Engineering Evaluation/Cost Analysis Work
Midway Atoll National Wildlife Refuge
Midway, Island

for
U.S. Fish and Wildlife Service

June 4, 2010
Engineering Evaluation/Cost Analysis Work Plan

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Midway Island

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June 4, 2010

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1.0 INTRODUCTION AND SCOPE OF SERVICES

This work plan presents the scope and schedule for the completion of an Engineering Evaluation/Cost Analysis (EE/CA) for lead-contaminated soil at the Midway Atoll National Wildlife Refuge (Refuge or site) for the U.S. Fish and Wildlife Service (FWS). The site location is shown in Figure 1 and the site layout is shown in Figures 2 through 12. This work plan has been prepared for the FWS under Delivery Order 101819X716 and in general accordance with GeoEngineers’ task order proposals, dated July 28, 2009 and February 9, 2010, and our task order change order, dated June 3, 2010.

1.1 Work Plan Organization

This work plan describes the rationale and scope of services for the EE/CA. The following appendices are also included:

- Appendix A – Field Sampling Plan.
- Appendix B – Quality Assurance Project Plan (QAPP)
- Appendix C – Streamlined Risk Evaluation (SRE)
- Appendix D - Health and Safety Plan (HASP)

1.2 Scope of Services

Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and the Superfund Amendments and Reauthorization Act (SARA) of 1986, Congress provided a mechanism for the cleanup of uncontrolled hazardous waste sites. In August 1993, the U.S. Environmental Protection Agency (EPA) prepared “Guidance for Conducting Non-Time-Critical Removal Actions Under CERCLA.” This guidance details the requirements for the completion of an EE/CA.

We propose that the FWS address the risks presented by lead contaminated soil as a non-time-critical removal (NTCR) action. The goal of an NTCR is to reduce threats to human health and the environment. For discussion purposes, the lead-contaminated soil around existing buildings can be viewed as one operable unit (OU), and the remaining soil at the site and potential pesticide contamination can be viewed as a separate and distinct OU that will be addressed through future actions, if deemed necessary by FWS. Under this approach, lead is the only contaminant of concern (COC) in soil and avian species are the only potentially significantly impacted receptors.

On June 2, 2010, the FWS requested that GeoEngineers expand the scope of the EE/CA to identify and evaluate additional aspects of the planned abatement of lead from buildings and n site soils. The expanded EE/CA will: 1) include a description of the nature and extent of lead in soil at the site; 2) identify ongoing and threatened release sources; and 3) identify and evaluate alternatives for remediating lead from buildings and in site soils. The evaluation of remediation alternatives will include a detailed analysis of: 1) potential cleanup methods, 2) the scope of cleanup that would be conducted under each alternative, 3) the extent the alternative addresses existing and future ecological risks, 4) the threat of recontamination for each alternative, 5) options for disposal of wastes, 6) worker safety considerations, and 7) an opinion of costs.
Under the expanded scope of work, GeoEngineers will identify and address all pertinent aspects of the development and comparative assessment of alternatives to remediate the lead in soil and to address ongoing or threatened sources of additional lead contamination (for example, lead paint on buildings).

It is assumed that a clean-up level that is protective of ecological health will also be protective for human receptors. The conclusions of GeoEngineers work will serve as the foundation for evaluating response actions.

As part of our work, GeoEngineers will also complete a SRE. The summary of SRE tasks is provided below.

### 2.0 BACKGROUND SUMMARY

#### 2.1 Site Location and Description

The Refuge is a United States possession located in the Northwestern Hawaiian Islands at 28°12'35" North latitude and 177°22'47" West longitude, approximately 1,100 miles northwest of Oahu and at the northwestern end of the Hawaiian Island chain (Figure 1). The real property on which the Refuge exists, as well as all operational facilities, was formerly known as Naval Air Facility (NAF) Midway Island. NAF Midway Island, under the control and jurisdiction of the U.S. Department of Navy, was transferred to the U.S. Department of the Interior, FWS, on October 31, 1996 and the last contingent of Navy personnel left on June 30, 1997.

The Refuge consists of three islands and a lagoon, enclosed by a circular coral reef (atoll) approximately five statute miles in diameter, and is surrounded on all sides by the Pacific Ocean. The largest island, Sand Island, has an area of 1,201 acres, and has a permanent population that varies from 30 to 100 people. Eastern Island has an area of 334 acres and has been uninhabited since 1970. Spit Island is an ephemeral sand spit with a current area of approximately 14 acres, and has never been inhabited.

All Refuge operational facilities are located on Sand Island. The facilities consist of an airfield, single and multi-unit residences, dining and recreational facilities and support facilities. A layout of Sand Island is shown in Figure 2.

The Refuge was established as an overlay Refuge in 1988 and was managed in coordination with the U.S. Navy until October 1996, when the Atoll was transferred to the FWS. The Refuge was established due to: 1) the use of the islands by 17 species of migratory seabirds as breeding and nesting habitat; 2) the use of the lagoon and near shore waters for feeding and the beaches of the islands for basking by the threatened Hawaiian green sea turtle; and 3) the use of the lagoon and near shore waters for feeding and breeding and the beaches of the islands for hauling out and pupping by the endangered Hawaiian monk seal.

On June 15, 2006, President George W. Bush signed Presidential Proclamation 8031 that encompasses the site into a fully protected marine conservation area. By applying the authority of the Antiquities Act, which gives the President discretion to declare objects or places of scientific or
historic interest a national monument, he created the Northwestern Hawaiian Islands Marine National Monument. The monument covers nearly 141,000 square miles of land and ocean.

2.1 Site History

Historical structures at the site typically were painted with lead-based paint (LBP). The FWS is currently undertaking the abatement of LBP of the structures. The ongoing abatement process does not address LBP residue on or in the ground surrounding existing buildings. Lead in soil represents a hazard to populations of nesting birds, particularly the Laysan Albatross; but also the Laysan Duck, Laysan Finch and Bonin Petrel.

Task 1 of GeoEngineers original scope of services included a preliminary review of the FWS’ “Ecological Risk Assessment (ERA) for Lead in Soil and Laysan Albatross Chicks on Sand Island, Midway Atoll National Wildlife Refuge”, dated September 24, 2009. GeoEngineers provided a review of the ERA in a memorandum dated October 20, 2009, offering a variety of concerns about the sampling and data evaluation methodology that affect the protective cleanup values derived in the document.

Based on the October 20, 2009 memorandum, FWS requested that GeoEngineers submit a representative number of remaining soil samples (collected by others) for confirmation testing for lead. In addition, ten soil samples were analyzed for polychlorinated biphenyls (PCBs), Resource Conservation Recovery Act (RCRA)-8 metals and organochlorine pesticides. The results, which have been provided to FWS separately, indicated the presence of low levels of PCBs, dichlorodiphenyltrichloroethylene (DDT), dichlorodiphenyl dichloroethylene (DDE) and dichlorodiphenyl dichloroethane (DDD) in some samples.

3.0 WORK PLAN TASKS

Work plan tasks include: 1) Field Investigation; 2) Sample Analysis and Validation; 3) Data Evaluation; 4) Risk Assessment; and 5) Report Preparation. A description of the scope of services for each task is presented below. Detailed sampling protocol and field/laboratory QA/QC procedures are discussed in Appendix A (Field Sampling Plan) and Appendix B (Quality Assurance Project Plan). A HASP, prepared for use by GeoEngineers’ field personnel in general accordance with Occupational Safety and Health Administration (OSHA) regulations, and Title 29 of the Code of Federal Regulations (CFR) 1910 Subpart I, 1910 Subpart Z (lead), is presented in Appendix C.

3.1 Field Investigation

The following sections provide a summary of the investigations proposed to characterize the site and to evaluate the actual or potential risk to the environment posed by lead contaminated soil. In general, GeoEngineers will advance up to 248 explorations using hand tools (augers, shovels, trowels, etc). Soil samples will be collected in the intervals between 0 to 6-inches, 12 to 18-inches and 24 to 28-inches below ground surface (bgs). The soil samples collected from the 0 to 6-inch interval will be collected using composite sampling techniques. A five point composite sample will be collected from a 10-foot radius of the each exploration. The use of the composite sample will allow for better characterization of the lead in soil in the most exposed soil profile.
Approximately 10 percent of the explorations will be advanced to 36-inches bgs to verify the absence/presence of lead in deeper soils. The deeper soil samples will be collected at 30 to 36-inches bgs. In addition, one duplicate sample will be collected and analyzed for every 20 primary samples. Soil conditions in the explorations will be carefully recorded in field notes. The samples will be submitted for laboratory analysis of lead by US Environmental Protection Agency (EPA) method 6010.

GeoEngineers anticipates that soil samples will be collected at various distances from each proposed sampling building. Samples will be collected at three sampling distances (0-15 feet, 15-30 feet and 30-45 feet) organized in a concentric pattern around each building. Soil samples will not be collected at locations where concrete, large trees, roadways or other obstacles are present. Areas that are not sampled due to access limitations will be documented. During previous work, the FWS placed a number of fabric liners over portions of the soil near buildings and other structures. If a fabric liner or mat is present, the fabric will be cut and a sample will be collected.

GeoEngineers selected the sampling locations to reflect a variety of different site structures, different construction types, construction dates, and site layouts. Figures 2 through 12 show the locations of the proposed explorations. Appendix A provides the Field Sampling Plan.

### 3.1.1. Mobilization, Lodging and Meals

GeoEngineers will be responsible for transportation of field staff to Honolulu, Hawaii. The FWS will arrange for, and cover the charter round trip expense for transportation of field staff, equipment and samples from Honolulu to Midway. We have assumed that the fieldwork will commence in June 2010.

While on island, GeoEngineers field staff will stay in the on-site barracks and meals will be provided at the Clipper House. We understand that the Refuge operates a small on-site store that is open during limited hours each day. GeoEngineers anticipates that Chugach Industries, the current Island contractor, will invoice GeoEngineers a lodging and meals per diem during our on-site field work.

### 3.1.2. Background Samples

GeoEngineers has identified 20 sampling locations for the collection of background soil samples. The locations of the background samples are shown on Figure 2 through 2E. GeoEngineers will collect samples at each background location from four intervals (0 to 6-inches, 12 to 18-inches, 24 to 28-inches, and 30-36 inches bgs). The proposed background sample locations are in areas on the Refuge that have not been historically developed, to the best of our knowledge, based on a review of historical aerial photographs and previous reports.

### 3.1.3. Residential Structure Samples

GeoEngineers selected five current or former residential structures for lead-in-soil sampling. Figures 2 through 12 show the location of the selected residential structures. The residential structures were selected to cover a variety of construction types, styles and years. The soil around the following structures will sampled.

- **Building 4203 (Bravo Barracks)** – The Bravo barracks consists of a three story structure that is still in use for residential housing. It is assumed that the lead in soil concentrations in building 4203 will be similar to those in building 4204 (Charlie Barracks).
Building 421 (Historic Officers Quarters) – Building 421 is one of a number of single family residential structures that were used to house military officers. Building 421 has been used in the recent history for housing of onsite workers. It is assumed that the lead in soil concentrations in building 421 will be similar to the other historical officer quarters (Buildings 414, 415, 416, 417, 418, 419, 422, 423 and 424).

Building 4210 (Concrete Duplex) – Building 4210 is a concrete residential. It is assumed that the lead in soil concentrations in building 4210 will be similar to the other concrete duplexes (Buildings 4208, 4209, 4211 and 4212).

Building 3504 (Marine Barracks) – Building 3504 was historically used as residence for military personnel. It is assumed that the lead in soil concentrations in building 3504 will be similar to the other Marine Barracks, building 3503.

3.1.4. Operational and Historical Structure Samples

GeoEngineers selected seven non-residential structures for lead-in-soil sampling. Figures 2 through 12 show the location of the selected structures. The structures were selected to cover a variety of construction types, styles and years. The soil around the following structures will be sampled.

Building 623 (Cable House) – Building 623 is a historical cable house on the northern portion of the site. Building 623 is one of the oldest structures at the Facility. It is assumed that the lead concentrations in soil at building 623 will be similar to those in the other Cable Houses (buildings 619, 626, 628 and 643)

Building 5303 (R-2 Unit) – Building 5203 is the former R-2 unit used for storage of drinking water at the Refuge. R-2 is a concrete structure with exterior paint.

Building 2403 (Furniture Warehouse Building) – Building 2403 is located near the Midway Mall Complex. The building is currently used for storage.

Building 3512 (Gymnasium Building) – Building 3512 is located in the central portion of the Refuge. The building was historically used as a gymnasium.

Building 363 (Recycling Storage Building) – Building 363 was historically used as a parachute and torpedo prepping area. The building is currently used for the storage of recycling materials such as paper and plastic.

Building 1124 (Harbor Shop and Office) – Building 1124 is located on the northeastern side of the inner harbor. The building is not currently used.

3.1.5. Opportunistic Samples

GeoEngineers will collect opportunistic samples at various locations on the island, as deemed necessary or useful for evaluating ecological risks. These opportunistic samples may be taken around other buildings of concerns or different sections of the island.

3.1.6. Map Generation and Location Control

GeoEngineers will record the position of each exploration using a sub-meter Global Positioning System (GPS) instrument or by measuring the locations of the explorations, relative to fixed site features, using a measuring tape or measuring wheel. In addition, GeoEngineers will document the surrounding surface features of all site buildings (for example, location of walkways, dense...
vegetation and obstructions) The information gathered during this step will be used by GeoEngineers to estimate the volume of lead-contaminated soil that may be generated during future remediation activities.

3.1.7. X-Ray Florescence (XRF) Testing

GeoEngineers will submit approximately 100 soil samples for laboratory analysis of lead content using an x-ray fluorescence (XRF) instrument. GeoEngineers will compare the XRF data to the sample analytical data generated by EPA Method 6010 (see Section 3.2) to evaluate whether XRF data are adequate for guiding future remedial excavation activities. We anticipate that a range of lead concentrations will be submitted for testing by XRF methods. The target concentrations will range from non-detect to higher concentrations, with the bulk of the testing in the range of the estimated cleanup concentrations (50 to 100 mg/kg).

