



**Naval Facilities Engineering Systems Command Pacific
JBPHH HI**

Draft

**Shallow Soil Vapor Extraction and
Air Sparging Work Plan
Red Hill Bulk Fuel Storage Facility
JOINT BASE PEARL HARBOR-HICKAM O'AHU HI**

January 2023



**Naval Facilities Engineering Systems Command Pacific
JBPHH HI**

Draft

**Shallow Soil Vapor Extraction and
Air Sparging Work Plan
Red Hill Bulk Fuel Storage Facility
JOINT BASE PEARL HARBOR-HICKAM O'AHU HI**

January 2023

Prepared for NAVFAC Pacific by
AECOM Technical Services Inc
1001 Bishop Street Suite 1600
Honolulu HI 96813-3698

N62742-17-D-1800
CTO N6274222F0212

CONTENTS

Acronyms and Abbreviations	v
1. Introduction and Purpose	1
2. Roles and Responsibilities	1
3. Background	2
3.1 Climate	2
3.2 Soil and Geology	2
3.3 Groundwater	3
3.4 Surface water	3
3.5 Historical Land Use	3
3.6 Current Land Use	3
3.7 Conceptual Site Model	4
4. Technology Overview	8
4.1.1 Air Sparging	8
4.1.2 Soil Vapor Extraction	8
5. Project Quality Objectives	8
6. Field Work Activities	11
6.1 Utilities and Concrete Metal Clearance	11
6.2 Drilling Mobilization/Demobilization	11
6.3 Air Sparging Injection Points	12
6.3.1 Location Identification	12
6.3.2 Installation	12
6.4 Shallow Soil Vapor Monitoring locations	15
6.5 SVE Extraction Point	15
6.5.1 Hume Line Investigation and SVE Point Installation	15
6.5.2 SVE Well Construction	16
6.6 Mobilization of SVE SKID and Generator	17
6.6.1 Utility Connections	18
6.7 Mobilization of AS Equipment	18
6.8 Baseline Monitoring	18
6.9 Soil Vapor Extraction	19
6.10 Operational Phase	19
6.10.1 SVE Step-Test	19
6.10.2 SVE Constant Rate Test	20
6.10.3 Air Sparge and SVE	20
6.10.4 AS/SVE Step Test	21
6.10.5 AS/SVE Constant Rate Test	22
6.11 Short term operation of shallow SVE/AS	23
7. Data Evaluation	23
7.1 SVE Data Evaluation	23
7.2 AS Data Evaluation	24
7.3 Analysis Of Mass Removal	24
8. Project Schedule and Reporting	25

9.	Sample Details	25
	9.1 Handling, Shipping, and Custody	26
	9.2 Laboratory Quality Control Samples	26
10.	References	26

APPENDIXES

A	Standard Operating Procedures
B	Analytical Data Package Requirement for Chemical Analyses
C	SVE Operations and Maintenance Manual
D	Soil Gas Sampling Standard Operating Procedure
E	Project Schedule

FIGURES

1	In-Progress Field Map (as of October 17, 2022), Adit 3 LNAPL Site Characterization, November 20, 2021, JP-5 Release	6
2	Investigation Area Cross Section	7
3	Proposed AS Injection, SVE Wells, and SVMP Locations	14

TABLES

1	Roles and Responsibilities	1
2	Project Quality Objectives for Shallow Soil Vapor Extraction and Air Sparging Pilot Study	9
3	Step Test Measurements	20
4	Constant Rate Test Measurements	20
5	Parameter and Frequency of Measurements During Step Test	22
6	Parameter and Frequency Measurements During Constant Rate Test	22
7	Sample Type and Matrix Identifiers	25
8	Field QC (SACODE) Type Identifiers	26
9	Sample Depth Identifiers	26
10	Sample Date	26

ACRONYMS AND ABBREVIATIONS

AECOM	AECOM Technical Services, Inc.
AS	air sparging
BH	borehole
BTEX	benzene, toluene, ethylbenzene, and xylenes
btf	below tunnel floor
GAC	granular activated carbon
JP-5	Jet Propellant 5
LNAPL	light nonaqueous-phase liquid
Navy	Department of the Navy, United States
PID	photoionization detector
PQO	project quality objectives
psi	pounds per square inch
SVE	soil vapor extraction
SVMP	soil vapor monitoring point
TPH-D	total petroleum hydrocarbons-diesel range organics
TPH-G	total petroleum hydrocarbons-gasoline
TPH-O	total petroleum hydrocarbons-residual, or motor oil range organics
VOC	volatile organic compound

1. Introduction and Purpose

This shallow soil vapor extraction (SVE) and air sparging (AS) pilot study work plan describes the methods and procedures for pilot study work to be conducted at the Red Hill Bulk Fuel Storage Facility (Red Hill). The purpose of the pilot study is to evaluate the effectiveness of using SVE and AS technologies to remove volatile hydrocarbons by phase transfer and by introducing atmospheric air into the subsurface to enhance biodegradation. An existing linear drainpipe beneath Red Hill's tunnel floor near the Adit 3 tunnel entrance, known as the Hume Line, is a permeable piping apparatus that runs through previously identified impacted zones. The utility of the Hume Line as a conduit for subsurface vapor extraction will be evaluated during the pilot study. Proposed locations for installation of air injection wells, an additional SVE well and vapor monitoring points for evaluation of AS and SVE technologies have been identified through site characterization activities completed between November 2021 and October 2022. The proposed locations may be altered depending on the results of additional characterization completed prior to the pilot study.

