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## PROJECT

SIGNAL MILL
**PROJECT PROPOSAL**

## PURPOSE

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

## DUE DATE

DECEMBER 12, 2018

# Table of Contents

**1.0 Project Understanding** ........ 6
1.1 Project Purpose ........ 6
1.2 Project Background ........ 6
1.3 Technical Considerations ........ 9
1.4 Potential Challenges ........ 10
1.5 Stakeholders ........ 10
**2.0 Scope of Services** ........ 10
2.1 Task 1.0 Work Plan ........ 10
2.1.1. Task 1.1 Sampling and Analysis Plan (SAP) ........ 10
2.1.3 Task 1.2 Health and Safety Plan (HASP) ........ 11
2.2 Task 2.0 Field Sampling ........ 11
2.3 Task 3.0 Analysis ........ 11
2.3.1 Task 3.1 Dry Sieve Analysis ........ 11
2.3.2 Task 3.2 X-Ray Fluorescence Analysis ........ 11
2.3.3 Task 3.3 Acid Digestion ........ 11
2.3.4 Task 3.4 Flame Atomic Absorption Spectroscopy Analysis ........ 11
2.3.5 Task 3.5 XRF and FAAS Correlation ........ 12
2.4 Task 4.0 Risk Assessment ........ 13
2.4.1 Task 4.1 Human Health Risk Assessment ........ 13
2.4.2 Task 4.2 Ecological Risk Assessment ........ 15
2.5 Task 5.0 Project Impacts ........ 16
2.6 Task 6.0 Project Management ........ 16
2.6.1 Task 6.1 Project Coordination ........ 16
2.6.1.1 Task 6.1.1 Meetings ........ 16
2.6.1.2 Task 6.1.2 Correspondence ........ 16
2.6.1.3 Task 6.1.3 Schedule Management ........ 16
2.6.2 Task 6.2 Deliverables ........ 17
2.6.2.1 Task 6.2.1 Website ........ 17
2.6.2.2 Task 6.2.2 Final Presentation ........ 17
2.6.2.3 Task 6.2.3 Preliminary Assessment/ Site Investigation Report ........ 17
2.6.2.3.1 Task 6.2.3.1 30% Deliverable ........ 17
2.6.2.3.2 Task 6.2.3.2 60% Deliverable ........ 17
2.6.2.3.3 Task 6.2.3.3 Final PA/SI Report ........ 17

2.7 Project Exclusions ..... 17
**3.0 Project Schedule** ..... 17
3.1 Total Project Duration ..... 17
3.2 Critical Path ..... 18
**4.0 Staffing Plan** ..... 18
**5.0 Cost of Engineering Services** ..... 20
**6.0 References** ..... 22
**7.0 Appendix** ..... 26
7.1 Appendix A: Gantt Chart ..... 26

## List of Figures

Figure 1.2 Signal Mill in Relation to Wikieup and McCracken Mine........................................... 7
Figure 1.1 Signal Mill Site location marked by yellow pin.......................................................... 7
Figure 1.3 Signal Mill Evidence of ATV Tracks [3]..................................................................... 7
Figure 1.4 Bureau of Land Management Site Investigation Sample Locations [1]........................ 9

## List of Tables

Table 1.1 Signal Mill Site Summary with Contaminants ............................................................. 8

## List of Equations

Equation 2.1 Upper Confidence Limit for Normal Distributions [5] .................................. 12
Equation 2.2 Upper Confidence Limit for Lognormal Distributions [5].............................. 12

# LIST OF ACRONYMS

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| BLM | Bureau of Land Management |
| CDI | Chronic Daily Intake |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COC | Contaminants of Concern |
| SF | Slope Factor |
| EPA | Environmental Protection Agency |
| EPC | Exposure Point Concentration |
| FAA | Flame Atomic Adsorption |
| ICP | Inductively Coupled Plasma |
| IEUBK | Integrated Exposure Uptake Biokinetic |
| IRIS | Integrated Risk Information System |
| OSHA | Occupational Safety and Health Administration |
| RFC | Reference Concentration |
| QA/QC | Quality Assurance and Quality Control |
| XRF | X-Ray Fluorescence |
| FPXRF | Field Portable X-Ray Fluorescence |

# 1.0 Project Understanding

## 1.1 Project Purpose

The purpose of the project is to conduct a preliminary assessment and site investigation that will include risk assessment at Signal Mill. The areal extent of the site is approximately 8 acres and is located on Bureau of Land Management land [1]. The site will be examined for the severity and spatial extent of contaminants. After investigation, Signal Mill will be characterized for human and ecological risk. This investigation will provide guidance for the Bureau of Land Management on how to proceed with this area of land.