The laboratory XRF testing will be conducted in a manner similar to in-situ testing. That is, the laboratory will perform XRF analyses without any preparatory steps (for example, drying, sieving and grinding). The proposed analytical methodology is intended to obtain data that are similar to data that will be collected in the future, during remedial excavation and/or capping.

3.2 Sample Analysis and Validation

The laboratory analytical plan has been designed to fulfill the following data collection needs:

- Evaluate the presence and concentrations of lead in soil;
- Assess the nature and extent of contamination; and
- Risk-based decision making.

GeoEngineers will procure an analytical laboratory to complete the soil analyses for this project. The following analytical methods will be used:

- Total lead in soil using EPA Method 6010;
- Leachable concentrations of lead, in soil, using EPA Method 1311, toxicity characteristic leaching procedure (TCLP). Five soil samples will be tested for leachable concentrations of lead; and
- Approximately 100 confirmation soil samples will analyzed using XRF methods. This testing will allow us to confirm the validity of using an XRF instrument for guiding the future excavation activities.

3.2.1 Data Quality Objectives

Consistent with EPA risk assessment methodology, the quality assurance goal for EPA Method 6010 analyses will be to generate analytical data that are sufficient for risk assessment purposes and capable of calculating human health risk below the $1 \times 10^{-6}$ risk level. During laboratory procurement, the analytical method reporting limits will be compared to these reporting limit (MRL) goals to determine if the target reporting limits will be sufficient for risk assessment purposes. The MRL goals are discussed in the QAPP (Appendix B).
3.2.2 Data Management

GeoEngineers will enter the data in a comprehensive database, review, and validate the data. The data set will be organized in a manner that will facilitate risk screening and statistical manipulation, and allow it to be exported to other data platforms, if requested by the FWS.

3.3 Data Evaluation

This task includes efforts related to the analysis of data once it has been verified that the data are of acceptable accuracy and precision. GeoEngineers will analyze all site investigation data and present the results of the analyses in an organized and logical report. The data evaluation process is described in detail in Appendix C. Risk Assessment.

An SRE will be conducted to assess whether lead in soil poses unacceptable risks, and if so, to develop a screening level for lead that is protective of avian receptors. Appendix C contains a copy of the SRE Work Plan.

3.4 Reporting

This task covers all efforts related to the preparation of the findings once the data have been evaluated. The task covers all draft and final reports as well as task management and quality control.

- GeoEngineers will prepare a report upon receipt of the laboratory analytical data. The report will: 1) discuss the field investigation and risk assessment activities, 2) present removal alternatives, and 3) compare removal alternatives, using the criteria identified in EPA's 1993 EE/CA Guidance. GeoEngineers will recommend a removal action alternative. Where possible, we will include supporting documentation (for example, laboratory analytical data) in electronic format to save paper and reduce the cost and bulk of the report. The EE/CA will:
  - Evaluate alternatives for the abatement of lead from structures. Abatement may include physical removal using hand techniques, chemical techniques, and sanding techniques;
  - Evaluate whether demolition of select structures, including a number of the Cable House buildings and the Marine Barracks, is a reasonable remediation option;
  - Assess options and costs for the abatement of asbestos from the structures slated for demolition;
  - Estimate costs for re-painting abated structures;
  - Evaluate potential remediation options or demolition options for the existing fuel storage tanks;
  - Evaluate potential remediation options for the abatement of lead from the exterior of the water tanks;
  - Evaluate remedial alternatives for hazardous building materials that were recently removed by the FWS and are currently stored at the site; and
  - Evaluate the costs and logistics associated with conducting abatement of hazardous building materials and soil excavation activities under a phased schedule or concurrently. For each operable unit, an assessment will be made of whether adopting a no action alternative presents an imminent and substantial endangerment.
Future remediation work at the site may be divided into geographic operable units, which would allow the FWS to prioritize remediation activities at the areas presenting the highest threats and in the most cost effective manner. Possible operable units may include:

- Operable Unit 1 – Buildings 619, 623, 626 and 64 (Cable Buildings).
- Operable Unit 2 – Buildings 578 and 579 (Marine Barracks).
- Operable Unit 3 – Building 4203 (BOQ Bravo Barracks) and the lead contaminated soil within the area of buildings 4203, 4204 and the Officers Quarters buildings 415, 416, 417, 418, 419, 421, 422, 423, 424 (buildings where lead paint has already been removed).
- Operable Unit 4 – Building 259 (Midway Mall).
- Operable Unit 5 – Building 5309 (HM storage building).
- Operable Unit 6 – Buildings 393 (SK1 warehouse, 356 (Transmission shop), 357 (Machine shop), 331 (Medical Clinic/Offices), 249 (Cold storage), 3501 (R3 pump station), 363 (Torpedo shop/recycling) and 151 (Seaplane Hangar).
- Operable Unit 7 – Fuel storage tanks located at Fuel Farm.
- Operable Unit 8 – The remaining buildings or structures, including water storage tanks, that are in use by the FWS.

GeoEngineers will assist the FWS in the preparation of a planning level estimate for the disposal of the existing hazardous waste inventory at the site. While these costs cannot be covered under the Comprehensive Environmental Response, Compensation (CERCLA) response action, it is likely that the disposal of the materials can be competed in conjunction with the ongoing lead abatement projects.

The report will also clearly describe: 1) the quantities and concentrations of lead in soil at the site and the background levels surrounding the site; 2) the number, locations, and types of nearby populations and activities; and 3) the potential transport mechanism and the expected fate of lead in the environment.

The report will initially be prepared in draft form, allowing revisions by FWS, if necessary. We will issue the report in its final form after receipt of comments on the draft report. The EE/CA will be completed in accordance with EPA’s Guidance for Conducting Non-Time-Critical Removal Actions under CERCLA, under the following outline:

- Executive Summary
- Site Characterization
  - Site description and background
  - Previous removal actions
  - Source, nature and extent of contamination
  - Analytical data
  - Streamlined risk evaluation
- Identification of removal action objectives
3.4.1 Remedial Alternatives Development and Screening

The initial step for the EE/CA is to develop a list of general response actions that may be effective for addressing lead contamination at the site. GeoEngineers will develop a range of distinct, hazardous waste management alternatives that will remediate or manage the lead contamination at the site. Establish Remedial Action Objectives and General Response Actions

GeoEngineers will develop site-specific remedial action objectives (RAOs). The RAOs will specify the contaminant(s) and media of concern, the exposure route(s) and receptor(s), and an acceptable contaminant concentration or range of concentrations for each exposure scenario. As part of the RAO development process, GeoEngineers will establish preliminary remediation goals (PRGs), based on readily available information or chemical-specific applicable rules and regulations (ARARs).

GeoEngineers will develop general response actions which are likely to satisfy the RAOs. Likely response actions include: 1) treatment, 2) excavation, 3) capping, and/or 4) other actions. The evaluation of response actions will include consideration of: 1) contaminant areas and volumes, 2) protectiveness of each response action, and 3) the chemical and physical characteristics of the site.

3.4.1.1 Identify and Screen Technologies

GeoEngineers will identify and evaluate hazardous waste treatment technologies, based on the developed general response actions, to identify the technologies that are appropriate for the contamination at the site. This evaluation will be based primarily on a technology’s ability to effectively address the contaminants at the site, but will also take into account a technology’s implementability and cost. GeoEngineers will select representative process options, as appropriate, to carry forward into remedial alternative development.
3.4.1.2 CONFIGURE AND SCREEN ALTERNATIVES
The potential technologies and process options, identified by GeoEngineers (under Section 3.5.1.2) will be will be defined with respect to size and configuration of the representative process options; time for remediation; rates of flow or treatment; spatial requirements; distances for disposal; and required permits, imposed limitations, and other factors necessary to evaluate the alternatives. If many distinct, viable options are available and developed, a screening of alternatives will be conducted to limit the number of alternatives that undergo the detailed analysis and to provide consideration of the most promising process options. The alternatives will be screened on a general basis with respect to their effectiveness, implementability and cost.

3.4.2 Detailed Analysis of Remedial Alternatives
GeoEngineers will complete a detailed analysis and comparison of remedial alternatives and recommend an alternative that is likely to be effective at the site. The detailed analysis will include a comparison of the remedial alternatives, relative to the following evaluation criteria:, which will include effectiveness, implementability and cost.

4.0 SCHEDULE
Field work is scheduled for June 10 through June 17, 2010. GeoEngineers anticipates that the analytical results will be available by July 16, 2010. It is anticipated that the draft EE/CA will be completed within 12 to 16 weeks of receipt of the analytical data.

5.0 LIMITATIONS
We have prepared this work plan for use by the FWS. This work plan is not intended for use by others, and the information contained herein is not applicable to other sites.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted environmental science practices in this area at the time this work plan was prepared. No warranty or other conditions express or implied should be understood.

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6.0 REFERENCES


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LEGEND:

PROPOSED BACKGROUND SAMPLE LOCATION

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LEGEND:
- PROPOSED SAMPLING AREAS
- SOILS AROUND STRUCTURE SAMPLED BY US FISH AND WILDLIFE SERVICE IN 2009
- PROPOSED BACKGROUND SAMPLE LOCATION
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**Legend:**
- 15' sampling area
- 30' sampling area
- 45' sampling area
- Proposed Sample Location
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Structure #421 Sampling Plan
USFWS - Midway Atoll
Midway Island

Figure 5

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Reference: Drawing created from sketch provided by GeoEngineers personnel.

LEGEND:
- 15' sampling area
- 30' sampling area
- 45' sampling area
- Proposed Sample Location
Notes:
1. The locations of all features shown are approximate.
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Reference: Drawing created from sketch provided by GeoEngineers' personnel.
Reference: Drawing created from sketch provided by GeoEngineers' personnel.

USFWS - Midway Atoll
Midway Island

Structure #3504 Sampling Plan

Notes:
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Reference: Drawing created from sketch provided by GeoEngineers' personnel.
APPENDIX A
Field Sampling Plan
APPENDIX A
FIELD SAMPLING PLAN
GENERAL

This appendix describes the field procedures, field quality assurance/quality control (QA/QC) protocol, and the chemical testing program to be implemented during site activities. The field activities will include the following activities:

- Collection of soil samples from hand tools;
- Collection of soil from hand augers;
- Location control;
- Decontamination procedures; and
- Handling of IDW.

Collection of Soil Samples Using Hand Tools

Soil samples will be collected from near-surface using tools such as spades, shovels, trowels, and scoops. At each sample location, hand tools will be used to remove surface soil until the desired sample depth interval is reached. At that depth, a sample will be collected using a stainless steel or plastic scoop. Representative soil samples can be collected using this procedure with proper care. Chrome-plated tools will not be used.

If soil sample is to be a discrete sample, collect soil using a clean/decontaminated stainless-steel (organic analyses) or plastic (inorganic analyses) spoon. Composite soil samples will be collected using a stainless-steel or plastic spoon, and transferred to a stainless steel or plastic bowl. The samples will be mixed in the bowl to make a single sample.

Samples will be placed in a cooler with ice and delivered to the analytical laboratory within laboratory-specified holding times. Standard chain-of-custody procedures will be observed during transport of the samples to the laboratory.

Collection of Soil Samples from Hand Augers

This system consists of an auger, a series of extensions, and a "T" handle. The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample is collected directly from the auger. The hand auger sampling procedure is summarized below:

- Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.
- Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the drilling location.
- Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.
After reaching the desired depth, slowly and carefully remove the auger from the hole. When sampling directly from the auger, collect the sample after the auger is removed from the hole.

Place the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, place the sample into appropriate, labeled containers and secure the caps tightly; if another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow the steps above.

Abandon the hole according to applicable regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

Samples will be placed in a cooler and delivered to the analytical laboratory within laboratory-specified holding times. Standard chain-of-custody procedures will be observed during transport of the samples to the laboratory.

Location Control
GeoEngineers will record the position of each exploration with a sub-meter grade GPS instrument or each point will be measured to known locations.

Decontamination Procedures
The objective of the decontamination procedure is to minimize the potential for cross contamination between exploration locations and between individual samples within a specific exploration. Sampling equipment will be decontaminated in accordance with the following procedures before each sampling attempt or measurement.

- Brush equipment with a wire brush, if necessary, to remove large particulate matter.
- Rinse with potable tap water.
- Wash with nonphosphate detergent solution (liquinox and potable tap water).
- Rinse with potable tap water.

Handling of Investigation-Derived Waste
IDW anticipated to be generated during the project includes soil cuttings and decontamination water. Soil cuttings will be placed back in the exploration in the order removed. Purge water will be placed in U.S. Department of Transportation (DOT)-approved 55-gallon drums. Each drum will be labeled with the project name, exploration number, general contents, and date. The drummed IDW will be stored on-site pending future disposal. Disposable items, such as sample bags, gloves and protective overalls and paper towels, will be placed in plastic bags after use and deposited in trash receptacles for disposal.

LABORATORY ANALYTICAL PLAN
Laboratory analyses will be conducted in accordance with EPA approved methods. The project will utilize the laboratories accepted method detection limits as our reporting goals. The following methods will be utilized for soil samples:
- Total lead in soil, using EPA Method 6010.
- Leachable concentrations of lead in soil, using EPA Method 1311 (toxicity characteristic leaching procedure).
- Total lead, using a x-ray florescence (XRF) instrument.
APPENDIX B
Quality Assurance Project Plan (QAPP)
APPENDIX B
QUALITY ASSURANCE PROJECT PLAN

Introductory Note: This Quality Assurance Project Plan (QAPP) identifies key personnel involved in project management, outlines data generation and acquisition procedures, provides assessment and oversight protocols and establishes data usability objectives. This QAPP is based on the United States Environmental Protection Agency’s (EPA) “Guidance for Quality Assurance Project Plans, EPA QA/G-5” dated December 2002. Many of the items specified in the QAPP guidance document have been included in the body of this work plan or Appendix A. Remaining items have been addressed in this QAPP.

Throughout the project, environmental measurements will be conducted to produce data that are scientifically valid, of known and acceptable quality, and meet established objectives. QA/QC procedures will be implemented so that precision, accuracy, representativeness, completeness, and comparability of data generated meet the specified data quality objectives.

This QAPP will be used during the following three stages:

■ Project Planning – to present the plans for project execution from a quality assurance viewpoint.
■ Project Implementation – to act as a guide for quality assurance reviews and as the specifications for assessing the quality of data generated.
■ Project Completion – to serve as a basis for determining whether the project has attained established goals.