AECOM Technical Services, Inc. (AECOM) will conduct the shallow SVE and AS pilot study in eight stages:

1. Install four AS Injection points to approximately 11 feet below tunnel floor (btf) using an electric drilling rig with a 1-foot prepacked screen.
2. Install up to 10 shallow vapor observation points using a hammer drill.
3. Mobilize and retrofit a preowned SVE system.
4. Install the AS system.
5. Install a dedicated SVE well and construct a second access point to the Hume Line.
6. Evaluate the capacity of the Hume Line to facilitate gas extraction by testing the maximum extraction flow rate, optimizing the extraction flow rate, evaluating the radius of influence and testing the composition of the extracted gas.
7. Evaluate the capacity of the subsurface to accept pressurized atmospheric air.
8. Perform general operation and maintenance activities on the AS and SVE System.

The information collected will assist in the evaluation and design of potential future remediation activities for the Red Hill.

2. Roles and Responsibilities

This contract is to be carried out under Naval Facilities Engineering Systems Command Contract N62742-17-D-1800, Contract Task Order N6274222F0212.

Table 1: Roles and Responsibilities

Role	Name
AECOM Project Manager	Dustin Goto
AECOM Quality Manager	Robin Boyd
AECOM CLEAN Health and Safety Manager	Devon Molitor
AECOM Operations Manager	Skylar Pauli
AECOM Task Manager	George Sauer
AECOM Technical Subject Matter Expert (SME)	Brad Koons

Role	Name
AECOM Project Chemist	John Fong
AECOM Field Team Leader	Rachel Tucci
AECOM Site Safety Manager	George Sauer
AECOM Site Safety and Health Officers	<ul style="list-style-type: none"> • George Sauer • Stuart Anderson • Justin Wood • Petros Paulos • Andy Burkemper • Chris Beza
AECOM Site Geologist/Sampling Technicians	<ul style="list-style-type: none"> • Rachel Tucci • Collin Ferguson • Gita Datt
Subcontractors	<ul style="list-style-type: none"> • Manual hammer driller – PCS • Well Installation – VWD • Utilities clearance – GH

GH	Geotech Hawaii
PCS	Pacific Commercial Services
VWD	Valley Well Drilling

3. Background

3.1 CLIMATE

The climatological condition of the surrounding area consists of warm to moderate temperatures and low to moderate rainfall. The average annual precipitation is approximately 40 inches, which mainly occurs between November and April (Giambelluca, Nullet, and Schroeder 1986). Average temperatures range from low 60s to high 80s degrees Fahrenheit. In particular, the Adit 3 tunnel has portions in which a suction pressure is exerted for containment practices.

3.2 SOIL AND GEOLOGY

Red Hill is located within the Ko'olau Volcanic Series. The Ko'olau formation consists of basaltic lava flow that erupted from a fissure line approaching 30 miles in length and trending in a northwest rift zone (Wentworth and Macdonald 1953). Pāhoehoe and 'a'ā lava flows are present in the Ko'olau formation. The valleys on either side of Red Hill Ridge were formed as a result of fluvial erosion and are filled with sedimentary deposits (alluvium and colluvium), also known as valley fill, underlain by residual (weathered basalt), also known as saprolite. Saprolite zones in Hawai'i are typically around 75 feet thick but can be 300 feet thick or greater beneath the valley floors or in areas of high precipitation (Hunt Jr. 1996; Macdonald, Abbott, and Peterson 1983). The results of a recently conducted geophysical seismic survey in North and South Hālawa Valleys, Red Hill, and Moanalua Valley (DON 2018) found that valley fill and saprolite extend much deeper in the valleys surrounding Red Hill, particularly in the center of the valleys and below the streambeds.

The Red Hill facility is located in a region that has its soils mapped as Helemano-Wahiawā association consisting of well-drained, moderately fine-textured and fine-textured soils (USDA SCS 1972). The surfaces of the basaltic flows have been weather to form reddish -brown clayey silt, which is where the name "Red Hill" was derived from. These soils typically range from nearly level to moderately sloping and occur in broad areas dissected by very steep gulches, which typically formed in material weathered from basalt to a depth of approximately 10 feet below ground surface. Along the slopes, the basaltic bedrock is covered with approximately 10–30 feet of Ko'olau residuum. These soils were derived from weathering of the underlying basalt bedrock or were deposited as alluvium/colluvium.

The younger alluvium/colluvium deposits were derived from fractured basalts and tuff. Beneath the surficial soils, alternating layers of clay and basalts are encountered at depth. The northwestern slope of Red Hill is generally barren of soil and consists of outcropping basalt lava flows to the valley floor

3.3 GROUNDWATER

Near Red Hill, the basal aquifer water table lies between 15 and 20 feet above mean sea level, and regionally groundwater flows toward Pearl Harbor (*mauka* to *makai*), although potential exists for variability in localized flow directions depending on geologic formations and other factors.

The Red Hill Facility is located at the administrative boundary between the Waimalu Aquifer System of the Pearl Harbor Aquifer Sector and the Moanalua Aquifer System of the Honolulu Aquifer Sector. The underlying aquifer is classified as a basal, unconfined, flank-type aquifer and is currently used as a drinking water source.

There is a United States Department of the Navy (Navy) Supply Well 2254-01 (also known as Red Hill Shaft), located within the Adit 3 Tunnel. The nearest Honolulu Board of Water Supply (BWS) public drinking water supply well (BWS Hālawa Shaft Well 2354-01) is located hydraulically cross-gradient of the facility approximately 4,400 feet to the northwest and pumps water from the basal aquifer.