## 1.2 Project Background

Signal Mill is in Arizona, approximately 22 miles south of Wikieup in Mohave County and east of the McCracken Mine; see Figure 1.1 below for a general map. Signal Mill borders the Big Sandy River on the western bank as seen in Figure 1.2. 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 [2]. 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 [2].

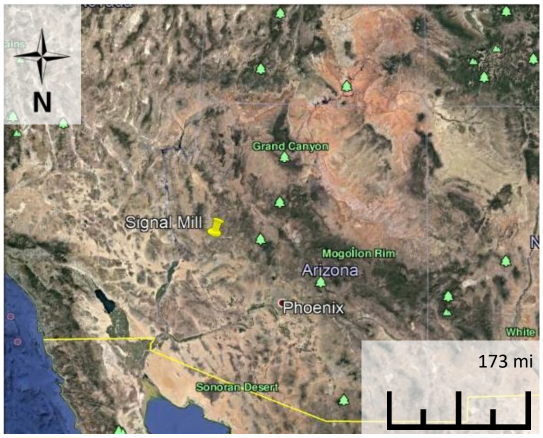


Figure 1.1 Signal Mill Site location marked by yellow pin.

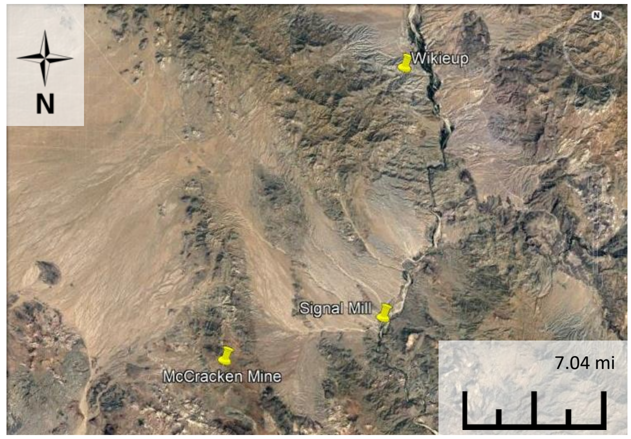


Figure 1.2 Signal Mill in Relation to Wikieup and McCracken Mine

As of today, there are only remains of Signal Mill. It is evident that the site is used as a recreation area, as all-terrain vehicle tracks are present. Figure 1.3 presented below shows evidence of all-terrain vehicle tracks at the site.


Figure 1.3 Signal Mill Evidence of ATV Tracks [3]

The only data available on Signal Mill is from the Bureau of Land Management site investigation conducted on April 9, 2018 [1]. The data collected from this brief investigation is presented in Table 1.1. The red cells in Table 1.1 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 1.1.

Table 1.1 Signal Mill Site Summary with Contaminants [1]

| 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 1.1 is visually represented across the site in Figure 1.4. 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 [1].