PROJECT ORGANIZATION, ROLES AND RESPONSIBILITIES

GeoEngineers’ project personnel are described in this section. Descriptions of the responsibilities, lines of authority and communication for the key positions relating to quality assurance and quality control are provided below. This organization facilitates the efficient production of project work, allows for an independent quality review and permits resolution of any QA issues before submittal of the final report.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (FWS) is the primary stakeholder for the project. Ms. Mari Jilbert will serve as the technical contact for all parties for this phase of work.

Project Implementation Team

GeoEngineers will implement the proposed actions on behalf of the FWS. Roles of key team personnel are described below.

ASSOCIATE-IN-CHARGE: CHRIS BREEMER, R.G.

Within GeoEngineers, Inc. there are two levels of project responsibility; the Associate-in-Charge and Project Manager. The Associate-in-Charge is ultimately responsible for technical quality, schedule,
budget and staff resources for the project. This person is responsible to the FWS for fulfilling contractual and administrative control of the project, providing technical oversight, and providing overall review of project deliverables.

**SENIOR PROJECT MANAGER: JOEY HICKEY**
The GeoEngineers Project Manager (PM) will maintain primary responsibility for the operations and management of the project. The PM will manage the project, communicate with team members, coordinate daily operations, and maintain control over the schedule, budget, and technical aspects of the project. The PM will have responsibility for project deliverables and manage subcontractor procurement activities.

**HEALTH AND SAFETY OFFICER: WAYNE ADAMS**
The Health and Safety Officer (HSO) will be responsible for ensuring: 1) project personnel maintain appropriate levels of training, as specified by Occupational Health and Safety Administration (OSHA); 2) health and safety plans (HASPs) are prepared and maintained in accordance with OSHA protocols and 3) field operations are conducted using health and safety protocols that are appropriate and protective. The HSO will ensure that subcontractors have HASPs relative to their respective contracts.

**QUALITY ASSURANCE OFFICER: JOEY HICKEY**
The Quality Assurance Officer (QAO) responsibilities will include monitoring project quality assurance procedures to ensure compliance with this QAPP. The QAO will be responsible for providing final review of all project deliverables and will serve as a technical resource throughout the project.

The Project QA Leader is responsible for coordinating QA/QC activities as they relate to the acquisition of field data. The QA Leader has the following responsibilities:

- Serves as the official contact for laboratory data QA concerns.
- Responds to laboratory data QA needs, resolves issues, and answers requests for guidance and assistance.
- Reviews the implementation of the QAPP and the adequacy of the data generated from a quality perspective.
- Maintains the authority to implement corrective actions as necessary.
- Reviews and approves the laboratory QA Plan.
- Evaluates the laboratory’s final QA report for any condition that adversely impacts the data.
- Ensures that appropriate sampling, testing, and analysis procedures are followed and that correct quality control checks are implemented.
- Monitors subcontractor compliance with data quality requirements.
FIELD OVERSIGHT MANAGER: JOEY HICKEY
The field manager will be responsible for implementing the work plan, including preparation for the field events, implementation of all field activities, and maintaining chain-of-custody for samples until they are transported to the analytical laboratory. GeoEngineers staff geologists, engineers, or environmental scientists will assist with implementation of the field activities. Specific responsibilities include the following:

- Coordinates data collection activities to be consistent with information requirements.
- Supervises the compilation of field data and laboratory analytical results.
- Assures that data are correctly and completely reported.
- Implements and oversees field sampling in accordance with project plans.
- Coordinates work with on-site subcontractors.
- Schedules sample shipment with the analytical laboratory.
- Monitors that appropriate sampling, testing, and measurement procedures are followed.
- Coordinates the transfer of field data, sample tracking forms, and log books to the Project Manager for data reduction and validation.
- Participates in QA corrective actions as required.

LABORATORY MANAGEMENT: ESC LAB SCIENCES
The subcontracted laboratory conducting sample analyses for this project is required to obtain approval from the QA Leader before the initiation of sample analysis to assure that the laboratory QA plan complies with the project QA objectives. The Laboratory’s QA Coordinator administers the Laboratory QA Plan and is responsible for quality control (QC). Specific responsibilities of this position include:

- Ensure implementation of the QA Plan.
- Serve as the laboratory point of contact.
- Activate corrective action for out-of-control events.
- Issue the final QA/QC report.
- Administer QA sample analysis.
- Comply with the specifications established in the project plans as related to laboratory services.
- Participate in QA audits and compliance inspections.

Special Training Needs/Certification
All field staff will also be trained in applicable OSHA guidelines pertaining to site work. Health and safety protocol will be followed during all field activities, as outlined in the attached HASP (Appendix C).

The field oversight manager will have 40 hours of Hazardous Waste Operations and Emergency Response (HAZWOPER) training, and will be up-to-date on annual 8-hour refresher courses.
Subcontractors

Subcontractors (XRF testing and laboratory) will be utilized by the implementation team to complete laboratory testing to support the proposed assessment activities.

QUALITY OBJECTIVES AND CRITERIA

The general quality objective of this QAPP is to provide environmental data for soil samples that are of known and dependable quality. Dependable data are necessary to ensure that interpretations and recommendations are based on sound data.

Specific project tasks that do not generate data are described in this section using a qualitative measure of success unique to each task. The measurements of success for each task are described in the following sections.

Project Quality Objectives

Task-related data quality objectives (DQOs) will vary according to the nature of the task. Data quality parameters for tasks requiring measurements will be evaluated on precision, accuracy, representativeness, completeness, comparability and range. Data quality for field sampling methods will be based on measurement quality criteria listed below, and may be checked using analytical results of field duplicate samples. For chemical analyses, established precision and accuracy protocols, combined with those outlined in this QAPP, should suffice for analytical data quality. The laboratory’s QA manager is responsible for maintaining the method-defined and QAPP-defined QA/QC criteria.

Measurement and Data Acquisition

Sampling Process Design

The basis and scope of the field sampling activities are described in Section 3.0 of the work plan. The schedule for project implementation is presented in the Section 4.0 of the work plan.

Sampling and Analytical Methods and Data Quality Objectives

Field sampling methods are described in detail in Appendix A. Analytical methods that are proposed for this project include:

- Total Lead by EPA Method 6010.
- Leachable concentrations of lead, in soil, using EPA Method 1311 (toxicity characteristic leaching procedure).
- Total lead using a x-ray florescence (XRF) instrument.
The laboratory method reporting limit (MRL) goal for lead in soil by EPA Method 6010 is 0.25 milligrams per kilogram (mg/kg).

**Preventative Maintenance – Field Equipment**

GeoEngineers performs routine inspections and preventative maintenances (parts replacement and cleaning) for all pieces of field equipment in our office warehouse. These activities are conducted before and after each fieldwork event. Maintenance activities are conducted by our field technicians who are specifically trained in the use, operation, and maintenance of the equipment.

All field equipment used during this project will be cleaned and decontaminated prior to use.

Each piece of equipment will be inspected and tested to ensure proper working function and facilitate replacement or repair of broken or non-operational components. Key spare parts will be included in the equipment cases to facilitate troubleshooting and repair under field conditions.

**Calibration and Corrective Action – Field Equipment**

During this project, no field equipment that requires calibration will be used.

**Preventative Maintenance – Laboratory Equipment**

Contract laboratories perform routine testing, inspection, and preventative maintenance (parts replacement and cleaning) of all instruments and equipment, and provide a clean, climate controlled environment for instrument/equipment operation.

Major instruments such as gas chromatographs, atomic absorption spectrophotometers, analytical balances and GC/MS systems are maintained under commercial service contracts or by qualified in house service technicians. All instrument maintenance is recorded in the associated instrument logbook for future reference and validation of scheduled maintenance. Logbook entries include the date, analysts name, detailed description of the problem, detailed explanation of the solution and a verification that the instrument is functioning properly.

**Calibration and Corrective Action – Laboratory Equipment**

The analytical laboratory will maintain standard procedures for calibration and a system of corrective action to ensure continuous acceptable quality levels for laboratory services. In order to meet this goal, the laboratory will be provided the standard calibration procedures communicated in the QAPP and will be required to state their ability to comply with the procedures. For corrective action, the QAPP contains the systems established to assure that conditions adverse to quality are promptly identified and corrected. This corrective action system functions at both the bench level through recognition and response to isolated events and at the management level through trend analysis.

**CALIBRATION OF LABORATORY INSTRUMENTS/EQUIPMENT**

In general, laboratory calibration procedures are divided into fixed or within-batch calibration. Fixed calibration utilizes a calibration curve over a number of analytical batches. In within-batch calibration, a calibration curve or factor is determined for each batch of analyzed samples.
Each instrument is normally calibrated for the specific analytical method for which it is allocated. Once the operating parameters have been established according to that method, the analyst prepares standard solutions containing all of the analytes of interest, any internal standards and any surrogate standards appropriate to the method. To establish the calibration curve for the particular analyte, these standard solutions are prepared at graduated dilution. One of the concentrations must be above the detection limit while the others are used to define the working range of the instrument.

Standards for instrument calibration are obtained from a variety of sources. Elemental standards are purchased from commercial suppliers, dated upon receipt and replaced as needed according to the methodology. A standard log is kept containing the analyte name, date of receipt, supplier lot number, concentration, any analyte dilutions and a unique code number.

Analysts document the use of standards by entering the code number in their notebooks. Specific guidelines for standards handling, preparation, and traceability for the selected analytical laboratory will be reviewed for conformance with this QAPP.

LABORATORY INSTRUMENT CALIBRATION FREQUENCIES

Instrument calibration is performed on an as-needed basis in accordance with the specific method requirements. Recalibrations are performed when fundamental changes to the instrument characteristics occur (i.e., change of analytical column, etc.) or when results of QC check standards or samples indicate an out-of-control condition.

LABORATORY CALIBRATION OF MISCELLANEOUS EQUIPMENT

Calibration and service of balances is performed on an annual basis by an outside company. Calibration is checked using standardized in-house weights for each day of use. Calibration of thermometers is performed by checking against a National Institute of Standards and Technology (NIST) traceable reference thermometer on an annual basis.

LABORATORY CALIBRATION EQUATIONS

The following are equations used to calculate calibration and response factors:

Calibration factors (CF) are calculated for those methods that use external standards and the response factor (RF) for those methods that use internal standards. The corresponding equations are specified below:

\[
CF = \frac{\text{Total Area of Peak}}{\text{Mass Injected in Nanograms}}
\]

\[
RF = \frac{(\text{Area of Analyte})(\text{Concentration of Internal Standard})}{(\text{Area of Internal Standard})(\text{Analyte Cnc})}
\]

The CFs and RFs for each of five analyte and surrogate concentrations are tabulated. In general, the five CFs or RFs for each analyte or surrogate should have a Percent Standard Deviation (% PSD) of less than 20 percent. The following equation is utilized for calculating the % PSD:

\[
\% \ PSD = \left( \frac{SD}{x} \right) \times 100
\]
Where, the SD or standard deviation of the initial 5 CFs or RFs for each compound is calculated with the following equation:

$$SD = \sqrt{n \sum_{i=1}^{n} \left( x_i - \overline{x} \right)^2 / (n - 1)}$$

Where $\overline{x}$ = mean of initial five CFs or RFs for each compound

If the % PSD is less than 20 percent, then the calibration curve is considered linear through the origin, and a mean CF or RF is used. The CFs and RFs for each compound are graphed and all calculations are kept in the analyst's notebook.

The validity of the calibration curve is checked daily for most instruments and more frequently for instruments with particularly sensitive detectors that tend to drift. The analyst prepares a daily calibration check standard solution in a similar manner as that prepared for the initial calibration check standard solution.

The daily calibration check standard solution CF or RF must be within 20 percent of the average CF or RF of the calibration curve. The following is the equation for calculating the percent difference of the average CF or RF calibration curve:

$$\text{% Difference} = \left[ \frac{(\text{Average CF or RF}) - (\text{Calibration Check CF or RF})}{\text{Average CF or RF}} \right] \times 100$$

Some organic analytical methods have prescribed limits that may differ from these calculations. In those cases, individual method specifications override these general procedures. In addition, some GC/MS tuning methods have prescribed calibration procedures that are not described here. In those cases, the individual method guidelines should be followed.

**LABORATORY CORRECTIVE ACTIONS – BENCH LEVEL**

Isolated events which may have a negative impact on quality are documented at the bench level through use of a nonconformance report (NCR). Any individual event that may affect quality is recorded on the NCR and brought to the immediate attention of the department manager. Examples of such events include quality control sample results out of control limits, one time variation in the method parameters due to an unusual matrix, and evidence of lab contamination and loss or damage to the sample or its extract. When such an event is recognized, its impact on quality is assessed and a corrective action is decided upon. The action is approved by the area supervisor and/or quality assurance officer. A copy of the nonconformance report is filed with the data report for subsequent review by the project manager. A second copy of the NCR is given to the quality assurance officer to be filed in chronological order.

Predetermined limits for data acceptability are given in the laboratory's specific QC policy's standard operating practices (SOPs) for each analytical area. Specific guidelines on how analysts are to respond to outliers are documented in the corrective action SOPs for each analytical area.
Sample Handling and Custody Requirements

Sample Containers

Sample containers will be obtained directly from the analytical laboratory performing the analysis. Container type, number, volume, preservatives and maximum sample holding times to extraction and/or analysis will be completed as specified by the respective EPA analytical methods.

All samples obtained for chemical analysis will be transferred in the field to laboratory-prepared sample containers and kept cool during transport to the testing laboratory. The sample containers will be filled completely to eliminate headspace in the container. Chain-of-custody procedures will be observed during transport of the samples to the testing laboratory.

Soil samples will be collected in plastic Whirl-Pak® bags. Whirl-Pak® bags are equipped with a built-in wire for self-closing and they include a puncture-proof tab. The bags are also designed with a built in write-on strip for labeling purposes.