3.4 SURFACE WATER

Surface water features in the general vicinity of the Adit 3 and the Red Hill Facility include South Hālawa Stream. Potential recharge (run-on and operational water use) from the Hālawa Quarry north of the tank farm Facility may also impact groundwater flow in this area. In Hālawa Valley, stream flow may contribute water to perched groundwater within alluvial material (valley fill) but is generally isolated from the underlying basal aquifer. Most precipitation percolates to the basal aquifer and does not maintain base flows in the streams (Izuka 1992). Groundwater that flows beneath the facility does not intercept surface water inland of the ocean shoreline (DON 2007). Both South Hālawa Stream and Moanalua Stream (to the north and south of Red Hill Ridge, respectively) are located approximately 170 feet or more above the basal water table.

3.5 HISTORICAL LAND USE

Prior to the 1940s, the surface of Red Hill supported sugar cane and pineapple agriculture. Historical Navy documentation showed that Red Hill ground surface was exposed and modified during the construction of the tank farms which began in 1940. A 1952 aerial image shows that unmaintained land of the ridge of Red Hill and agriculture on the lower reaches of Red Hill north of the Moanalua Golf Course.

3.6 CURRENT LAND USE

Red Hill is located on land zoned by the county as a mix of F-1 Federal and Military and P-1 Restricted Preservation districts. All major structures at the facility are located underground. Populated areas closest to the facility are 'Aiea to the West and Honolulu to the Southeast. Honolulu is a heavily populated and urbanized community.

Preservation land is located east and northeast of the facility boundary. To the southeast are residential single-family homes in Moanalua Valley; a high cliff face with a 100–200-foot elevation difference exists between the facility and this residential area. Southwest of the tank farm area on the lower southwest flank of Red Hill are the public Red Hill Elementary School and residential apartments, and

further west is U.S. Coast Guard Housing on F-1 Military land. North of the western segment of the facility boundary in South Hālawā Valley is the State Animal Quarantine Station, private businesses in Hālawā Industrial Park, and the State-operated Hālawā Correctional Facility. To the north of the Correctional Facility at the lower reaches of an inter-valley ridge that forms the north wall of South Hālawā Valley is the open-pit Hālawā Quarry operated by the Hawaiian Cement Company.

3.7 CONCEPTUAL SITE MODEL

Characterization of the Red Hill tunnel system near the Adit 3 entrance to and past the intersection of the Pearl Harbor tunnel (hereafter referred to as the Adit 3 tunnel) began immediately after the November 20, 2021 Jet Propellant 5 (JP-5) release. Investigation activities to determine the nature and extent of JP-5 impacts in the Adit 3 study area are ongoing. The network of completed and proposed subsurface investigation locations as of October 17, 2022; including boreholes (BHs), temporary wells (TWs), and soil vapor monitoring points (SVMPs) is presented on Figure 1. Locations in the Adit 3 tunnel are identified using a coordinate system starting at the point of origin located on the eastern edge of the Navy Well 2254-01 pumping station doorway. The coordinates represent the distance in feet from the origin, whereby coordinates with positive (+) values are to the west in the direction of the Adit 3 tunnel entrance, and coordinates with negative (-) values are to the east.

The JP-5 release occurred from an overhead pipe near station A3-375. Fuel moved along the tunnel floor toward the Adit 3 sump, approximately 700 feet west of the release point (Figure 1). The Hume Line, a 6-inch diameter concrete drainage pipe that runs beneath the tunnel floor, is shown in plan and cross section view on Figure 1 and Figure 2, respectively. The Hume Line was initially installed as a water management system and set at approximately 2.5 to 3 feet btf to act as a conduit for groundwater to migrate to the sump and limit tunnel flooding. The Hume Line was constructed with a loose connecting bell piping configuration. The top of the pipe was left unsealed to allow groundwater to enter the pipe, while the bottom of the pipe appears to have been grouted to limit vertical seepage and to direct fluids to the sump. The extent and condition of the Hume Line is not fully understood.

Figure 2 shows a shallow cross section of the Adit 3 tunnel based on the current understanding of the stratigraphy and the distribution of perched groundwater. Detailed descriptions of lithology were documented from cores collected during the installation of the two deep SVMPs shown on Figure 2 (A3-010-DSVMP and A3-375-DSVMP), indicating the presence of massive A'a basalt and loose (unwelded) A'a clinker. The remainder of the boreholes were completed using a hammer drill to a maximum penetration depth of approximately 6 feet btf. During advancement of boreholes using the hammer drill, subsurface materials were pulverized prior removal from the borehole; thus, good quality undisturbed samples could not be obtained for detailed lithologic assessment. Where hard drilling was noted during advancement of the hammer drill, the lithology is presented as massive basalt (Figure 2).