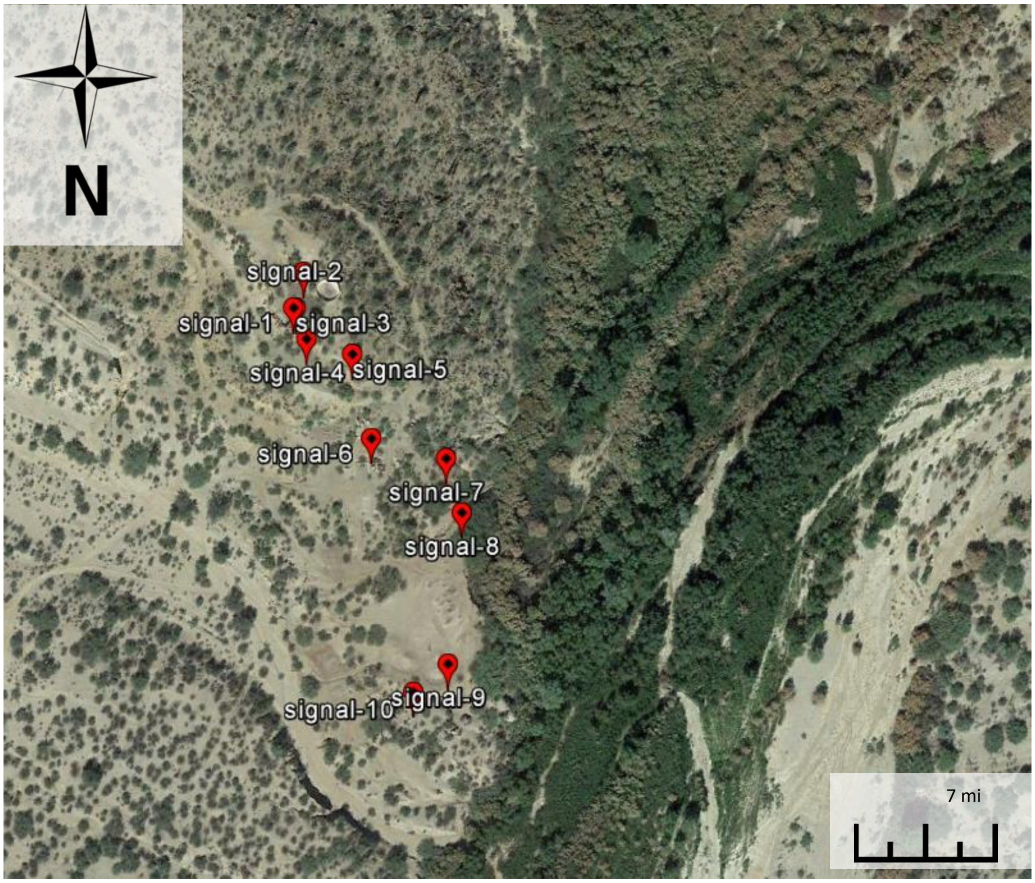


Figure 1.4 Bureau of Land Management Site Investigation Sample Locations [1]

## 1.3 Technical Considerations

The technical work required for the completion of the project includes soil sampling and the use of X-Ray Fluorescence technology to complete soil sample analysis. Wet chemistry analysis will be used to confirm and correlate XRF analyses performed through the use of Flame Atomic Adsorption (FAA) or Inductively Coupled Plasma (ICP). Furthermore, the quality assurance and quality control (QA/QC) are accounted for to ensure safety when sampling and analyzing the required data. Additionally, the preliminary assessment and site investigation based upon the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) will be followed. Prior to conducting filed work, personnel will receive a 40-hour OSHA HAZWOPER training. The technical considerations for other aspects of the project are discussed within the scope of the proposal.

### 1.4 Potential Challenges

Due to the remote location of the site, there are a few challenges that may be encountered. Preparations will be made in advance as to the best way to handle these challenges if and when they arise. Some of the potential challenges that could arise include:

- Weather conditions on site
- Transportation to the site

To help reduce the challenge of sampling due to weather, the forecast for the day of sampling in question can be looked at ahead of time and proper attire for unforeseen weather changes could be brought with to the site. With transportation to the site, a weekend spent out there to collect samples will help reduce any problems that may arise with having to go back and forth to the site more than once.

### 1.5 Stakeholders

Those who have a vested interest in the outcome of this project are the Bureau of Land Management (BLM) as well as recreational land users of the site.