Sample Handling and Custody

Sample handling and custody will be completed by the GeoEngineers field manager and laboratory sample control personnel. Sample handling in the field will typically consist of placement of soil samples into individual Whirl-Pak® bags and into insulated coolers with ice. The objective of the cold storage will be to attain a sample temperature of 4 degrees Celsius. Holding times will be observed during sample storage. Styrofoam peanuts or bubble wrap will be placed around the sample containers within the cooler, if necessary, to ensure safe storage and container integrity during transport.

Sample Identification

Each container will be labeled by the field technician to avoid the possibility of misidentification. Each sample label will contain the field sample identification, sample description, sample date, sample time and sampler name.

Upon receipt at the analytical laboratory, each sample will be logged into a bound notebook with numbered pages. Each sample will be assigned a unique laboratory identification number used by the laboratory for analysis assignment, sample tracking and data reporting.

Sample labels will be completed in permanent ink. Sample labels and/or chain-of-custody record will include the following information:

- GeoEngineers’ job number.
- Sample designation.
- Date of sample collection (month/day/year).
- Time of sample collection (hours:minutes).
Chain of Custody

Field sample management will follow specific procedures to ensure sample integrity. Sample possession will be tracked from collection to analysis. Each time the samples are transferred between parties, both the sender and receiver will sign and date the chain-of-custody form and specify which samples have been transferred. When a sample shipment is sent to the laboratory, the cooler will be sealed with custody tape and the original form will be placed with the samples and transported to the laboratory. A copy of the form will be retained in the project files. A chain-of-custody record will be completed for each batch of samples hand-delivered or shipped to the laboratory. The laboratory will assume sample custody upon receipt and retain the samples in a secure area.

In addition to the labels, seals and chain-of-custody form, other components of sample tracking will include the field log book, sample shipment receipt and laboratory log book.

Information that will be included on the COC form is:

- Project name and number.
- Sample identification number.
- Date and time of sampling.
- Sample matrix (soil) and number of containers from each sampling point, including preservatives used, if any.
- Depth of sample, if appropriate.
- Analyses to be performed.
- Names of sampling personnel and transfer of custody acknowledgment spaces.

Holding Times

Holding times are defined as the time between sample collection and extraction, sample collection and analysis, or sample extraction and analysis. Some analytical methods specify a holding time for analysis only. For many methods, holding times may be extended by sample preservation techniques in the field. If a sample exceeds a holding time, then the results may be biased low.

For example, if the extraction holding time for volatile analysis of samples is exceeded, then the possibility exists that some of the organic constituents have volatilized from the sample or degraded. Results for that analysis will be qualified as estimated to indicate that the reported results may be lower than actual site conditions.

Analytical Precision and Accuracy

The overall project quality assurance objective will be to develop and implement procedures to provide data that are accurate, reliable, reproducible, and representative of the site. Data quality will be assessed by representativeness, comparability, accuracy, precision and completeness. Definitions of these terms, as they apply to quality control, are described below.
Detection Limits

Analytical methods have quantitative limitations at a given statistical level of confidence that are often expressed as the method detection limit (MDL). Individual instruments often can detect but not accurately quantify compounds at concentrations lower than the MDL, referred to as the instrument detection limit (IDL). Although results reported near the MDL or IDL provide insight to site conditions, quality assurance dictates that analytical methods achieve a consistently reliable level of detection known as the practical quantitation limit (PQL). The contract laboratory will provide numerical results for all analytes and report them as detected above the PQL or undetected at the PQL.

Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of chemical compounds in the media sampled. Sampling plan design, sampling techniques and sample handling protocols will be developed to ensure that samples collected are representative of site conditions within the limitations of the collection technologies. The proposed documentation will establish protocols for assurance of sample identification and integrity. Field duplicate samples will be used to assess matrix homogeneity, and laboratory accuracy and precision.

Comparability

Data comparability will be ensured by monitored control of sample collection, analytical methods and data recording. Comparability of laboratory and field data will be maintained by using Environmental Protection Agency (EPA)-defined procedures where available. Data comparability will be maintained by use of consistent methods and units. Actual detection limits will depend on the sample matrix and will be reported as defined for the specific samples.

Accuracy

Accuracy is a measure of bias in the analytical process. The closer the measurement value is to the true value, the greater the accuracy. This measure is defined as the difference between the reported value versus the actual value and is often measured with the addition of a known compound to a sample. The amount of known compound reported in the sample, or percent recovery, assists in determining the performance of the analytical system in correctly quantifying the compounds of interest. Since most environmental data collected represent one point spatially and temporally rather than an average of values, accuracy plays a greater role than precision in assessing the results. In general, if the percent recovery is low, non-detect results may indicate that compounds of interest are not present when in fact these compounds are present. Detected compounds may be biased low or reported at a value less than actual environmental conditions. The reverse is true when recoveries are high. Non-detect values are considered accurate while detected results may be higher than the true value.

Accuracy will be expressed as the percent recovery of a surrogate compound (also known as “system monitoring compound”), a matrix spike result, or from a standard reference material and may be calculated using the equation(s) below.
For measurements where matrix spikes are used:

\[
\%R = 100\% \times \frac{S-U}{C_{sa}}
\]

Where:

- \( \%R \) = Percent Recovery
- \( S \) = Measured Concentration in Spiked Aliquot
- \( U \) = Measured Concentration in Unspiked Aliquot
- \( C_{sa} \) = Actual Concentration of Spike Added

For situations where a standard reference material (SRM) is used instead of or in addition to matrix spikes:

\[
\%R = 100\% \times \frac{C_m}{C_{sm}}
\]

Where:

- \( \%R \) = Percent Recovery
- \( C_m \) = Measured Concentration of SRM
- \( C_{sm} \) = Actual Concentration of SRM

Persons performing the evaluation must review one or more pertinent documents (USEPA February 1994; USEPA 1986; or USEPA 1983) that address criteria exceedences and courses of action. Matrix spikes and matrix spike duplicates are analyzed at a frequency of approximately one in 20.

**Precision**

Precision is the measure of mutual agreement among replicate or duplicate measurements of an analyte from the same sample and applies to field duplicate or split samples, replicate analyses, and duplicate spiked environmental samples (matrix spike duplicates). The closer the measured values are to each other, the more precise the measurement process. Precision error may affect data usefulness. Good precision is indicative of relative consistency and comparability between different samples. Precision will be expressed as the relative percent difference (RPD) for spike sample comparisons of various matrices and field duplicate comparisons for water samples.

\[
RPD(\%) = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} \times 100.
\]

This value is calculated by:
Where:

\[ D_1 = \text{Concentration of analyte in sample.} \]
\[ D_2 = \text{Concentration of analyte in duplicate sample.} \]

The calculation applies to split samples, replicate analyses, duplicate spiked environmental samples (matrix spike duplicates), and laboratory control duplicates. The RPD will be calculated for samples and compared to the applicable criteria. Precision can also be expressed as the percent difference (%D) between replicate analyses. Persons performing the evaluation must review one or more pertinent documents (USEPA February 1994; USEPA 1986; or USEPA 1983) that address criteria exceedences and courses of action. Relative percent difference goals for this effort is 30 percent in water and 40 percent in sediment for all analyses.

**Completeness**

Completeness is a measure of the amount of valid data obtained from the analytical system. The completeness of the data will be assessed during quality control reviews. The completeness goal will be 90 percent. Audits, internal control checks and preventative maintenance will be implemented to help maintain the above quality assurance objectives.

**FIELD AND LABORATORY QUALITY CONTROL REQUIREMENTS**

**Field Quality Control Requirements**

Field quality control measures will include collection of duplicate and rinseate blank samples as well as documentation of field measurements and observations, and field instrument calibration.

**Collection of Quality Control Samples**

**FIELD DUPLICATE SAMPLES**

Field duplicate samples will be collected for each matrix at a minimum frequency of 1 for every 20 samples (5 percent) of total with a minimum of one duplicate within each media per sampling event. Duplicate samples will be collected to assess matrix homogeneity, sampling procedures and laboratory analytical consistency. The field duplicates will be analyzed by the same analytical methods used for primary samples. Relative percent differences (RPDs) for field duplicates will be calculated to assess the data precision and accuracy and potential variability caused by sample handling.

In addition to replicate analyses performed in the laboratory, field duplicates also serve as measures for precision. Under ideal field conditions, field duplicates (referred to as “splits”), are created when a volume of the sample matrix is thoroughly mixed, placed in separate containers, and identified as different samples. This tests both the precision and consistency of laboratory analytical procedures and methods, and the consistency of the sampling techniques used by field personnel.

**RINSEATE BLANK SAMPLES**

One rinseate blank will be collected for each day of field sampling activities. Rinseate blanks will be collected by pouring distilled water over reusable sampling equipment (e.g. stainless steel
sampling spoon) at the conclusion of a day of sampling activities. Rinseate blank samples are intended to assess the effectiveness of equipment decontamination procedures.

**TRIP BLANK SAMPLES**
Sealed trip blank samples, consisting of carbon-free water, will be obtained from the analytical laboratory and accompany each batch of samples from the site to the project laboratory. If necessary, they will be used to assess the cleanliness of sample containers and container handling during transport and laboratory log-in. Since total lead is not volatile, no trip blanks will be submitted for laboratory analysis unless false positives are observed or suspected.

**Documentation of Field Activities**
Daily field activities, including observations, measurement data, and variations in field procedures will be recorded on appropriate field forms. The original field forms will be maintained in GeoEngineers’ office files. Copies of the completed forms will be maintained in a binder and sequentially numbered field file for reference during field activities. Indelible ink will be used unless prohibited by weather. Photographic documentation of field activities will be performed as appropriate. The daily record of field activities will include the following information:

- Date.
- Time of arrival and departure.
- Weather condition description.
- Field team description.
- List of daily activities and times conducted.
- Observation descriptions.
- List of samples collected with sample designations and locations specified.
- Photograph log.
- Field monitoring data, including health and safety monitoring.
- List of equipment used and calibration records, if appropriate.
- Site visitors.
- List of additional data sheets and maps completed.
- Signature of person completing field record.

Site conditions may make it necessary to modify the procedures described in this QAPP. Variations or modifications implemented during activities and the reason for the modification will be documented in field records. Sufficient information will be recorded in the log book so that all field activities can be reconstructed without reliance on personnel memory.

**Laboratory Quality Control Requirements**
The project laboratory will be required to adhere to a strict internal quality control program. Method blanks, duplicate samples, matrix spike and spike duplicate, and laboratory control standards are used at frequent intervals for internal quality control. A careful field sampling program, strict chain-of-custody procedures, and collection of adequate sample volumes for
duplicate and spike samples will provide the internal quality control needed for this program. Laboratory quality control measures, including information on calibration procedures, are described below.

**Method Blanks**

Method blanks, consisting of carbon-free water and carried through the analytical scheme, serve to measure potential contamination associated with laboratory storage, preparation, or instrumentation. For most analyses, method blanks are analyzed on a daily basis and at a frequency of one per 20 samples if more than 20 samples are analyzed in a given batch.

**Calibration Blanks**

Calibration blanks are prepared with standards to create an instrument calibration curve. They differ from other standards only by the absence of an analyte and provide the zero-point for the curve.

**Sample Blanks**

Sample blanks are used when characteristics such as color or turbidity interfere with a determination. In a spectrophotometric method, for example, the natural absorbency of the sample is measured and subtracted from the absorbency of the developed sample. Sample blanks are run only as necessary.

**Internal Standards**

Internal standards are measured amounts of certain compounds added after sample preparation or extraction. They are used in an internal standard calibration method to correct for sample results which are compromised by capillary column injection losses, purging losses, or viscosity effects. Internal standard calibration is currently used for volatile organic compounds (VOCs) and semivolatiles and by Gas Chromatograph/Mass Spectrometer (GC/MS) and inductively-coupled plasma (ICP) analytical methods.

**Surrogates**

Surrogates are measured amounts of certain compounds added before sample preparation or extraction. Analysts measure the surrogate recovery to determine systematic extractions problems. Surrogates are added to all samples analyzed for GC/MS extractables and volatiles and GC volatiles.

**Spikes**

Spikes are aliquots of samples to which known amounts of an analyte have been added and are extracted and analyzed. The stock solutions used for spiking are purchased or prepared independently of calibrations standards. The spike recovery measures the effects of matrix interferences and reflects the accuracy of the determination. Spike recoveries are calculated as follows:
% REC = (S – Rav/T – Rav) (100)

Where:

S = observed concentration of analyte in the spiked sample
Rav = average determination of the analyte concentration in the original sample
T = theoretical concentration of analyte in the spiked sample

Spikes are prepared and analyzed on a daily basis and at a frequency of at least one per 20 samples or one per batch, whichever is more frequent.

**Duplicates and Duplicate Spikes**

Duplicates are additional aliquots of samples subjected to the same preparation and analytical scheme as the original sample suite. In cases where the analyte concentration is consistently below the method detection limit, duplicate spikes are substituted for duplicate samples. The RPD between duplicates or duplicate spikes measures the precision of a given analysis. The RPD is calculated as follows:

\[
\% \text{ RPD} = \frac{(R_1 - R_2)}{\text{Rav}}(100) \\
= \frac{(S_1 - S_2)}{\text{Sav}}(100)
\]

Where:

R1 and R2 = duplicate determinations of the analyte in the sample
S1 and S2 = observed concentrations of the analyte in the spike and its duplicate
Rav = average determination of the analyte concentration in the original sample
Sav = average of observed analyte concentration in spike and spike duplicate

Duplicate and spike duplicates are prepared and analyzed on a daily basis, and at a frequency of at least 1 per 20 samples or 1 per batch, whichever is more frequent.

**Laboratory Control Standards**

Laboratory control standards (LCS) or quality control check standards (QCCS) are aliquots of carbon-free or deionized water to which known amounts of an analyte have been added. They are subjected to the sample preparation or extraction procedure and are analyzed as samples. Stock solutions used for LCSs are purchased or prepared independently of the calibration standards. The LCS recovery evaluates the functioning analytical method process and equipment function.

LCSs are prepared and analyzed on a daily basis and at a frequency of 1 per 10 samples if more than 10 samples are run on a given day. For every 10 samples logged in for a particular determination, the laboratory computer generates a call for an LCS to be analyzed. The true values
and recovered concentrations are archived and retrievable for statistical analysis. Laboratory control limits are calculated when 20 data points become available.