Potentiometric surface elevations for perched groundwater beneath the Adit 3 tunnel are presented on Figure 2, based on fluid level gauging data collected on October 3, 2022. Perched groundwater has been detected in most of the existing borehole and temporary well locations in the Adit 3 tunnel, from A3+375-TW to as far east as A3-200-BH, as of August 2022. The perched water zone may extend further to the east of A3-200-BH at depths greater than the total depth of the existing boreholes (approximately 6 feet btf), but the perched water appears pinch out to the west of the release point (approximately A3-375), as shallow water was not observed during installation of A3-375-DSVMP. As indicated in Figure 2, potentiometric head gradients within the perched groundwater unit are not uniform. A local maximum potentiometric surface elevation was consistently observed at A3+015, suggesting that focused recharge may be present near the pumping station entrance. Additionally, perched groundwater has never been observed at the location of A3+087-BH, which was installed to a total depth of approximately 4.5 feet btf. A3+087-BH lies between two existing boreholes (A3+150

and A3+050) where perched groundwater has consistently been observed (July to October 2022) at depths ranging from 2.5 to 4 feet btf. Investigation activities are currently underway to better understand groundwater recharge and flow conditions within the perched groundwater unit, including high-frequency monitoring of perched water levels in temporary wells using data logging pressure transducers and monitoring of local precipitation data. Additionally, a network of deep and intermediate-depth SVMs are proposed at locations shown on Figure 1, to be installed to depths below the perched water zone within the Adit 3 tunnel (DON 2022). The deep and intermediate SVMs will be installed using methods that allow for collection of intact cores for lithologic assessment to define the thickness and extent of the perched groundwater unit.

The distribution of JP-5 impacts in shallow subsurface materials is presented on Figure 1 and Figure 2. The blue line in Figure 2 signifies the water level observed and the orange arrows signifies the range of light nonaqueous-phase liquid (LNAPL) elevation observed. The current understanding of the of the JP-5 distribution is based on fluid level gauging data (i.e., accumulations of LNAPL or sheen in boreholes and temporary wells), results of hydrophobic dye testing (i.e., oil in soil), and concentrations of petroleum hydrocarbons detected in soil and groundwater. Additionally, Figure 2 includes a summary of soil headspace screening results obtained during borehole installation using a photoionization detector (PID) to convey the approximate distribution of hydrocarbon impacts in the shallow subsurface. Shallow subsurface impacts beneath the Adit 3 tunnel appear to be concentrated in the vicinity of the pumping station entrance (from approximately A3+050 to A3-110). LNAPL accumulations are consistently observed in A3-010-TW and A3-040-TW, indicating that LNAPL is present in shallow subsurface materials at an LNAPL saturation greater than residual levels in this area. It appears that LNAPL extends to the west at least as far as A3+050, where concentrations of total petroleum hydrocarbons – diesel range organics (TPH-D) (C10-C24) in soil and groundwater (1,200 milligrams per kilogram and 1,200 micrograms per liter, respectively) indicate the presence of LNAPL. To the east, LNAPL has been observed at the bottom of borehole A3-110-BH, consistent with TPH-D analytical results in soil collected from this location. The presence of LNAPL may extend further to the east of A3-110 at depths greater than approximately 6 feet btf (the maximum depth characterized using the hammer drill rig). The lateral and vertical extent of impacts will be refined based on data collected during installation of intermediate-depth SVMs.