## 2.0 Scope of Services

### 2.1 Task 1.0 Work Plan

The Work Plan below details all of the planning required to efficiently collect soil samples for analysis. The Work Plan consists of a project overview, project management, site background information, investigation approach, field investigation methods and procedures, investigation derived waste management, sample collection procedures and analysis, deviations from the Work Plan, Preliminary Assessment and Site Investigation (PA/SI) reporting, the Sample and Analysis Plan, and the Health and Safety Plan. The Sampling and Analysis Plan provides greater depth to the sample collection procedures and sample analysis in the lab. The Health and Safety Plan provides methods and procedures that ensure the safety of team members throughout sampling and analysis.

#### 2.1.1. Task 1.1 Sampling and Analysis Plan (SAP)

The SAP details the process that will be outlined and followed for the collection of soil samples on site and their subsequent analysis. This will detail how many samples will be taken to ensure accurate coverage of the site. The SAP will provide information on project data quality objectives, including how quality control will be maintained. Sampling rationale for the site investigation will be provided, outlining how grid sampling along with hot spot and background sampling will be determined. Sample labeling, documentation, preservation, and packaging and shipping will be determined. The methods used for soil sample analysis will be discussed.

#### 2.1.3 Task 1.2 Health and Safety Plan (HASP)

The HASP details hazards that may be encountered during sampling and analysis. Safety and health administration will be outlined along with an assessment of physical and chemical hazards that may be present on site. Training requirements to ensure health and safety will be discussed in the plan. Personal protective equipment required during the site investigation and lab analysis will be outlined. Decontamination procedures for personnel and equipment will be outlined along with waste disposal procedures. The HASP will include emergency response procedures to ensure safety during the site investigation.

### 2.2 Task 2.0 Field Sampling

Field sampling will follow the methods outlined in the SAP.

### 2.3 Task 3.0 Analysis

Analysis will be carried out as described in the SAP and includes the following analysis methods.

#### 2.3.1 Task 3.1 Dry Sieve Analysis

Samples will be dried and sieved according to SAP Section 4.1.

#### 2.3.2 Task 3.2 X-Ray Fluorescence Analysis

XRF analysis will be utilized to determine contaminants of concern (COC). The procedure followed is in the SAP Section 4.2.

#### 2.3.3 Task 3.3 Acid Digestion

Acid digestion will be utilized to prepare soil samples for the flame atomic absorption analysis and will be collected at a 20% rate. The procedures for acid digestion are outlined in the SAP Section 4.3.

#### 2.3.4 Task 3.4 Flame Atomic Absorption Spectroscopy Analysis

Samples prepared during acid digestions will be sent to external labs for flame atomic absorption spectroscopy analysis where concentrations of contaminants of concern will be determined, as outline in the SAP Section 4.4.

### 2.3.5 Task 3.5 XRF and FAAS Correlation

After the XRF and FAAS analyses, a correlation will be drawn between the results in order to check for accuracy of 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 our correlation. XRF data will be corrected based on the correlations provided.

Then, the 50% exposure point concentration (EPC) and 90% EPC will be determined for each COC. Exposure point concentrations will be calculated based on the distribution of the data. Depending on whether the data falls into a lognormal distribution or normal distribution, different statistical methods will be followed.

For normal distributions, the 50% EPC is the arithmetic mean value of a specific contaminant EPC across all samples. The 90% EPC for normal distributions is calculated using Equation 2.1.

Equation 2.1 Upper Confidence Limit for Normal Distributions [5]

$$UCL_{1-\alpha} = \bar{X} + t_{\alpha,n-1}\frac{s}{\sqrt{n}}$$

Where:

$UCL$ is the upper confidence limit

$\alpha$ is the percentile in question

*t* is the Student's *t* distribution with n-1 degrees of freedom

*n* is the number of samples

*s* is the standard deviation

For data that falls into a lognormal distribution, the 50% EPC will be calculated using a geometric mean. The 90% EPC for lognormal distributions will be calculated using Equation 2.2.

Equation 2.2 Upper Confidence Limit for Lognormal Distributions [5]

$$UCL_{1-\alpha} = \exp(\text{lnX} + \frac{s_{lnX}^2}{2} + \frac{H_{1-\alpha}S_{lnX}}{\sqrt{n-1}})$$

Where:

$lnX$ is the arithmetic mean of the log-transformed data

*H* is the Land H statistic for the sample size at the observed standard deviation of the log transformed data.