**Laboratory Data Validation and Usability**

Procedures at the laboratory for verifying data accuracy and completeness include at least three levels of review for both data accuracy and completeness before release. Data accuracy review is initiated at the bench level with a peer review system. At this level, all calculations and entries into data logbooks are checked for error by a second analyst. The second level of review is performed by an area supervisor. Upon completion of a batch sample data set and prior to release, the laboratory project manager conducts a third level of data accuracy review.

Review of data completeness is initiated in the sample login area to insure that internal worksheets match the request on the chain-of-custody forms. The laboratory project manager performs a second level of review before datasheets are given to the analytical areas. Once the results are complete, the laboratory project manager performs a third level of review to ensure that all analyses initially requested were performed.

**Verification and Validation Methods**

Data is verified and validated through several processes before release of the final data package. The process is initiated at the analytical bench through documentation of all testing parameters in the analyst’s notebook. All measurements and calculations for the sample as well as quality control measures are documented in the notebook. Once the analyst is satisfied that the analytical batch meets all quality control requirements and has quantified the sample results, they are transferred to a set of laboratory worksheets as stated on the chain-of-custody report.

When completed, the data on the worksheets are entered into an electronic database. The laboratory project manager reviews the results from the database and checks that the analyses performed are appropriate to the client’s requests. Related analyses from the same sample are compared for coherence, and the data are compared with previous results (if available) from the same source to observe any deviations from established trends. Any corrections that are necessary are made at this time and a final report is generated. After the final report is generated it is again reviewed by the project manager to ensure accurate transfer of information from the laboratory worksheets to the final report. After the final review, the laboratory project manager signs the final report. The laboratory manager reviews approximately 15 percent of all the approved PM reports.

Hardcopies of final reports, including the original laboratory worksheets and chain-of-custody are kept in a secure filing area for as minimum of 5 years.

Data reporting parameters typically included in the laboratory reports include the following:

- Chain-of-Custody Forms.
- Date of Sample Receipt and Condition.
- Dates of Sample Analysis, extraction, digestion, or distillation.
- Analytical tuning for GC/MS.
Initial calibrations for organics with the date each initial standard was run, the concentration and response factor of the compounds in each initial standard, and the average response factor and standard deviation for each compound in the initial standards.

Continuing calibrations for organics with the date that each daily or continuing standard was run, the concentration and response factor of the compounds in each daily or continuing standard, and the percent difference between the daily or continuing standard and the average initial calibration standard.

Initial calibration verification and continuing calibration verifications for inorganics with the true value, detected value and percent recovery for each parameter.

Mass spectra for compounds found in each sample and the corresponding standard.

Laboratory blank results including method blanks, calibration blanks, and continuing calibration blanks, and a list of associated samples.

Percent surrogate recoveries for samples blanks, duplicates, and matrix spikes with the names and concentrations of each surrogate compound.

Laboratory duplicate analysis with the relative percent difference between the duplicates.

Matrix spike/matrix spike duplicate analysis with the name and concentrations of each spiking compound, the percent recovery and the relative percent difference of the matrix spike and matrix spike duplicate recoveries.

Laboratory control sample analysis with percent recoveries and control limits for each parameter.

Inductively-coupled plasma (ICP) interference check sample with percent recoveries of parameters.

ICP linear range for each parameter determined by ICP.

Reporting and quantitation limits for all parameters.

Raw data to support calculation of the above summaries are kept at the project laboratory.

Data Reporting Management

Laboratories will report data in formatted hardcopy and digital form. Analytical laboratory measurements will be recorded in standard formats that display, at a minimum, the field sample identification, the laboratory identification, reporting units, qualifiers, analytical method, analyte tested, analytical result, extraction and analysis dates, and detection limit (PQL only). Each sample delivery group will be accompanied by sample receipt forms and a case narrative identifying data quality issues. Laboratory electronic data deliverables (EDD) will be established by GeoEngineers, Inc., with the contract laboratory. Final results will be sent to the Project Manager. The EDD will be compatible with MS Excel, and will include the following minimum data requirements in unique cells within the EDD:

- The reported concentration.
- The method reporting limit.
- Any flags assigned by the laboratory.
The sampling date and time.

The Chemical Abstracts Service (CAS) registry number.

Upon receipt of the analytical data, the EDD will be reduced into summary tables. Upon completion of the summary tables, the accuracy of the data reduction will be verified using the hard copy of the data received from the laboratory. Any exceptions will be noted and corrections will be made.

**Data Reduction**

Data reduction involves the conversion or transcription of field and analytical data to a useable format. The laboratory personnel will reduce the analytical data for review by the Quality Assurance Leader and Project Manager.

**Field Measurement Evaluation**

Field data will be reviewed at the end of each day by the field lead following the quality control checks outlined below and procedures in the QAPP. Field data documentation will be checked against the applicable criteria as follows:

- Sample collection information.
- Field instrumentation and calibration.
- Sample collection protocol.
- Sample containers, preservation and volume.
- Field QC samples collected at the frequency specified.
- Sample documentation and COC protocols.
- Sample shipment.

Cooler receipt forms and sample condition forms provided by the laboratory will be reviewed for out-of-control incidents. The final report will contain what effects, if any, an incident has on data quality. Sample collection information will be reviewed for correctness before inclusion in a final report.

**Field Quality Control Evaluation**

A field quality control evaluation will be conducted by the project manager reviewing field log books and daily reports, discussing field activities with staff, and reviewing field QC samples (field duplicates and laboratory results).

**Laboratory Data Quality Control Evaluation**

The laboratory data assessment will consist of a formal review of the following quality control parameters by the project manager:

- Holding times.
- Method blanks.
- Matrix spike/spike duplicates.
- Laboratory control spikes/spike duplicates.
Surrogate spikes.

Replicates.

In addition to these quality control mechanisms, other documentation such as cooler receipt forms and case narratives will be reviewed to fully evaluate laboratory QA/QC.

ASSESSMENT AND OVERSIGHT

Assessments and Response Actions

Assessments used during implementation of the project will include daily communication and updates during fieldwork and data quality review by the PM and QAO. Response actions to assessed issues will be coordinated between the PM, QAO and involved subcontractors.

Project Reports

Routine Communications

Subsequent to approval of the project work plan, GeoEngineers will communicate project status to the FWS Project Manager through periodic conference calls or emails. These calls will include discussion of project status and schedule, any quality assurance problems and recommended solutions, and data quality assessments.

Site-Specific Health and Safety Plans

A HASP will be prepared for the site in accordance with OSHA requirements in 29 CFR Part 1910 Subpart Z. The HASP will include general site information including access procedures, site/waste characteristics, hazard evaluation, on-site control, personal protection, and emergency information and procedures.
APPENDIX C
Streamlined Risk Evaluation (SRE)
APPENDIX C
STREAMLINED RISK EVALUATION

1.0 INTRODUCTION

This appendix presents the Streamlined Risk Evaluation (SRE) work plan, including the general approach and assumptions that will be implemented for the Engineering Evaluation/Cost Analysis (EE/CA).

Section 1.1 of this appendix discusses previous risk evaluations and toxicity studies completed at the Midway Atoll National Wildlife Refuge (Refuge or site) and in particular Sand Island. Section 1.2 discusses the objectives of and need for conducting the SRE.

1.1 Background

FWS and contractors have conducted a number of prior risk evaluations and toxicity studies at the site. This section presents a summary of these studies and the conclusions relevant to avian wildlife that utilize habitat at the site.

Ogden Environmental (Ogden, 1996), under contract to the US Fish and Wildlife Service (FWS), conducted a Screening Ecological Risk Assessment (SERA) as part of the 1996 Site Investigation at Midway Island. Ogden evaluated surface soil, groundwater, surface water, and sediment conditions at 36 terrestrial and marine study sites. Target receptors evaluated in the SERA include Laysan Albatross (*Phoebastria immutabilis*; ground nesting bird), Wedge-tailed Shearwater (*Puffinus pacificus*), Bonin Petrel (*Pterodroma hypoleuca*; burrowing birds), Golden Plover (*Pluvialis fulva*; Shorebirds), Green Sea Turtle (*Chelonia mydas*; endangered marine herbivore), Hawaiian Monk Seal (*Monachus schaunslandi*; endangered marine mammal), and marine aquatic invertebrates (prey base for higher trophic level receptors and indicators of sediment habitat quality). The SERA conclusions were as follows:

- A Baseline Ecological Risk Assessment (BERA) should be conducted and limited to the terrestrial environment at the Bulky Waste Landfill and the marine environment surrounding the Bulky Waste Landfill, the Runway Landfill, and two Inner Harbor sites.
- The BERA should be limited to the following contaminants of potential ecological concern (CPECs): polychlorinated biphenyls (PCBs) and organochlorine pesticides at the four sites and semivolatile organic compounds (SVOCs) in soil at the Bulky Waste Landfill.
- Target receptors considered in the BERA should be limited to burrowing birds (Wedge-tailed Shearwater and Bonin Petrel) for the terrestrial portion of the Bulky Waste Landfill. Ogden concluded that risks to ground nesting and shorebirds were minimal. Marine receptors considered in the BERA should include Green Sea Turtle, Hawaiian Monk Seal, and benthic infaunal and reef fish communities.
- The BERA should be limited to terrestrial exposure pathways (soil ingestion and dermal contact). Ogden concluded that potential risks from the inhalation exposure pathway were 3 to 6 orders of magnitude lower than those from ingestion and dermal contact.
Following the SERA, Ogden (1997) conducted a BERA as part of the 1996 Remedial Investigation at the site. The BERA focused on the concentration and distribution of PCBs and organochlorine pesticides at the four sites identified in the SERA. Subsurface soil data were obtained at the Bulky Waste Landfill to further evaluate the special status burrowing birds (Bonin Petrel was evaluated in the BERA to represent burrowing birds). Additional data were also obtained at the marine sites to evaluate the special status marine species (Green Sea Turtle and Hawaiian Monk Seal). Additional objectives of the BERA were to identify CPEC hot spots in the Bulky Waste Landfill and to improve estimates of exposure and risk.

GeoEngineers (2004), under contract with FWS, conducted a BERA at the February 2003 JP-5 Release Site in 2004. The 100,000-gallon JP-5 release took place at the Midway Island fuel storage facility, located at the Northeast corner of Sand Island. The primary objective of the BERA was to assess the potential for adverse impact to terrestrial species living in the vicinity of JP-5 fuel release. Terrestrial receptors evaluated were the Bonin Petrel and the Ironwood Tree. Contaminants evaluated in the BERA included petroleum-related compounds (JP-5, benzene, toluene, ethylbenzene, xylenes, and polycyclic aromatic hydrocarbons) and PCBs (lead was not identified as a CPEC). The BERA concluded that contaminants associated with the 2003 JP-5 release posed negligible risks to the Bonin Petrel and Iron Wood trees.

FWS conducted an ecological risk assessment (ERA) in 2009 to evaluate lead in soil and the affects of lead on Laysan Albatross chicks (FWS, 2009). The primary source of lead in soil is the lead-based paint (LBP) used on the current and historical structures on Sand Island. Paint chips from those structures have high levels of lead and are present in the soil where the Laysan Albatross nests are located. The objectives of the FWS ERA were to characterize lead concentrations in soil around selected structures and lead concentrations in reference (background) areas and compare lead levels in soil to blood-lead levels in co-located Laysan Albatross chicks.

FWS concluded:

- 67 milligrams per kilogram (mg/kg) is representative of upper-end background lead concentrations,
- Lead concentrations decrease with depth and distance from structures,
- Approximately 33 percent of the birds evaluated had blood-lead concentrations greater than the threshold for sensitive clinical effects (10 micrograms per deciliter [µg/dL]), and
- Soil lead concentrations less than 100 mg/kg will be protective of Laysan Albatross chicks (that is, those soil concentrations will not likely result in blood lead levels that exceed 10 µg/dL).

In summary, studies conducted by FWS and others at Sand Island between the late 1980s and 2003 have shown that Laysan Albatross nestlings (chicks) exhibited symptoms of lead toxicity and that their exposure is likely related to ingestion of LBP chips and soil contaminated with LBP chips, which the birds often pick up and place into their nests (FWS, 2009). The studies evaluating lead toxicity to the Laysan Albatross have identified lead-induced damages to the birds peripheral nervous systems, leading to a syndrome known as “droopwing,” where chicks are unable to retract their wings, which often drag on the ground (FWS, 2009).
1.2 Objectives and Need

Historical investigations at Midway indicate that the source of lead is lead-based paint that was historically applied to buildings and other structures. The lead paint has weathered over time and subsequently migrated into the soil surrounding these buildings.

The specific objectives of this SRE are to:

■ Assess whether lead concentrations in soil adjacent to lead-paint based buildings pose unacceptable risk to avian receptors that utilize habitat adjacent to these buildings;

■ Develop a site-specific cleanup level for lead in soil that is protective of all avian receptors that are present on Midway; and

■ Use the proposed soil cleanup level for lead to select a remedial approach.

The FWS policy goal applicable to Midway is to “protect special status species (including threatened and endangered species, migratory birds, marine mammals, and other protected marine species) from any acute or chronic impacts connected with site-related contaminants.”

The SRE approach outlined in this work plan takes into consideration the toxicity of lead to avian receptors, including the routes of exposure and the ecology of avian wildlife at Midway. The SRE report will include an evaluation of potential risks to avian receptors (Laysan Albatross, Bonin Petrel, and Laysan Duck) from exposure to lead-contaminated soil and a site-specific soil cleanup level for lead.

The FWS is currently undertaking the abatement of LBP from existing structures at Midway. However, this abatement process does not address LBP residues on or in the ground surrounding existing buildings. The additional site characterization that will be conducted prior to the SRE (discussed in the work plan) will characterize the magnitude and extent of lead contamination around a subset of the existing structures. The site-specific soil cleanup level for lead developed in the SRE will be used to estimate the volume of lead-contaminated soil that may need to be cleaned up or managed.

2.0 PRELIMINARY CONCEPTUAL SITE MODEL

The preliminary conceptual site model (preliminary CSM) introduces the framework for assessing receptors and routes of exposure that will be considered in the SRE. To be considered complete, an exposure pathway must have the following: an identified source of lead; a release or transport mechanism from the source; and an exposure route where contact to the receptor can occur.