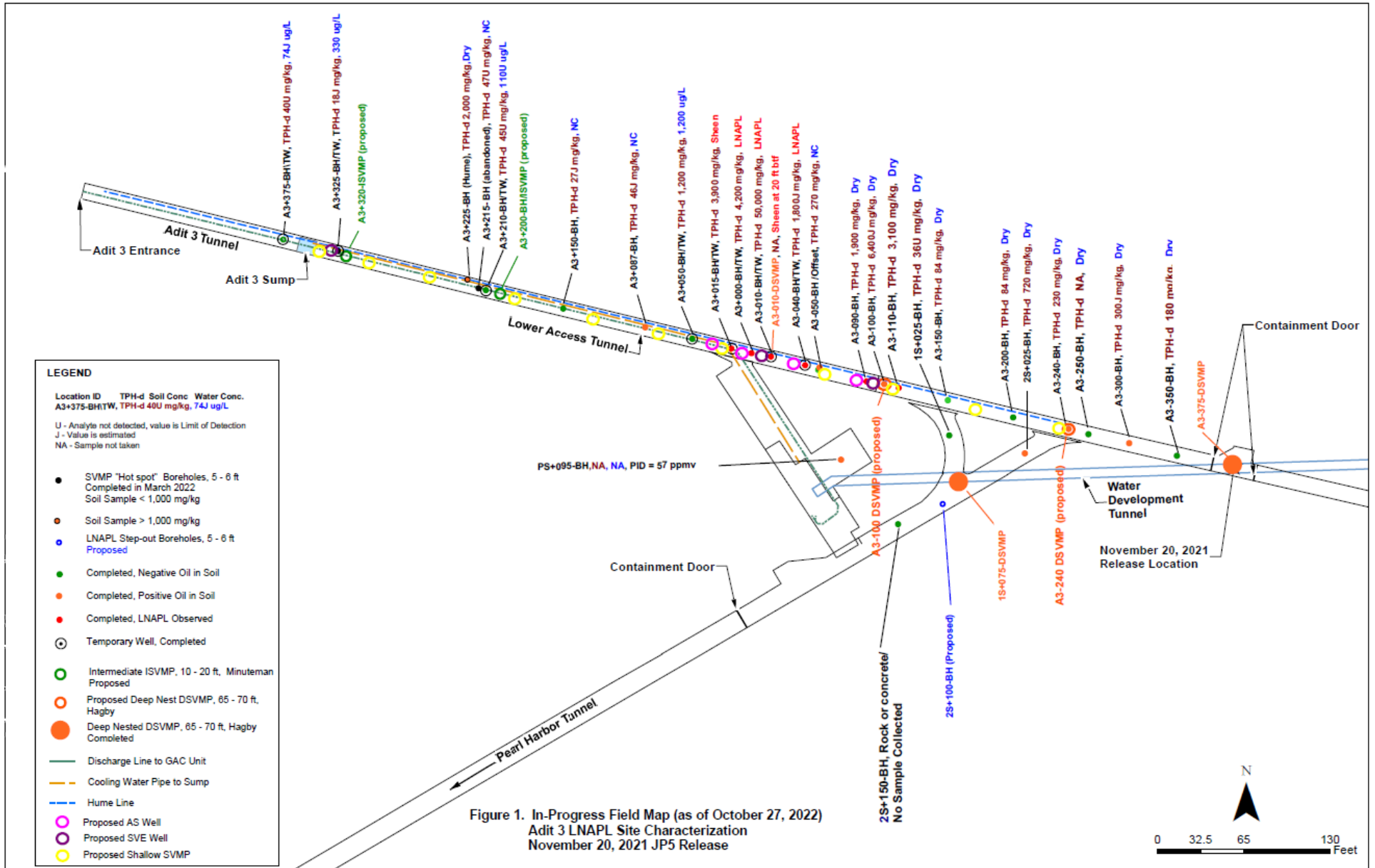


Figure 1: In-Progress Field Map (as of October 17, 2022), Adit 3 LNAPL Site Characterization, November 20, 2021, JP-5 Release