## 2.4 Task 4.0 Risk Assessment

Risk assessment will encompass a human health risk assessment and an ecological risk assessment.

### 2.4.1 Task 4.1 Human Health Risk Assessment

The human health risk assessment will be completed through the following four steps. Each step will be explained further in the following paragraphs.

1. Hazard Identification
2. Dose-Response Assessment
3. Exposure Assessment
4. Risk Characterization

Hazard identification is utilized to determine the COC's. The COC's will be identified and adverse health effects caused by the COC's will be determined.

The exposure assessment is the second step in risk assessment. The exposure assessment begins with the identification of exposure scenarios. Exposure scenarios attempt to characterize the conditions under which populations may be potentially exposed. Examples of exposure scenarios include residential adults, residential children, workers, recreational users, and trespasser scenarios. With the exposure scenario identified, the frequency and duration of that the receptor has with the identified hazard is quantified. The chronic daily intake can then be determined for the 50% and 90% exposure point concentrations.  Following this, receptor doses can be estimated and the main route investigated for the project will be ingestion.

The toxicity assessment will describe the likelihood and severity of adverse health effects are related to the amount of exposure to a COC [6]. The EPA Integrated Risk Information System (IRIS) is an environmental database that creates a chemical search to find the toxicity of that chemical resulting from chronic exposure used by EPA. Reference Dose (RfD) is associated with the non-carcinogenic assessment and it is the daily intake that is not related to any adverse health effects. The slope factor is associated with Carcinogenic risk, and is the slope of the dose-response curve at very low exposures. Carcinogenic risk, non-carcinogenic risk, and lead risk are described in the following paragraphs.

Carcinogens are one of the main concerns of the public and consist of chemicals or contaminants that cause cancer once in contact with the body. The carcinogenic risk is the chronic daily intake (CDI) associated with the exposure assessment multiplied by the slope factor. If risk is between $10^{-4}$ and $10^{-6}$ is considered to be excess risk.

Non-carcinogens are chemicals or contaminants that do not cause cancer and are generally measured on a hazard index. This index is the ratio of a potential intake dose from exposure to the safe dose of that specific chemical. To calculate the Hazard Index, chronic daily intake is divided by reference dose of that chemical [7]. A hazard index greater than one indicates excess risk.

For lead, the calculations cannot be used. Instead, biokinetic models that examine the interaction between lead and target areas within the human body are utilized. The EPA's Integrated Exposure Uptake Biokinetic (IEUBK) is a simulation software model which lead from air, water, dust, soil, and paint are inputs to determine concentration of lead in the blood based [8]. The model is for children who are between 6 months to 7 years. The lead concentration of concern in children's blood is 10 microgram per deciliter (ug/dL).

Similarly to the IEUBK, EPA provides methodology for the Adult Lead Model. The Adult Lead Model is used to assess blood lead concentrations in adults as well as the fetal blood lead concentration in women of childbearing age [9].

The last step is human health risk assessment is risk characterization. Risk characterization determines the probability of adverse effects due to exposure.

### 2.4.2 Task 4.2 Ecological Risk Assessment

An ecological risk assessment is the process of determining how likely it is that an environmental stressor may affect the natural world, and the significance of those effects [10]. An ecological risk assessment is divided into three phases: problem formulation, risk analysis, and risk characterization.

Problem formulation is the first step of the ecological risk assessment process. The purpose of this phase is to establish the goals, scope, and focus of the assessment. To accomplish this the environmental stressors must first be identified and characterized in terms of environmental effects. Stressors are considered to be chemical or physical and are examined for duration, frequency, timing, and scale [10]. Furthermore, characterizing the at-risk environment aids in understanding how these stressors will play a part in ecological harm. Ecological effects are identified through field work, laboratory testing, and the chemical structure-activity relationship [10].