Exposed receptors and routes of exposure are discussed in the context of "complete" or "incomplete" pathways. The preliminary CSM considers these pathways, as well as known and suspected sources of lead contamination, affected media, known and potential routes of migration, and the presence of known and potential avian receptors. Figure C-1 presents a graphical representation of the preliminary CSM. More discussion on the preliminary CSM is provided subsequently in this section, including the mechanisms of lead toxicity in avian receptors, the life history of avian receptors at Midway, and the sources of lead contamination.
2.1. Avian Toxicity to Lead

Numerous studies have documented lead as a cause of lethal and sublethal effects in birds (Eisler, 1988). The solubility of ingested lead in birds is increased by low stomach pH, which makes the lead more available for absorption into the blood stream. Observable signs of lead poisoning in birds include loss of appetite; lethargy; weakness; emaciation; tremors; drooped wing; and impaired locomotion, balance and depth perception. Toxic and sublethal effects of lead on birds held under controlled conditions vary widely with species, age and sex and the form and dose of lead administered. In general it has been shown that nestlings (juveniles) are more sensitive to the effects of lead than are older birds.

In studies specific to Midway, lead poisoning was determined to be the leading cause of mortality in Laysan Albatross in a 3-year study by Work et. al. (1998). Two more recent evaluations of lead toxicity in birds at Midway were conducted by Finkelstein et. al. (2003) and the FWS (2009). These studies confirmed that elevated blood lead levels were correlated with observable (droop wing) effects found in Laysan Albatross chicks.

2.2. Avian Receptors/Life History

Review of the historical literature and subsequent discussions with Midway Atoll National Wildlife Refuge staff (Personal Communication, John Klavitter, Deputy Refuge Manager, April 14, 2010) indicate that there are three avian receptors of concern that should be addressed in the SRE; Laysan Albatross, Bonin Petrel and Laysan Duck (Anas laysanensis). Information about the life histories of these species is discussed below. This information will be used in the SRE to assess the level of exposure to lead and in the development of risk-based cleanup levels.

2.2.1. Laysan Albatross

Laysan Albatross are the most abundant species of bird found on Midway; approximately 71 percent of the world population of Laysan Albatross nest on Midway. They nest on the ground on almost any non-paved surface and return to the same nesting sites annually. Approximately 450,000 breeding pairs were nesting at Midway Atoll (including Sand, Eastern, and Spit islands) in January 2008. The Laysan Albatross breed each November and egg laying continues until mid-December. Chicks hatch from late January through February and fledge in mid-June through late July. The adults take turns incubating eggs and caring for young, staying on the nest for up to 3 weeks at a time. Most Laysan Albatross do not breed until they are 6 to 8 years old and have an average life span of 12 to 40 years (www.fws.gov/midway/laal.html).

The average weight of the Laysan Albatross is 2.4 kilograms; the males are normally larger than the females. The Laysan Albatross is primarily a nocturnal surface feeder, which feeds primarily on squid, fish, crustaceans and flying fish eggs in the open ocean (www.fws.gov/midway/laal.html).

2.2.2. Bonin Petrel

Bonin Petrel is an exclusively nocturnal species of seabird. They feed offshore for squid, fish, and crustaceans and marine insects, and are thought to capture their prey by sitting on the water and by dipping while in flight. Average adult petrels weigh less than one-half of a kilogram (Seto and O’Daniel, 1999).
Bonin Petrels currently nest only on Sand Island. They return to Midway in August to excavate burrows in sandy soils for their nests, which can be 5 to 8 feet long and three feet deep. Egg laying begins in January and continues through March. The first eggs hatch in February, but the majority of eggs hatch in March and April. The fledged chicks and adults leave Midway by late June and early July.

2.2.3. Laysan Duck

The Laysan Duck has been federally-listed as endangered since 1967 and identified as Critically Endangered by the World Conservation Union (FWS, 2009). The Laysan Duck has the most restricted range of any duck in the world, with a single naturally-occurring population on Laysan Island and a small population at Midway (birds translocated from Laysan Island). In 2004 and 2005, 42 ducks were transferred from Laysan to Midway; the population has grown rapidly and appears to be healthy. The population of Laysan Ducks at Midway had increased to almost 200 ducks by 2007.

Average weights for Laysan Ducks vary by age from 98 grams (age 14) to 402 grams (age 42). Laysan Ducks are between 15 and 17 inches in length.

Habitat requirements include vegetation in which to take cover, a prey base of invertebrates, a source of fresh water, and protection from mammalian predators. On Laysan Island and Midway Atoll, the ducks use the following habitats: upland vegetation, ephemeral wetlands, freshwater seeps, mudflats, the Hypersaline Lake, and coastal areas. The Laysan Duck generally feeds at night on a wide variety of terrestrial and wetland invertebrates, seeds, and succulent plants. Ducks are primarily insect feeders, but may also feed on leaves and seeds (www.fws.gov/pacificislands/fauna/laysanduck.html). Ducklings have more restrictive requirements than adults because of their high nutritional needs for growth and initial inability to process salt water. Duckling activities are concentrated near sources of fresh water with nearby cover and high prey densities (FWS, 2009).

Nesting season runs from February and November; however, most eggs are laid between April and August. Nests are built on the ground under thick vegetation, especially bunchgrass (*Eragrostis variabilis*). On Laysan Island the typical clutch size is around 4 eggs, while the average clutch size on Midway Island in 2005 and 2006 was 7 eggs. Incubation lasts around 28 to 29 days (www.fws.gov/pacificislands/fauna/laysanduck.html).

2.3. Exposure Pathways

Previous risk assessments (1996 SERA, 1997 BERA, and 2004 BERA) at Midway have evaluated avian exposure to soil via the ingestion, dermal, and inhalation exposure pathways. The 1996 SERA concluded that the inhalation pathway was insignificant relative to the ingestion and dermal exposure pathways. Inhalation exposure pathways were not evaluated in the 1997 BERA (Ogden, 1996 and 1997). The 2004 BERA conducted at the JP-5 Release Site evaluated Bonin Petrel exposure to petroleum-related contaminants in soil and found that potential hazard indices for the soil ingestion exposure pathway were a minimum of five orders of magnitude larger than hazard indices associated with the dermal contact and inhalation exposure pathways (GeoEngineers, 2004). In addition, dermal exposure to lead is limited due to low dermal absorptions rates through
skin because feathers help limit the amount of soil in direct contact with the skin. Additional
discussion on the correlation of soil ingestion and blood lead levels is provided below.

2.3.1. Soil Ingestion at Midway

Many species of birds ingest soil both deliberately and incidentally. Shorebirds that probe
sediments for food incidentally ingest high levels of sediment/soil, as do upland (terrestrial) birds
that use soil as part of their digestion. Pelagic piscivorous (fish/shellfish eating) seabirds such as
the albatross and petrel are not known to ingest soil or sediment either incidentally or deliberately
as part of their dietary behavior. However, because both the albatross and petrel nest on or under
the ground, they may be exposed incidentally to soil during nesting activities. The Laysan Duck
may be incidentally exposed through the ingestion of sediment during foraging for aquatic insects
and other invertebrates. Based on life history information discussed above it appears that the
duck may be infrequently exposed to soil.

In evaluating exposure to lead at Midway (ingestion), Finkelstein et. al. (2003) found no correlation
between isotopic compositions of lead in soil at albatross nesting sites and lead in albatross chick
blood, but did find a correlation between blood lead isotopic compositions of albatross chicks with
droop wing and lead isotopic compositions of paint chips from the affected chick’s nests. These
results lead this group to conclude that ingestion of lead paint (chips) by albatross chicks, and not
the indirect ingestion of soil, was the primary source and exposure of lead in these birds. The
USFWS study conducted a similar evaluation of blood lead levels and soil lead concentrations and
again similarly concluded that little to no correlation exists between lead in soil and blood lead in
the albatross. The highest blood lead levels were correlated with the proximity of nest sites to
buildings contained LBP.

Applying the conclusions of both these studies, avian exposure (albatross, petrel and duck)
appears to driven by the proximity of bird nesting sites to buildings that contain lead-based paint
(current or historical) and by the direct or indirect ingestion of paint chips by chicks utilizing these
nest sites. The exposure of these birds through the ingestion, dermal contact and inhalation of
lead in soil appears to be negligible relative to the ingestion of paint chips.

2.4. Conclusions

We developed the preliminary CSM based on a review of site-specific historical studies, personal
communications and the potential for exposure and toxicity of lead to avian receptors. From this
information we draw the following conclusions:

- Lead is toxic to avian wildlife according the scientific literature and based on direct
  observations of lead toxicity on avian receptors on Midway (droop wing in albatross).
- Prior avian studies at Midway have correlated blood lead levels to the presence of paint chips
  and nesting sites but not to levels of lead found in the soil.
- In meeting the objectives of the EE/CA, groundwater and surface water will not be considered
  sources of potential lead contamination at Midway.
- The inhalation and dermal contact of lead in avian receptors at Midway presents negligible
  toxicity when compared to the ingestion pathway.
Three species of birds (Laysan Albatross, Bonin Petrel and Layasan Duck) are the most likely receptors to be exposed to potential lead contamination.

The albatross appears to be the most highly exposed due to the proximity of nesting sites to lead-contaminated buildings. There is a high correlation between blood lead levels and the presence of lead-based paint chips adjacent to these nesting sites.

In the absence of observable paint chips, the petrel represents the highest level of incidental soil exposure due to this species burrowing/nesting behavior.

The Laysan Duck appears to have the lowest level of lead exposure because this species has high levels of nesting and foraging activity in non-lead-impacted wetland areas on Midway. The Laysan Duck may be exposed through limited terrestrial or upland foraging.

These conclusions provide the basis for developing two lines of evidence for assessing lead risk to avian receptors at Midway and for completing the SRE. The two lines of evidence that we propose are: 1) the correlation of blood lead levels to soil lead concentrations, based on information from the scientific literature; and 2) using a risk-based concentration approach for lead in soil that will be protective of the Bonin Petrel which has the highest exposure to soil.

The approach to developing the two lines of evidence is discussed in Section 3 below.

### 3.0 RISK APPROACH

The potential risk to the Laysan Albatross, Bonin Petrel, and Laysan Duck from exposure to LBP and lead-contaminated soil will be evaluated using a line-of-evidence (LOE) approach. Numerous studies at Sand Island have shown that ingesting LBP chips from buildings and the ground has caused mortality and other aspects of lead poisoning, including droop wing, in Laysan Albatross chicks (USFWS, 2009a; Finkelstein et al, 2003; Sileo et al, 1990; Sileo and Fefer, 1987). Therefore, we have assumed that visible LBP chips will be removed as part of future remedial actions at Sand Island. The focus of the risk evaluation will be to evaluate avian exposure to soil that is contaminated with ground, crushed, or pulverized (that is, non-visible) LBP chips.

The two LOE that will be evaluated in this risk evaluation are 1) Avian Blood Lead – Soil Lead Correlation and 2) Avian Exposure Modeling. These two LOE, along with the background lead soil concentration, which will be calculated as part of the Removal Site Evaluation, will be used to develop a soil lead cleanup level that will be protective of the Laysan Albatross, Bonin Petrel, and Laysan Duck. The soil lead cleanup level will be used to help identify removal actions for lead-contaminated soil in the vicinity of buildings.

The soil lead cleanup levels will be developed for the Bonin Petrel (the most highly exposed receptor to soil) due to their nesting behavior (underground burros). The soil lead cleanup levels that are protective of the Bonin Petrel are expected to be protective of the Layson Albatross and Laysan Duck. However, as mentioned above, the use of the Bonin Petrel to develop protective soil lead cleanup levels is based on the assumption that visible paint chips, which are a significant concern to the Laysan Albatross chicks, will be removed during a future remediation activities.
3.1. Risk-Based Concentration: Avian Blood Lead – Soil Lead Correlation

Several studies (Finkelstein et al., 2003 and USFWS, 2009a) evaluated potential correlations between Laysan Albatross blood lead levels and soil lead concentrations. Significant correlation could not be developed due to the variability in the blood lead and soil lead data; however, the data from both studies can and will be used, along with data from similar studies. The data will be used to develop a range of lead concentrations in soil that are protective of avian species at Midway and to ground-truth the results of the avian exposure modeling and RBC development (described in Section 3.2).

3.2. Risk-Based Concentration: Avian Exposure Modeling

This section presents our approach to developing an RBC for lead in soil. The RBC will be used to delineate the extent of soil requiring removal after soil with visible paint chips has been removed. The RBC will be developed for the Bonin Petrel because it is the most highly-exposed receptor and the resulting RBC should be protective of the Laysan Albatross and Laysan Duck. Bonin Petrel exposure to soil will be assumed to occur entirely within their nesting burrows since they obtain their diet directly from the ocean. The lead soil RBC will not consider avian exposure to paint chips because studies have shown that the LBP in chips near buildings are adversely affecting Laysan Albatross chicks (USFWS, 2009a; Finkelstein et al, 2003; Sileo et al, 1990; Sileo and Fefer, 1987).

Using the justification presented in Section 2 in developing a preliminary CSM for the SRE, the RBC will be based on the ingestion of lead in soil as the primary avian exposure pathway to lead in soil.

The goal of the RBC is to estimate the levels of lead in soil that the Bonin Petrel can come in contact with that will not result in systemic (internal) effects in these birds. Assumptions about the Bonin Petrel soil ingestion rates are discussed below.

3.2.1. Bonin Petrel Intake Modeling

The daily intake of compounds was estimated for the Bonin Petrel using scientifically accepted methodology. For ecological receptors like the petrel, which can be exposed through various routes of exposure, daily intake models have been developed that express exposure in terms of constituent intake per kilogram of body weight per day (mg/kg/day). The intake models are constituent-specific and incorporate exposure point concentration data as well as receptor-specific information such as the frequency of exposure, body weight, and soil ingestion rate. Intake rates were estimated using allometric models, based on body weight. Both the allometric models and the intake models are discussed in the following sections.