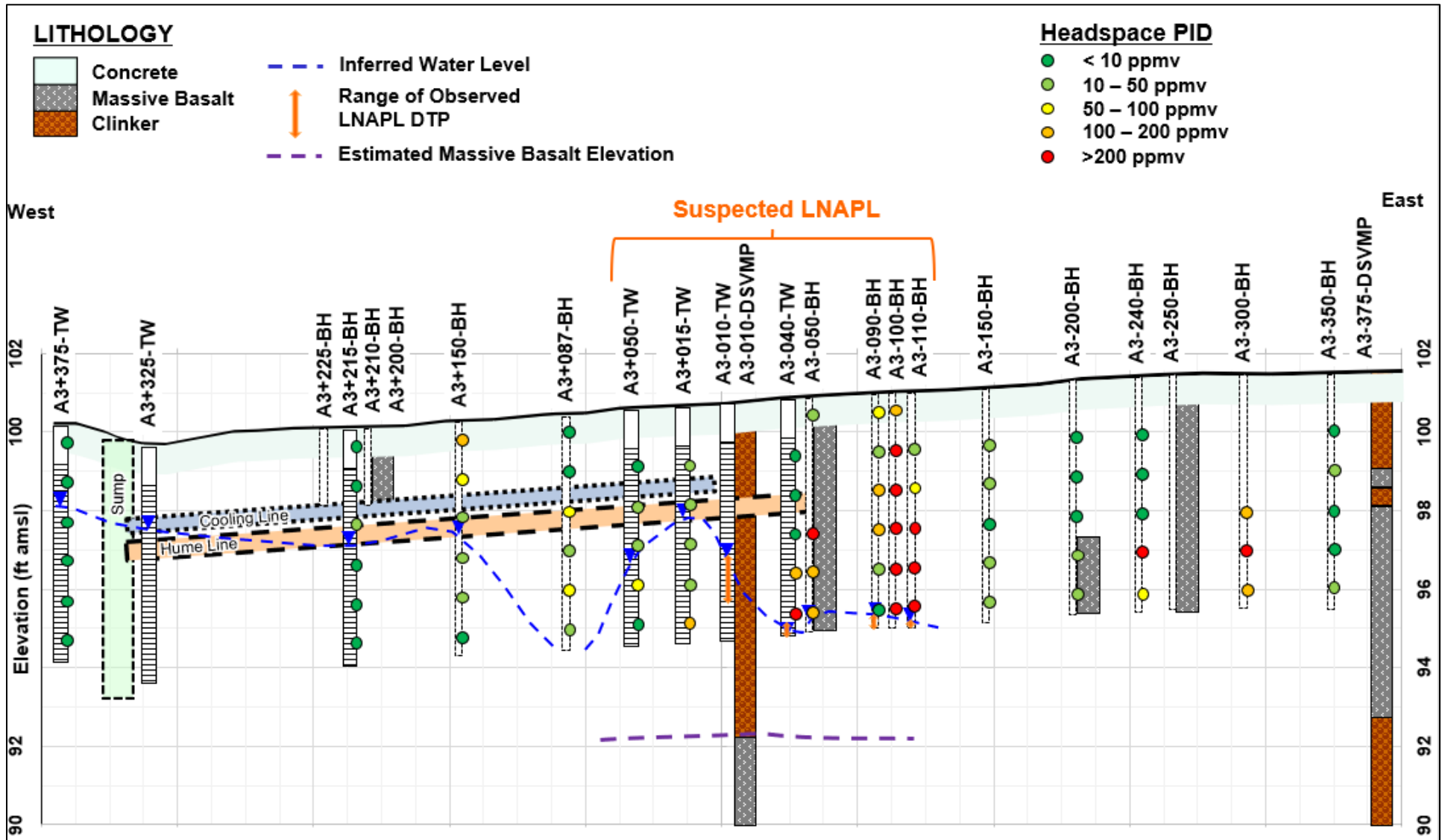


Figure 2: Investigation Area Cross Section

4. Technology Overview

4.1.1 Air Sparging

AS is an in situ remediation technology that involves injection of air below the water table with the intent of treating volatile and/or aerobically biodegradable organic compounds. As injected air moves through petroleum-impacted soil and groundwater, volatile compounds present in the nonaqueous, dissolved, and adsorbed phases partition into the injected air, which ultimately moves upward through the saturated zone into the vadose zone. For the Red Hill pilot test, the injected air that emerges from the saturated zone into the vadose zone will be captured by the SVE system and treated using granular activated carbon (see Section 4.1.2 below). In addition to the removal of volatile compounds through mass transfer mechanisms such as stripping of dissolved compounds from groundwater and direct volatilization, the injected air also increases the dissolved oxygen content in groundwater, which increases rates of aerobic biodegradation of hydrocarbons. The extent to which biodegradation, direct volatilization, and stripping from the dissolved phase individually contribute to overall hydrocarbon mass removal/destruction is application-specific and depends on characteristics of the target compounds (volatility and biodegradability), site stratigraphic controls over air distribution, various mass transfer limitations, and aspects of the design and operation of the AS system. However, biodegradation is often the dominant remedial mechanism in the latter phases of sparging system operation when mass removal through stripping and direct volatilization have significantly slowed.

4.1.2 Soil Vapor Extraction

SVE is an in-situ remediation technology that involves inducing air flow in the vadose zone to promote mass transfer of volatile petroleum hydrocarbon compounds from adsorbed, dissolved, and nonaqueous liquid phases into the gas phase, where it is removed under vacuum and treated above ground. In addition to promoting the mass transfer of volatile petroleum compounds, inducing the flow of oxygen-rich air through the vadose zone helps support enhanced aerobic biodegradation of petroleum hydrocarbons.

The extracted vapors are processed through a vapor/liquid separator to remove liquids and excess moisture before the air is treated. The vapor stream is then processed through granular activated carbon (GAC) to treat the vapor stream prior to releasing it to the atmosphere. The pilot study aims to aid in identifying the permeability of the shallow subsurface by identifying a radius of influence as well as establishing an estimate on mass removal based on analytical data of the vapor stream extracted.

5. Project Quality Objectives

As a component of preparing this work plan, project quality objectives (PQOs) were developed for the study following Standard Operating Procedure I-A-1: *Development of Project Quality Objectives* included in Appendix A. The PQOs (Steps 1 through 5) are presented in Table 2 for reference and were used to guide work plan development. PQO achievement for the pilot studies are presented in Section 7 and in other applicable sections of the work plan.

Table 2: Project Quality Objectives for Shallow Soil Vapor Extraction and Air Sparging Pilot Study

Problem (Step 1) The efficacy of in situ SVE and AS to deplete the mass of petroleum hydrocarbons in the shallow subsurface is uncertain at the Site. Application of SVE and AS are proven in situ remediation technologies that have been shown to reduce the mass of petroleum hydrocarbons in the subsurface at numerous sites by promoting direct mass transfer of volatile hydrocarbons into the gas phase, and by enhancing aerobic biodegradation processes.

Study Goals (Step 2)	Study Questions (Step 2)	Data Needs and Schedule (Step 3)	Study Area (Step 4)	Analytical Approach (Step 5)
Determine design and optimal operating parameters for Shallow SVE system.	What is the estimated zone of influence for the Hume line and vertical SVE point?	During baseline, SVE step and constant rate tests: <ul style="list-style-type: none"> Distribution of soil gas pressure in shallow unsaturated zone. Concentrations of oxygen, carbon dioxide, and methane in soil gas 	Unsaturated zone beneath the tunnel floor (above perched water) where petroleum hydrocarbon impacts are present.	Changes in subsurface gas pressure and soil gas composition in response to changes in vapor extraction flow rate will be utilized as indicators of the SVE zone of influence: <ul style="list-style-type: none"> Measure vacuum response at monitoring wells and SVMPs screened above the perched water table. A measurable vacuum response in a monitoring point during vapor extraction indicates that there is a pressure gradient in the direction of the monitoring point, demonstrating that soil gas in the vicinity of the monitoring well is being captured. Measure concentrations of oxygen, carbon dioxide, and methane in soil gas measured in monitoring wells and SVMPs screened above the perched water table. During vapor extraction, the vadose zone is aerated by drawing air from the atmosphere into the subsurface. The flow of oxygen-rich, atmospheric air is therefore expected to increase the concentration of oxygen in the subsurface, while reducing concentrations of petroleum hydrocarbon biodegradation products such as carbon dioxide and methane. In addition to providing a line of evidence for assessing air flow distribution in the subsurface, changes in concentrations of these gases in response to changes in vapor extraction flow rates will provide a means of evaluating microbiological activity.
	What is the air permeability distribution within the target zone? What are the appropriate vapor extraction flow rates and applied vacuum levels?	During baseline, SVE step and constant rate tests: <ul style="list-style-type: none"> Vapor extraction flow rates Vacuum measurements at extraction point(s) Distribution of soil gas pressure in shallow unsaturated zone during baseline, step tests, and constant rate vapor extraction tests. Concentrations of petroleum hydrocarbons, oxygen, and carbon dioxide in extracted soil gas Concentrations of oxygen, carbon dioxide, and methane in soil gas 		<ul style="list-style-type: none"> Air permeability distribution will be evaluated based on changes in subsurface gas pressure at different distances from the extraction points in response to changes in vapor extraction rates. Appropriate vapor extraction flow rates and applied vacuum levels for longer-term SVE operation will be determined based on maintaining a pore volume exchange rate to optimize mass transfer of volatiles and ensure that the subsurface is adequately aerated to promote aerobic biodegradation. If soil gas monitoring points located within the target remediation zone do not exhibit evidence of induced air flow during the pilot testing activities (e.g., no measurable vacuum response and no change in composition of soil gas in response to vapor extraction), installation of additional vertical SVE points may be considered.
	Are additional vertical SVE points necessary to achieve adequate air flow through the target remedial zone?			
	What are the initial petroleum hydrocarbon mass removal rates?	Constant Rate SVE and AS/SVE testing: <ul style="list-style-type: none"> Vapor extraction flow rates Concentrations of petroleum hydrocarbons in extracted soil gas Concentrations of oxygen and carbon dioxide in extracted soil gas 		<ul style="list-style-type: none"> Measure vapor extraction flow rates. Collect vapor samples for laboratory analysis to determine concentrations of petroleum hydrocarbons in extracted vapor Measure concentrations oxygen and carbon dioxide in extracted soil gas. Removal rates for volatile hydrocarbons by mass transfer into the vapor phase will be calculated by multiplying the concentration of volatile petroleum hydrocarbons in the extracted vapor (mass of petroleum hydrocarbons per unit volume of extracted vapor) by the measured volumetric vapor extraction flow rates (volume of extracted vapor per unit time). Vapor phase mass transfer rates will be compared to laboratory treatability test results to estimate the composition of the in-situ LNAPL, and the mass fraction of the remaining LNAPL that can likely be addressed through the vapor phase mass transfer mechanism. Mass removal by aerobic biodegradation (consumption of oxygen and/or production of carbon dioxide) will be calculated from measured vapor extraction flow rates and changes in oxygen and/or carbon dioxide relative to ambient, atmospheric levels. Rates of oxygen utilization and/or carbon dioxide production will be multiplied by representative stoichiometric coefficients to estimate rates of hydrocarbon biodegradation.
	Is SVE off-gas treatment capacity sufficient?	Constant Rate SVE and AS/SVE testing: <ul style="list-style-type: none"> Vapor extraction flow rates Concentrations of petroleum hydrocarbons in extracted soil gas, and effluent air discharged to atmosphere 		Mass loading rates and off-gas treatment efficiency will be evaluated based on measured vapor extraction flow rates and concentrations of volatile petroleum hydrocarbons measured in influent, mid-fluent, and effluent vapor samples. Data will be evaluated to verify treatment capacity of the off-gas treatment using activated carbon, and to estimate frequency of activated carbon changeouts for longer-term SVE operation.