The analysis phase of an ecological risk assessment examines data on the potential effects and exposure of the stressor. During this phase characterization of exposure and of ecological effects occurs. Characterization of exposure looks at the interaction between the stressor and ecological component affected. The stressor is examined for its distribution or pattern of change. The ecological component is characterized to determine how it will interact with the stressor [10]. Characterization of ecological effects develops an ecological response analysis that quantifies the effect of stressor on the ecological component. Once there is a quantified effect, a cause and effect relationship are evaluated. Data developed from the characterization of ecological effects is used to evaluate need for action [10]. Additionally, local species will be identified with special emphasis placed on endangered species.

Risk is characterized for the ecological assessment based on the stressors that affect plant and animal health. It integrates the analyses from the exposure characterization, describes the uncertainties, strengths and limitations of the analyses, and synthesizes the overall conclusion of environmental risk at the site. The risk characterization is designed to inform the BLM in making risk management decisions.

## 2.5 Task 5.0 Project Impacts

Project impacts will be assessed with regard to the environment and healt, along with social and economic impacts that will come from the results of the preliminary site assessment and analysis.

## 2.6 Task 6.0 Project Management

This section includes the items that support the organization of the project.

### 2.6.1 Task 6.1 Project Coordination

#### *2.6.1.1 Task 6.1.1 Meetings*

To ensure the appropriate development of the project, it is necessary to meet as a team, with the technical advisor, and with the client. Team meetings will occur on a weekly basis to track project progress and to identify upcoming tasks. Meetings with the technical advisor are scheduled as necessary to review progress and attain guidance. Client meetings are much less frequent and are only held for general guidance and final deliverables. For every meeting, members of the team will create an agenda. After the meeting, minutes will be sent to the team for feedback and additions. Meeting agendas and minutes will be kept in a binder for convenience and documentation.

#### *2.6.1.2 Task 6.1.2 Correspondence*

Correspondence is kept through email, phone, and in-person communication between team members, grading instructors, technical advisors, and the client, which is the Bureau of Land Management (BLM). The client contact for our team is Wyatt La Fave.

#### *2.6.1.3 Task 6.1.3 Schedule Management*

The team is responsible for managing their schedule for the approaching deadlines. To aid with this, the team will use Google calendar and added all the required project deliverable due dates and to set upcoming meetings. If the team gets off track, efforts will be made to get back on track by completing deliverables in a shorter amount of time than was originally planned.

### 2.6.2 Task 6.2 Deliverables

#### *2.6.2.1 Task 6.2.1 Website*

One of the required deliverables is a website which presents the progression and findings of the work completed. The website will be private as requested by the client. The final website will be completed by May 3rd.

#### *2.6.2.2 Task 6.2.2 Final Presentation*

Students will give a presentation at NAU's Undergraduate Symposium (UGRADS) on April 26, 2019.

#### *2.6.2.3 Task 6.2.3 Preliminary Assessment/ Site Investigation Report*

##### 2.6.2.3.1 Task 6.2.3.1 30% Deliverable

The first deliverable for the PA/SI report is the 30% deliverable. This report comprises about one-third of the total report and is used to ensure that the project is on time. The 30% deliverable will be completed by March 1st.

##### 2.6.2.3.2 Task 6.2.3.2 60% Deliverable

Similarly, the 60% deliverable ensures the project is on time, but with about two thirds of the report completed. The 60% deliverable will be completed by April 5th,

##### 2.6.2.3.3 Task 6.2.3.3 Final PA/SI Report

The final report encompasses all data collected and provides the results of the preliminary assessment and site investigation. The final deliverable will be completed by May 3rd.

## 2.7 Project Exclusions

Exclusions to the project include water sampling and core soil sampling because the greatest concern at the site is contaminant migration. Therefore, the most effective way to measure this is by testing surface soil samples.

# 3.0 Project Schedule

## 3.1 Total Project Duration

The project was started on October 9, 2018 and will end on May 9, 2019 for a total project length of 153 days. A schedule is visualized for the project utilizing a Gantt Chart available in Appendix A.

### 3.2 Critical Path

The critical path is composed of the tasks needed to be completed so that the project stays on time. The critical path is outlined in red on the Gantt chart for a total length of 124 days to complete the critical path tasks. The critical path is composed of completing the work plan, field sampling, soil analysis, risk assessment, project impacts, and creating the final PA/SI report.