**Allometric Models.** Allometric modeling is a common approach to estimating intake rates when empirical data for a particular species is unavailable (EPA, 1993). Allometric models are developed through regression analysis and are based on positively-correlated relationships between parameters such as body weight, body size, and ingestion rate. Allometric models are often developed for mammals or birds or specific groups of mammals or birds. Allometric models that were based on body weight have been used to estimate soil ingestion for the petrel as discussed below.
**Soil Ingestion**

Soil ingestion rates have been estimated for only a few wildlife species and are not specifically available for the petrel. GeoEngineers estimated a soil ingestion rate for the petrel by first estimating the petrel's dietary ingestion rate and then applying a percentage of that rate as incidental soil ingestion. A dietary ingestion rate for sea birds was used for the petrel and developed by EPA (1993) using an allometric equation based on the petrel's body weight. GeoEngineers assumed an incidental soil ingestion rate of 60 percent of the dietary intake, based on the upper range of soil ingestion data for shorebirds (Reeder, 1951). The highest range of incidental soil ingestion was assumed because of the petrel's underground nesting behavior and close association with potentially-contaminated subsurface soil. The allometric model for incidental soil ingestion by the petrel is represented by the following equation:

\[
ING_{soil} = 0.495 \times BW_{petrel}^{0.704} \times %_{soil} \quad \text{Equation 1}
\]

Where:

- \( ING_{soil} \) = Ingestion rate for soil (g/day)
- \( BW_{petrel} \) = Body weight for the petrel (g)
- \( %_{soil} \) = Amount of soil ingested as a percent of total diet (unitless)

**Soil Ingestion Model**

The intake models for estimating the petrel's exposure through ingestion soil are presented below.

\[
EDI = \frac{EPC_{soil} \times ING_{soil} \times CF}{BW_{petrel}} \times AUF_{petrel} \quad \text{Equation 2}
\]

Where:

- \( EDI \) = Estimated daily intake of lead (mg/kg/day)
- \( EPC_{soil} \) = Exposure point concentration in soil (mg/kg)
- \( ING_{soil} \) = Ingestion rate for soil (g/day)
- \( BW_{petrel} \) = Body weight of petrel (kg)
- \( CF \) = Conversion factor (kg/g)
- \( AUF \) = Area use factor defining petrel's frequency of exposure to soil (unitless).

### 3.2.2. Toxicity

This section describes methodology that will be used to: 1) obtain data on toxicological effects of avian exposure to lead; and 2) derive lead toxicity reference values (TRVs) from the data. The
potential for adverse ecological effects will be evaluated using lead toxicity data from literature for
target receptors. When data are unavailable, data for target species data for appropriate surrogate
receptors will be used.

TRVs will be obtained from the literature for target species (or surrogate species) appropriate to
this assessment. In addition to hardcopy literature searches, the following commercial on-line
electronic databases may be queried: ECOTOX (including AQUIRE and PHYTOTOX), TOXNET
(Toxicology Data Network), HSDB (Hazardous Substances Data Bank), RTECS (Registry of Toxic
Effects of Chemical Substances), Zoological Record Online, NTIS, BIOSIS Previews, Inside
Conferences (Conference Papers), ENVIROLINE, ScienceDirect Life Sciences Collection, BioOne,
Springerlink, CSA Life Sciences Abstracts, ASFA (Aquatic Sciences and Fisheries Abstracts), and
Pollution Abstracts.

Depending on the effects data that are available, each test species dose will be adjusted to
account for differences in body weight, species type, and endpoint. The final adjusted dose, called
a TRV, will be used in the quantification of risk, as discussed in Section 4.2. When effects data are
based on bird test species, the effects data will be modified for the petrel by allometrically
adjusting the dose for differences in body weight using methodology from Sample and Arenal
(1999) as follows:

\[
EDI_p = EDI_t \left(\frac{BW_t}{BW_p}\right)^{(1-1.2)}
\]

where:

- \(EDI_p\) = Adjusted EDI for petrel (mg/kg/d)
- \(EDI_t\) = EDI for avian test species (mg/kg/d)
- \(BW_t\) = Body weight of avian test species (kg)
- \(BW_p\) = Body weight of target species (kg)

Uncertainty factors will also be applied to: 1) account for interspecies differences when mammals
are the test species and, 2) to develop a final TRV that is based on chronic and subchronic no-
observed effect NOAEL or NOEL, lowest-observed effect LOAEL or LOEL and lethal dose (LD_{50})
endpoints. A summary and explanation of the use of body weight adjustment and species and
endpoint uncertainty factors that are used to derive a TRV for the petrel will be presented in the
SRE.

### 3.2.3. Risk-Based Concentration Methodology

Risk to potential receptors is generally quantified using standard hazard quotient (HQ)
methodology (EPA, 1997). Under this approach, the risk (HQ) posed to the receptor is calculated
for each contaminant of potential ecological concern (CPEC) and appropriate exposure route by
dividing the receptor’s estimated daily intake (EDI) by the appropriate TRV. This comparison is
made for each CPEC and is expressed as:
Where EDI equals the estimated daily intake of lead and TRV equals the toxicity reference value for the CPEC for the same exposure route. An HQ less than 1 indicates that the exposure is less than the TRV, which is typically regarded as having negligible risk. An HQ significantly greater than 1 suggests the receptor may be exposed to unacceptable risk. It may be necessary to remediate or further study contaminated soil with an HQ greater than 1 (USEPA, 1997).

The RBC, shown in Equation 5 below, represents a concentration in soil (equivalent to the EPC in Equation 2) that is calculated by rearranging the estimated daily intake (EDI) (Equation 2) and hazard quotient (HQ) (Equation 4) to solve for the EPC, shown in Equation 2. The Bonin Petrel RBC for lead in soil will be calculated using the following equation:

\[ RBC = \frac{HQ \times BW_{petrel} \times TRV_{petrel}}{ING_{soil} \times CF \times AUF_{petrel}} \]  

Equation 5

3.3. Uncertainties

Estimates of the potential for adverse affects from exposure to contaminants such as lead must often be made with imperfect information (data gaps) and several sources of uncertainty. To ensure that conclusions protective of avian receptors are reached, despite these uncertainties, numerous assumptions will be made that tend to overestimate rather than underestimate potential risks. The SRE will include a list of uncertainties that should be considered when evaluating risk management decisions at the site. The following four primary types of uncertainties will be discussed and should be considered when evaluating conclusions from the SRE:

- Receptor
- Exposure
- Effects
- Risk

4.0 REFERENCES


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Health and Safety Plan (HASP)
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## ATTACHMENTS

Attachment A. GeoEngineers’ Health and Safety Forms

   Form A-1 – HASP – GeoEngineers Employee Acknowledgment

   Form A-2 – Health and Safety Pre-Entry Briefing

   Form A-3 – Accident Report Form

   Form A-4 – Exposure Report for GeoEngineers Employees

   Form A-5 – Visitor Site Safety Form
1.0 INTRODUCTION

This health and safety plan (HASP) is to be used in conjunction with the GeoEngineers’ Safety Program Manual. This HASP was designed to identify, evaluate, and minimize potential health and safety hazards, as well as to provide emergency response guidance for accidents which may occur during environmental field activities being completed by GeoEngineers, Inc. (GeoEngineers) during the collection of soil samples at the Midway Atoll National Wildlife Refuge (Refuge or Midway).

This HASP is intended to comply with the requirements of the Occupational Safety and Health Administration (OSHA) – 29 Code of Federal Regulations (CFR) 1910 Subpart I, 1910 Subpart Z (lead) and GeoEngineers’ Corporate Health and Safety Program.

Amendments to this HASP may be made as the contaminant profile is updated, a change in the work status or tasks is made, or regulatory requirements dictate. Any changes will be brought to the attention of those covered under this HASP through additional training and appropriate notice.

All personnel working at this site shall follow the safety provisions outlined in the HASP. The Site Safety Officer (SSO) is responsible for implementing the HASP and completing the tailgate meeting using documentation forms provided in Attachment A.

This HASP addresses the procedures to be adhered to during the field activities at the Refuge. All personnel working at this site will follow all safety provisions outlined in this HASP. The Site Safety Officers’ (SSO) primary responsibility is implementing this HASP and completing the tailgate meeting, using documentation forms provided in Attachment A. All questions or concerns regarding site safety should initially be directed to the SSO.

Liability Clause: If requested by subcontractors, this HASP may be provided for informational purposes only. In this case, Form C-3 shall be signed by the subcontractor. Please be advised that this HASP is intended for use by GeoEngineers Employees only. Nothing herein shall be construed as granting rights to GeoEngineers’ subcontractors or any other contractors working on this site to use or legally rely on this Site Safety Plan. GeoEngineers specifically disclaims any responsibility for the health and safety of any person not employed by them.

2.0 PERSONNEL

<table>
<thead>
<tr>
<th>Title</th>
<th>Name</th>
<th>Address</th>
<th>Telephone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor</td>
<td></td>
<td>GeoEngineers, Inc.</td>
<td>503.624.9274</td>
</tr>
<tr>
<td>Associate</td>
<td>Chris Breemer</td>
<td>GeoEngineers, Inc. 15055 SW Sequoia Pkwy., Suite 140 Portland, Oregon 97224</td>
<td>503.603.6674</td>
</tr>
<tr>
<td>Project Manager and Site Safety Officer</td>
<td>Joey F. Hickey</td>
<td>GeoEngineers, Inc. 15055 SW Sequoia Pkwy., Suite 140 Portland, Oregon 97224</td>
<td>503.603.6660</td>
</tr>
</tbody>
</table>
2.1 PERSONNEL TRAINING

<table>
<thead>
<tr>
<th>Name of Employee on Site</th>
<th>40 Hour Hazwoper Training</th>
<th>8-Hour Hazwoper Refresher</th>
<th>Hazwoper Awareness Training</th>
<th>First Aid/CPR</th>
<th>Date of Respirator Training</th>
<th>Date of Respirator Fit Test</th>
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</thead>
<tbody>
<tr>
<td>Joey F. Hickey</td>
<td>4/24/95</td>
<td>5/2/09</td>
<td>NA</td>
<td>2/21/07</td>
<td>5/2/09</td>
<td>6/3/10</td>
</tr>
<tr>
<td>Kimberly Robinette</td>
<td>NA</td>
<td>NA</td>
<td>6/2/10</td>
<td>2/3/07</td>
<td>6/2/10</td>
<td>6/3/10</td>
</tr>
<tr>
<td>Barbara Burkholder</td>
<td>3/5/10</td>
<td>6/2/10</td>
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<td>5/31/10</td>
<td>6/2/10</td>
<td>6/3/10</td>
</tr>
</tbody>
</table>

3.0 BACKGROUND

3.1 Proposed Site Work Covered by this HASP

Media to be handled include soils and liquids. If circumstances or site conditions alter any of the methods or procedures outlined, which are pertinent to the investigations, this HASP will be updated to incorporate any such changes. Level D personal protective equipment (PPE) will be utilized during the completion of the project.

4.0 HAZARD ASSESSMENT AND ABATEMENT

A hazard assessment will be completed prior to the start of each activities. Updates will be included in the daily log. Potential hazards at the site may include:

- Physical hazards
- Chemical hazards
- Biological hazards
- Other personnel considerations.

4.1 Physical Hazards

4.1.1 Heat Stress

In hot weather, heat stress can be a serious hazard for workers at waste sites. Heat stress often results from protective clothing decreasing the body’s natural ventilation and ability to lose heat by evaporating sweat. It may also occur anytime work is performed at elevated temperatures.

If the body’s physiological processes fail to maintain a normal body temperature because of excessive heat and dehydration, many physical reactions can occur. The reactions can range from mild (fatigue, irritability, anxiety, and decreased dexterity) to death. Because heat stress is one of
the most common and potentially serious illnesses that workers face, regular monitoring and other preventive measures are vital. At a minimum, a potable water source will be available at the site to prevent dehydration and to maintain workers’ body fluids at normal levels.

### 4.1.2 Heat Exhaustion

Heat exhaustion is a state of very definite weakness or exhaustion caused by the loss of fluids from the body. Heat exhaustion, while less dangerous than heat stroke, still needs to be immediately treated.

**SYMPTOMS**

Pale, clammy, moist skin, profuse perspiration, and extreme weakness; body temperature is normal, pulse is weak and rapid, and breathing is shallow. The person may have a headache, vomit, and experience dizziness.

**TREATMENT**

Remove the person to a cool, shaded, or air-conditioned place, loosen clothing, place in a head-low position, and provide bed rest. Consult a physician, especially in severe cases. The normal thirst mechanism is not sensitive enough to ensure body fluid replacement. Have patient drink 1 to 2 cups of water immediately, and every 20 minutes thereafter, until symptoms subside. Total water consumption should be 1 to 2 gallons per day.

### 4.1.3 Heat Stroke

Heat stroke is an acute and dangerous reaction to heat stress caused by failure of heat regulating mechanisms of the body (i.e., the body’s temperature control system that causes sweating stops working correctly). If the victim is not cooled very quickly, the body temperature may raise high enough to cause brain damage or death.

**SYMPTOMS**

Red, hot, dry skin, although the person may have been sweating earlier; nausea, dizziness, confusion, extremely high body temperature, rapid respiratory and pulse rates, unconsciousness or coma.

**TREATMENT**

This condition can be fatal if not treated immediately! Call for an ambulance or helicopter for immediate transport of victim to the nearest hospital or medical facility (Section 9). Concurrent with the call for help, immediately cool the victim by soaking him or her in cool (not cold) water, covering the victim’s body with wet towels or cloths, sponging the body with cool water, or pouring cool water on the person to reduce the temperature to a safe level (102°F). Do not give coffee, tea or alcoholic beverages.

### 4.1.4 Storms

Storms strong enough to endanger operations may require termination of site activities. These can include thundershowers, electrical storms, high winds, dust devils, or protracted conditions of less intensity that interfere directly with safety (high heat) or quality control efforts (rain, blowing dust). The SSO will stop all work whenever dangerous weather conditions occur. Do not stand under tall trees during lightning storms. Secure loose equipment during rains.
4.1.5 Tripping and Falls

Personnel will avoid tripping hazards whenever possible by establishing a clear path of travel between the sampling location and the field vehicle. Personnel will be aware of any objects both natural or manmade that may cause injury or pose a tripping or fall hazard.