Study Goals (Step 2)	Study Questions (Step 2)	Data Needs and Schedule (Step 3)	Study Area (Step 4)	Analytical Approach (Step 5)
Determine design and optimal operating parameters for Shallow AS system.	Is SVE zone of influence sufficient to capture vapors?	During baseline, SVE step tests, SVE constant rate tests, AS/SVE Step and Constant Rate Tests: <ul style="list-style-type: none"> Concentrations of VOCs in ambient tunnel air 	Within tunnel	Ambient air within the tunnel will be monitored continuously using a PID to verify that vapors from AS system operation are adequately captured by SVE system and not migrating into tunnel breathing space at concentrations that exceed thresholds provided in the Site-specific Health and Safety Plan.
	What are the measured radii of influence (ROIs), appropriate air injection well spacing, and air injection depths?	<ul style="list-style-type: none"> Changes in mass removal rates by SVE system before and during injection tests Distribution of dissolved oxygen in groundwater before and during injection tests Concentrations of dissolved petroleum hydrocarbons in perched groundwater before and after injection tests 	Zone of perched groundwater where petroleum hydrocarbon impacts are present	<ul style="list-style-type: none"> Depths of AS well installation to be determined based on field observations during drilling. Based on reviews of the available geologic and hydrogeologic information from investigation activities in the Lower Access Tunnel, it appears that the massive A'a layer may act as a potential confining layer for perched water. It is anticipated that AS wells will be installed to the depth the massive A'a contact, at the base of the perched groundwater zone. The massive A'a contact is estimated to be approximately 8.5 to 11 feet below the tunnel floor but could vary given the heterogenous geological conditions of the site. Measure vapor extraction flow rates and collect SVE vapor samples for laboratory analysis to evaluate changes in concentrations of petroleum hydrocarbons during AS testing. An increase in vapor phase mass removal rates during AS operation indicates that the AS system is effective in transferring volatile petroleum hydrocarbon compounds from the saturated zone into the vadose zone for removal by SVE. Measure concentrations dissolved oxygen in perched groundwater in response to various air injection flow rates to evaluate relationship between air injection flow rate and ROI. Measure concentrations of dissolved petroleum hydrocarbons at pilot test monitoring wells before and after AS testing to evaluate ROI.
	For the estimated ROI, what are the optimal AS operation parameters?	<ul style="list-style-type: none"> Changes in mass removal rates by SVE system at various air injection flow rates Distribution of DO during injection test at various air flow rates Dissolved oxygen uptake rates in perched groundwater zone Groundwater elevations and pressures in perched groundwater zone 		<ul style="list-style-type: none"> Measure vapor extraction flow rates and collect SVE vapor samples for laboratory analysis to evaluate changes in concentrations of petroleum hydrocarbons during AS testing. Measure concentrations dissolved oxygen in perched groundwater during and following AS testing. Estimate dissolved oxygen utilization rates by plotting decay of dissolved oxygen over time following AS shut down. Dissolved oxygen utilization rates may be used to identify optimal air injection frequency and pulse duration needed to sustain aerobic conditions in perched groundwater. Monitor changes in water table elevation through a combination of manual fluid level gauging and Installation of pressure transducers in monitoring wells screened into the perched groundwater zone. Water table measurements will be evaluated to determine the hydraulic response to AS and used to optimize the injection timing and flow rate.

