a meet up point if the team is separated and needs to reconvene.

7.0 Decontamination Procedures

7.1 Personal Decontamination

Personal decontamination will be an essential aspect is maintaining a sterile environment. This will be especially important in minimizing health risk. The team will abide by the following protocol for personal decontamination.

All team members, assistants, and advisors will bring two pairs of shoes to the field. One pair will be worn in the vehicle, while the other pair will only be worn on the site. Trash bags will be transported to the site to store and seal the on-site shoes that may become contaminated. These shoes will be dusted off with a brush and gloves on as much as possible before placed in the storage bags. Tyvek suits will be worn on site, covering clothing and protecting it from contamination. The suits will be dusted off with the brush and placed in a trash bag before being placed in the vehicle. Additionally, nitrile gloves will be worn to protect bare skin from being contaminated. These gloves will be thrown into a trash bag and sealed before entering the vehicle. Hands will be washed on site with soap and water and team members will shower after returning to the hotel.

7.2 Equipment Decontamination

The equipment that will be used on-site and that needs to be decontaminated are the trowels. These will be decontaminated by first brushing off any dirt and debris, and then washed. Trowels will be washed inside one of the five gallon buckets using a scrub brush and soapy water. After scrubbing the trowel, water will be poured over the trowel to rinse it. After the rinse, trowels will be dried with the paper towels. Gloves should be worn during decontamination of the trowels. The gloves and paper towels used during the decontamination process will be stored in trash bags and hauled off site. After sampling and final decontamination occurs, the equipment will also be stored in trash bags to add another layer between them and the vehicle.

7.3 Waste Disposal

Water bottles, papers, plastic bags, wash water and adhesive tapes will be generated in the decontamination process that must be disposed of as hazardous waste materials in the lab at NAU, where the appropriate personnel will come remove the materials. Wash water used during the investigation will be disposed of on site.

8.0 Emergency Response Procedures

In case of a serious emergency with one of the team members, the team will contact the individual's provided emergency contact. Depending on the severity of the event, emergency medical professionals may be contacted, though this is unlikely to occur. The personal emergency contacts are provided below.

If the emergency warrants a need to go to the hospital the nearest hospital is Kingman Regional Medical Center approximately 74 miles away from the site. The address of the Hospital is, 3269 Stockton Hill Rd, Kingman, AZ 86409. The hospital phone number is (928) 757-2101. A map to the hospital is provided in Figure B8.1. From Signal Mill head northeast on Signal Road toward Dipsoarus Drive. Continue on US-93 North to Kingman and take exit 51 from I-40 West. Continue on Stockton Hill Road until Kingman Regional Medical Center is reached.

Figure B8.1 Kingman Regional Medical Center Map from Signal Mill

8.1 Emergency Contacts

Provide below in Table B8.1 are the emergency contact information for team members.

Table B8.1 Emergency Contact List

Team Member	Cell Phone Number	Emergency Contact	Relationship	Phone Number
Angelina Cruse	(602) 653-4265	Tessa Cruse	Sister	(480) 336-0561
Anna Gorman	(805) 602-2681	Leslie Kneafsey	Mother	(805) 801-2818
Ali Husain	(267) 237-7957	Khaled Dashti	Friend	(424) 666-9940
Wyatt La Fave	(520) 400-8339	Wendy La Fave	Mother	(520) 403-2599
Bridget Bero	(928) 607-2516	Charlie Beadles	Husband	(928) 607-8688
Josue Juarez	(928) 580-1985	Alfredo Juarez	Father	(928) 261-6772