4.2 Chemical Hazards

4.2.1 Lead

Lead is a heavy, ductile, soft, gray metal that is toxic to a number of organs and organ systems in the body including the liver, kidneys, blood-forming organs (primarily located in the bones), and the central nervous system (CNS). Acute exposure to heavy metals can produce symptoms such as stomach distress and vomiting, mental confusion and sluggishness, heart palpitations, breathing difficulties, and renal (kidney) failure. Chronic exposures can be characterized by deterioration in function of the liver and kidneys, CNS degradation, and abnormal changes in blood cell counts (especially white blood cells).

The potential routes of exposure to lead during this project are the inhalation of airborne dusts containing lead particulates and contact with lead-impacted paint chips and debris. Lead-contaminated materials can enter the body through the respiratory system, open wounds or contamination and ingestion of food. Preventing these routes of exposure necessitates the use of appropriate protective clothing (respirators, gloves, tyvek) and proper decontamination procedures. The OSHA PEL for lead is 0.05 mg/m³, while the ACGIH TLV is 0.15 mg/m³.

Heavy metals present the greatest risk to site personnel through inhalation and ingestion of soil particles. Their inhalation/ingestion hazards should be significantly mitigated by wet conditions while excavating contaminated soil. If site activities generate visible dust, the SSO will be notified immediately to assess the need for air monitoring and lab analysis for inhalable and respirable particulates.

**SUMMARY OF LEAD HAZARDS**

<table>
<thead>
<tr>
<th>Compound/Description</th>
<th>Exposure Limits/IDLHb</th>
<th>Exposure Routes</th>
<th>Toxic Characteristics</th>
</tr>
</thead>
</table>
| Lead (and inorganic compounds as lead) | PEL 0.05 mg/m³  
  TLV 0.05 mg/m³  
  REL 0.05 mg/m³  
  IDLH 100 mg/m³ | Inhalation, ingestion, skin and/or eye contact | Lassitude (weakness, exhausting), insomnia, facial pallor, anorexia, weight loss, malnutrition, constipation, abdominal pain, colic, anemia, gingival lead line, tremor, wrist and ankle paralysis, encephalopathy, kidney disease, irritated eyes, hypotension |

4.3 Biological Hazards

Personnel will avoid snakes, insects, branches or vegetation that may cause physical harm. Chemical resistant gloves /workgloves as appropriate, long sleeve shirt and pants should be worn to reduce exposure.
4.4 Other Personnel Safety Considerations

No personnel will attempt to lift more than 60 pounds alone. Poor lifting technique may cause injury when attempting to lift even a few pounds. Any person exhibiting poor lifting technique will be corrected by one of the other workers on site. Good lifting technique requires keeping the back as straight as possible and bending the legs. All personnel will eat regular meals and receive adequate sleep to sustain energy and awareness. Maintenance of "Team Spirit" is essential.

Vehicle traffic on the island is minimal. Personnel will double check traffic lanes before crossing, will verify the proper working condition of all vehicles prior to their use and will be familiar with the operation of the chosen vehicle.

Potentially exposed personnel will wash gloves, hands, face, and other pertinent items to prevent hand-to-mouth contact. This will be done prior to hand-to-mouth activities including eating, smoking, etc. The contaminants when found in soils, present the greatest risk to site personnel through inhalation and ingestion of soil particles. Therefore proper skin and inhalation measures should be taken to prevent exposure (see Section 5.0 Personal Protective Equipment and Other Required Equipment).

Individual PELs or action limits are not expected to be exceeded given the planned activities. Adequate personnel and equipment decontamination will be used to decrease potential ingestion and inhalation.

5.0 PERSONAL PROTECTIVE EQUIPMENT AND OTHER REQUIRED EQUIPMENT

Site activities include handling and sampling contaminated soil. Site hazards include potential exposure to hazardous materials, and physical hazards such as trips/falls, heavy equipment, and exposure.

- Level D PPE, unless a higher level of protection is required, will be worn at all times on the site. Potentially exposed personnel will wash gloves, hands, face and other pertinent items to prevent hand-to-mouth contact. This will be done prior to hand-to-mouth activities including eating, smoking, etc.

5.1 Level D Personal Protective Equipment

- Work uniform with long sleeves and long pants, as needed;
- Steel-toed boots (leather or polyvinyl chloride [PVC]), as needed;
- Chemical resistant gloves (Nitrile, 4H, or equivalent), as needed;
- Chemical goggles or face shield, as needed; and
- Hard hat, as needed.

5.2 Respirator Selection, Use and Maintenance

- If respirators are required, site personnel shall be trained before use on the proper use, maintenance and limitations of respirators. Additionally, they must be medically qualified to wear a respiratory protection in accordance with 29 CFR 1910.134. Site personnel who will
use a tight-fitting respirator must have passed a qualitative or quantitative fit test conducted in accordance with an OSHA-accepted fit test protocol. Fit testing must be repeated annually or whenever a new type of respirator is used. Respirators will be stored in a protective container.

- A cartridge change-out schedule shall be developed based on known site contaminants, anticipated contaminant concentrations and data supplied by the cartridge manufacturer related to the absorption capacity of the cartridge for specific contaminants. Site personnel shall be made aware of the cartridge change-out schedule prior to the initiation of site activities. Site personnel shall change respirator cartridges if they detect increased resistance during inhalation or detect vapor breakthrough by smell, taste or feel, although breakthrough is not an acceptable method of determining the change-out schedule.

- The Site Safety and Health Supervisor shall periodically (weekly) inspect respirators at the project site, if they are used. Site personnel shall inspect respirators prior to each use in accordance with the manufacturer’s instructions. In addition, site personnel wearing a tight-fitting respirator shall perform a positive and negative pressure user seal check each time the respirator is donned, to ensure proper fit and function. User seal checks shall be performed in accordance with the GeoEngineers respiratory protection program or the respirator manufacturer’s instructions.

5.3 General Safety Equipment

- First aid kit
- One A, B, C fire extinguisher
- Eye wash

6.0 DECONTAMINATION

6.1 General Decontamination Procedures

This section describes general decontamination procedures. Personnel working at a site could possible become contaminated in a number of ways, including:

- Exposure to vapors, gases, mists, or particulates in air
- Skin contact with contaminated tools or fluids

Protective clothing and respirators help prevent the wearer from becoming contaminated or inhaling contaminants, while good work practices help reduce contamination on protective clothing, instruments and equipment. Even with these safeguards, however, contamination may occur. Harmful materials can be transferred into clean areas, exposing unprotected personnel. In removing contaminated clothing, personnel may contact contaminants on clothing or inhale them. To prevent such occurrences, decontamination procedures and methods must be established before anyone enters a site, and must continue and/or be modified when necessary throughout site operations. Attachment #3 contains schematics regarding the set-up of decontamination operations.
6.1.1 Disposal of Contaminated Materials

All materials and equipment used for decontamination must be disposed of properly. Clothing, tools, buckets, brushes and all cleaning solutions and spoils must be secured in drums or other containers and labeled correctly for transportation and disposal or incineration in the on-site system.

7.0 GENERAL OPERATIONAL PROCEDURES

7.1 Communications

Successful communications between field personnel in and around the sampling areas is essential. Hand signals will be used as necessary and have the following meanings:

- Clutching throat - cannot breathe;
- Thumbs up - okay or affirmative;
- Thumbs down - having trouble or negative; and
- Hands on top of head - need help, remove at once.

7.2 Standard Operating Procedures

- No smoking, eating, drinking, gum or tobacco chewing, or applying of cosmetics will be permitted in the designated work areas.
- The instructions of the Site Safety Officer will be followed.
- No horseplay will be tolerated.
- Airborne release of contaminants will be minimized.
- Contact with waste material will be minimized.
- The hands and face of personnel must be thoroughly washed as soon as possible upon leaving the work area and before eating, drinking, or other activities.
- Since medicine can potentate the effects of toxic chemicals in exposure conditions, medicines should not be used by employees working on the site. Personnel who must be on medication should advise their supervisor and the Site Safety Officer prior to beginning work at the site.
- No alcoholic beverages or drowsiness-inducing medications will be consumed before or during work activities.
- All personnel are responsible for reading and understanding the provisions of this HASP. Any individual who will be doing work on the site needs to sign the HASP Acknowledgment verifying that they have reviewed this HASP and agree to follow all of the procedures put in place by the Site Safety Officer.

Attachment A contains a Health and Safety Acknowledgment form to be completed by each individual working at the site.
8.0 MEDICAL MONITORING

Workers are required by OSHA to have a full hazardous materials physical if exposed to concentrations of toxic substances above permissible exposure limits (PEL) for 30 or more days per year (29 CFR (1910.125 App C).

9.0 EMERGENCY RESPONSE PLAN AND SERVICES

In the unlikely event of a fire or explosion, emergency services will be immediately contacted. Since the work is on an island, special response methods are necessary, which are detailed below. In addition, all site personnel will be notified of the problem. Only small fires may be extinguished by workers at the site. If the fire is too large, or if personnel are in doubt, the affected area will be evacuated.

If there is an accident or emergency at the site, one or more of the following services will be contacted as necessary:

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phone Numbers (Hospital):</strong></td>
<td>Radio Channel 1 or ext. 456</td>
</tr>
<tr>
<td>Ambulance:</td>
<td>Radio Channel 1 or ext. 456</td>
</tr>
<tr>
<td>Police:</td>
<td>Radio Channel 1 or ext. 456</td>
</tr>
<tr>
<td>Fire:</td>
<td>Radio Channel 1 or ext. 103 (0800-1700) Airport Fire Dept. If using Radio: &quot;Station all calls, station all calls, this is an emergency.&quot;</td>
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<td>Location of Nearest Telephone:</td>
<td>Hand radios are carried by field personnel (FWS UHF #5)</td>
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<tr>
<td>Nearest Fire Extinguisher:</td>
<td>Vehicle</td>
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<tr>
<td>Nearest First-Aid Kit:</td>
<td>Vehicle</td>
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9.1 Standard Emergency Procedures

■ Get help -
  ■ send another worker to phone on-island clinic (if necessary)
  ■ as soon as feasible, notify GeoEngineers’ project manager

■ Reduce risk to injured person -
  ■ turn off equipment
  ■ move from injury location (if possible)
  ■ keep warm
■ perform CPR (if necessary)

■ Transport injured person to medical treatment facility (if necessary) -
  ■ Minor emergencies (discretion of SSO) to on-island medical clinic
  ■ Major emergencies (discretion of SSO) using med-evac procedures as follows:
    ■ Contact on-island medical clinic. They will inform party of proper procedure and stabilize patient until evacuation transport arrives.
    ■ By the Midway ambulance (if necessary) or field vehicle
    ■ Stay with person at medical facility

■ Keep GeoEngineers manager appraised of situation and notify human resources manager of situation

10.0 APPROVALS

1. Plan Prepared

   ____________________________
   Signature ____________________
   ____________________________
   Date ______________________

2. Plan Approval

   ____________________________
   PM Signature ____________________
   ____________________________
   Date ______________________

3. Health & Safety Officer

   ____________________________
   ____________________________
   Date ______________________

4. Principal

   ____________________________
   Signature ____________________
   ____________________________
   Date ______________________
ATTACHMENT A

GeoEngineers’ Health and Safety Forms
FORM A-1
HASP – GEOENGINEERS EMPLOYEE ACKNOWLEDGMENT

(All GeoEngineers' site workers complete this form, which should remain, attached to the safety plan checklist and filed with other project documentation).

I, hereby verify that a copy of the current Safety Plan has been provided by GeoEngineers, Inc., for my review and personal use. I have read the document completely and acknowledge a full understanding of the safety procedures and protocol for my responsibilities on site. I agree to comply with all required, specified safety regulations and procedures. I understand that I will be informed immediately of any changes that would affect site personnel safety.

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<th>Print Name</th>
<th>Signature</th>
<th>Date</th>
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Inform employees, contractors and subcontractors or their representatives about:

- The nature, level and degree of exposure to hazardous substances they're likely to encounter;
- All site-related emergency response procedures; and
- Any identified potential fire, explosion, health, safety or other hazards.

Conduct briefings for employees, contractors and subcontractors, or their representatives as follows:

- A pre-entry briefing before any site activity is started; and
- Additional briefings, as needed, to make sure that the Site-specific HASP is followed.

Make sure all employees working on the Site are informed of any risks identified and trained on how to protect themselves and other workers against the Site hazards and risks.

Update all information to reflect current site activities and hazards.

All personnel participating in this project must receive initial health and safety orientation. Thereafter, brief tailgate safety meetings will be held as deemed necessary by the Site Safety and Health Supervisor.

The orientation and the tailgate safety meetings shall include a discussion of emergency response, Site communications and site hazards.
FORM A-3
ACCIDENT REPORT FORM

To (Supervisor): _____________________________________________

From (Employee or PL): _______________________________________

___________________________________________

Telephone (include area code): _________________________________

Name of injured or ill employee: _________________________________

Date of accident Time of accident Exact location of accident

___________________________________________

Narrative description of accident:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Nature of illness or injury and part of body involved Lost Time? Yes No

________________________________________________________________________

________________________________________________________________________

Probable Disability (Check One)

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<tr>
<th>Lost Work Day</th>
<th>Lost Work Day With Days of Restricted</th>
<th>No Lost Work Day</th>
<th>First Aid Only</th>
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<tbody>
<tr>
<td>Fatal</td>
<td>Away From Work</td>
<td>Activity</td>
<td>Work Day</td>
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Corrective action taken by reporting unit corrective action that remains to be taken (by whom and when):

________________________________________________________________________

________________________________________________________________________

Employee Signature __________________________ Date ________________

Name of Supervisor (Print) __________________________ Date ________________

Supervisor’s Signature __________________________ Date ________________
FORM A-4
EXPOSURE REPORT FOR GEOENGINEERS EMPLOYEES

Project Number: 
Date: 

Description of exposure: 

Medical attention on site: 

Other: 

Name of Employee (Print) 
Employee Address 
Employee Signature Date
FORM A-5
VISITOR SITE SAFETY FORM

I verify that a copy of the current HASP has been provided by GeoEngineers, Inc. to inform me of the hazardous substances on Site and to provide safety procedures and protocols that will be used by GeoEngineers’ staff at the Site. By signing below, I agree that the safety of my employees is the responsibility of the undersigned company.

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<th>Print Name</th>
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