## 4.0 Staffing Plan

The staff members of the company and their abbreviations are as follows: Senior Engineer (SENG), Engineer (ENG), Engineer in Training (EIT), and Laboratory Technician (LAB).

Qualifications for senior personnel will be provided for all staff members. The qualifications for the Senior Engineer include a Bachelor's degree in environmental engineering or related engineering field, ten or more years of experience in the field of environmental engineering or related field, Professional Engineer (PE) license in environmental engineering or related field, working knowledge of Arizona Department of Environmental Quality and EPA regulations, and experience in project management. The qualifications for the Engineer include a Bachelor's degree in environmental engineering or related engineering field, five or more years of experience in the field of environmental engineering or related field, and a Professional Engineer (PE) license in environmental engineering or related field. The qualifications for the Engineer in Training include a Bachelor’s degree in environmental engineering or related field. The qualifications for the Laboratory Technician include a Bachelor of Science in chemistry or related field.

The proposed staffing plan is provided below in Table 4.1. The table provides proposed working hours of all staff members on each task outlined in the Scope. The organization of Table 4.1 shows tasks and subtasks, where the overall task shows the cumulative hours for the subtasks. The total hours for each staff member is calculated based on the overlying tasks, as the subtasks compose the major tasks.

Table 4.1 Staffing Plan Hours Breakdown

| Task | SENG (hr) | ENG (hr) | EIT (hr) | LAB (hr) |
|---|---|---|---|---|
| **1.0 Work Plan (Cumulative)** | 8 | 24 | 24 | 0 |
| 1.1 Sampling and analysis Plan (SAP) | 4 | 12 | 12 | 0 |
| 1.2 Health and Safety Plan (HASP) | 4 | 12 | 12 | 0 |
| 2.0 Field Sampling | 2 | 23 | 23 | 0 |
| **3.0 Analysis (Cumulative)** | 2 | 23 | 23 | 120 |
| 3.1 Dry Sieve Analysis | 0 | 0 | 0 | 40 |
| 3.2 X-Ray Fluorescence Analysis | 0 | 0 | 0 | 40 |
| 3.3 Acid Digestion | 0 | 0 | 0 | 16 |
| 3.4 Flame Atomic Absorption Spectroscopy analysis | 0 | 0 | 0 | 12 |
| 3.5 XRF and FAAS Correlation | 2 | 23 | 23 | 12 |
| **4.0 Risk Assessment (Cumulative)** | 16 | 48 | 40 | 0 |
| 4.1 Human Health Risk Assessment | 8 | 24 | 20 | 0 |
| 4.2 Ecological Risk Assessment | 8 | 24 | 20 | 0 |
| 5.0 Project Impacts | 2 | 4 | 2 | 0 |
| **6.0 Project Management (Cumulative)** | 142 | 116 | 78 | 16 |
| 6.1 Project Coordination | 40 | 24 | 8 | 4 |
| **6.2 Deliverables (Cumulative)** | 96 | 88 | 0 | 12 |
| 6.2.1 Website | 16 | 8 | 0 | 0 |
| 6.2.2 Final presentation | 16 | 16 | 0 | 0 |
| 6.2.3 PA/SI Report | 64 | 64 | 0 | 12 |
| Sum (hours) | 170 | 234 | 188 | 136 |
| Total working hours | 728 | | | |

The Senior Engineer will work 168 hours during the project. The Senior Engineer’s main role is to guide the project and dedicate most of their time to ensuring quality outputs. This is reflected in the Table above, as most working hours are towards project deliverables. The Engineer and Engineer in Training will work 240 and 192 hours respectively over the course of the project. Both of these personnel will be doing the bulk of the sampling and analysis for the project. The Engineer will work slightly more hours than the Engineer in Training due to their greater knowledge of the project. The Engineer will also aid the Engineer in Training in their tasks. The Laboratory Technician will work a total of 136 hours over the course of the project. Their time will be allocated mainly lab work. The Laboratory Technician will be preforming all the required lab test and prepare the results for the engineering staff.

## 5.0 Cost of Engineering Services

The cost estimate for this project was calculated from the cost of personnel, travel, supplies, and subcontracting. The cost of personnel was calculated by first determining the time commitment per employee per task, as provided in Table 4.1. Indirect costs are included in the personnel hourly rates. The cost breakdown is included in Table 5.1.

Table 5.1 Cost Analysis for Engineering Services

| Line Item | Classification | Quantity | Rate | Cost | Total Cost |
|---|---|---|---|---|---|
| 1.0 Personnel | SENG | 170 | $147/ hr | $24,990 | $56,382 |
| | ENG | 234 | $76/hr | $17,784 | |
| | LAB | 188 | $42/hr | $7,896 | |
| | EIT | 136 | $42/hr | $5,712 | |
| 2.0 Travel | Gas | 506 mi | $0.38/mi | $192 | $1,728 |
| | Food | 6 ppl x 3 day | $41/day | $738 | |
| | Vehicle | 4 day | $60/day | $240 | |
| | Hotel | 3 room x 2 night | $93/night | $558 | |
| 3.0 Supplies | Sampling and lab fees | NA | NA | $18,750 | $18,750 |
| 4.0 Subcontract | Arsenic Test | 20 sample | $50/sample | $1,000 | $1,350 |
| | FAAS Test | 20 sample | $15/sample | $300 | |
| | Shipping | 1 batch | $50/batch | $50 | |
| 5.0 Total Project Cost | | | | | **$78,210** |

The supplies section includes sampling and lab materials, each at a unique price value. The sampling supplies breakdown can be found in Table 5.2 below, which provides everything necessary for sampling. Personal protective equipment prices were based on rates provided on the ULINE Safety Products storefront. Lastly, the subcontracting fees include the cost of arsenic testing that will be sent out to external lab for twenty samples as well as FAAS testing at NAU Engineering soil laboratory for another twenty samples. Arsenic analysis and shipping was provided by Western Technologies, Inc. The total proposed cost of engineering services is $78,210.

*Table 5.2: Sampling supplies Breakdown*

| Item | Quantity | Rate | Cost |
| --- | --- | --- | --- |
| **Gallon Ziploc Bags** | 3 boxes | $5/box of 38 [18] | $15 |
| **Sharpies** | 1 package | $8/package of 12 [19] | $8 |
| **5 gallon buckets w/lid** | 3 buckets | $6/bucket [20] | $60 |
| **Field log books** | 2 books | $20/book [21] | $120 |
| **Labels** | 1 roll | $15/roll of 300 [22] | $15 |
| **Gloves** | 3 cartons | $17/carton of 100 [23] | $51 |
| **Trash bags** | 1 roll | $16/roll of 50 [24] | $16 |
| **Hand Trowels** | 4 trowels | $10/trowel [25] | $40 |
| **Deionized Water** | 15 Gallons | $55/5 gal [26] | $165 |
| **Water** | 30 Gallons | $6/5 gal | $36 |
| **Sampling Supplies** | 100 samples | $100/sample | $10,000 |
| **Lab Supplies** | 100 samples | $15/sample | $1,500 |
| **ENE Lab Rental** | 15 days | $415/day | $6,225 |
| **Soap** | 1 pack | $15/pack of 3 [27] | $15 |
| **Storage Bins** | 4 | $40/pack of 4 | $160 |
| **Batteries (40 pack)** | 1 box | $20/ 1 box | $20 |
| **200-foot Tape Measure** | 2 | $22/tape measure | $44 |
| **Permanent Marker** | 6 | $26/1 Permanent marker | $156 |
| **Compass** | 2 | $13/compass | $26 |
| **Heavy Duty Freezer Plastic Bags (one Gallon)** | 150 | $5/38 bags | $20 |
| **Survey Flags** | 100 | $8/bundle of 100 | $8 |
| **GPS** | 2 | $10/day | $40 |
| **Scrubber/Sponge** | 2 scrubber | $5/scrubber [28] | $10 |
| **Total** | | | **$18,750** |

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# 7.0 Appendix

## 7.1 Appendix A: Gantt Chart