6. Field Work Activities

Field work activities include:

- Utilities and concrete metal clearance
- Drilling mobilization/demobilization
- AS injection point installation
- SVMP installation
- Hume Line investigation
- SVE point/Hume Line excavation installation
- AS/SVE utilities connection
- SVE step tests
- SVE constant rate test
- AS/SVE step tests
- AS/SVE constant rate test

6.1 UTILITIES AND CONCRETE METAL CLEARANCE

Geotech Hawaii will clear a 3-foot radius at the initial 14 locations identified on Figure 1. Utilities and metal will be cleared using shielded ground-penetrating radar between 200 and 500 megahertz. Anomalies will be marked on the ground using paint or colored crayon. The area cleared for drilling and excavation will be clearly identified.

6.2 DRILLING MOBILIZATION/DEMobilIZATION

An electrically driven low access drill rig will be used to install these four AS injection wells. The electric rig requires:

- 460 volts, 15 amps powered by the 460-volt outlet located at approximately A3-250. This outlet must supply power to an electrical supply wiring cord (three phase plus ground) that extends a maximum distance of 600 feet. The power supply cord must be safely cable tied to the utility conduits running along the tunnel wall.
- Water may be required to keep the drill bit cool. Water can currently be sourced from a spigot in the pump station along the eastern wall. Water will be supplied through a minimum of ¾ inch hose with heavy duty non-leak coupling hose and ¾ inch shut-off ball valve.
- The electric rig, which is anticipated to weigh approximately 345 pounds, will be conveyed in the tunnel by two-wheel transport. It is anticipated that the rig will be routed from Adit 2 via a train to the drill locations.
- The electric rig must be bolted to the floor before use. This requires drilling holes into the floor and installing an appropriate bolting system (such as expansion bolts).

6.3 AIR SPARGING INJECTION POINTS

6.3.1 Location Identification

Zones of interest for the implementation of active remediation technologies were identified during the site investigation through the characterization of LNAPL, impacted groundwater and soil since the November 2021 spill. Based on reviews of the available geologic information from investigation in the Lower Access Tunnel, it appears that the massive 'a'ā layer may act as a potential confining layer for perched water. It is anticipated during drilling that the top of the massive 'a'ā layer would be the ideal depth for the sparging wells to maximize the radius of influence in the saturated zone. The top of the massive 'a'ā is estimated to be approximately 8.5 to 11 feet btf but could vary given the heterogenous geological conditions of the site.

Three of the four injection points are spaced evenly approximately 30 feet apart and located below the identified LNAPL in the perched water. The orientation of these three injection wells is such that the SVE system can capture the volatilized gas while using the Hume Line as an extraction conduit (Figure 3). A fourth location is proposed near A3-100, where JP-5 impacts were noted in shallow soil immediately below the tunnel floor. A vertical SVE well will also be installed in this location to capture sparged air. Additional investigation of the tunnel is underway and sparging locations may be adjusted based on updates to the conceptual site model.

6.3.2 Installation

The exact placement of the AS injection points will be determined based on a review of all available data on the site geology, hydrogeology, and distribution of impacts at the time of installation. Installation of the AS injection points will coincide with highly impacted locations with identified LNAPL. Figure 1 shows the proposed AS well locations.

AECOM's subcontractor, Valley Well Drilling, will use an electric drill rig to install four AS wells to approximately 11 feet below the tunnel floor. The exact depth of the AS well screens will be determined based on field observations during drilling to ensure that screens are placed within zones of adequate permeability to facilitate air injection and, where possible, that they be installed below the estimated extent of LNAPL impacts.

- During drilling activities, soil cores will be logged to describe lithology and screened for the presence of JP-5 impacts using a PID. Soil samples will be collected for laboratory analysis at the depth of the air injection well screen interval, near the capillary fringe, and in the vadose zone. Additional soil samples may be collected at depths where field screening indicates the potential for JP-5 impacts.
 - Soil will be analyzed for total petroleum hydrocarbons-gasoline, TPH-G, TPH-D, naphthalene, benzene, toluene, ethylbenzene, and xylenes [BTEX], 1-methylnaphthalene, and 2-methylnaphthalene.
- The wells will be constructed with a 1-foot pre-packed screen. A sand filter pack will be placed in the annulus between the screen and the borehole and installed to 2 feet above the screen.
- A 6-inch bentonite plug will be placed above the sand pack.
- Dry bentonite chips and concrete will be used to complete the well to approximately 1 foot below the tunnel surface.

- Water parameters, such as turbidity, temperature, pH, specific conductivity, dissolved oxygen, and oxidation-reduction potential, will be collected.
 - Water samples will also be collected and analyzed for TPH-G, TPH-D, BTEX, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene.
- A well head assembly will be retrofitted for each injection well with a quick connect piping with the use of cam and grove connections or similar fittings.
- A flow measurement device (venturi flow meter or similar device), include a pressure gauge and a flow regulator (globe valve or similar flow regulation) will be attached to the flow manifold from the AS equipment.
 - The final completion will be dependent on utility clearance and equipment staging approval.
- The well head assembly will be completely below the tunnel surface with a water-tight traffic rated surface completion.

Materials:

- 1-inch prepacked 0.010-inch screen (1 foot)
- 1-inch × 11-foot PVC Riser Sch 40
- Sand (US Mesh 20-40)
- Bentonite and cement
- Traffic rated vault
- Magnehelic pressure gauge
- Flow measurement device (Venturi flow meter or similar device)
- Flow regulator

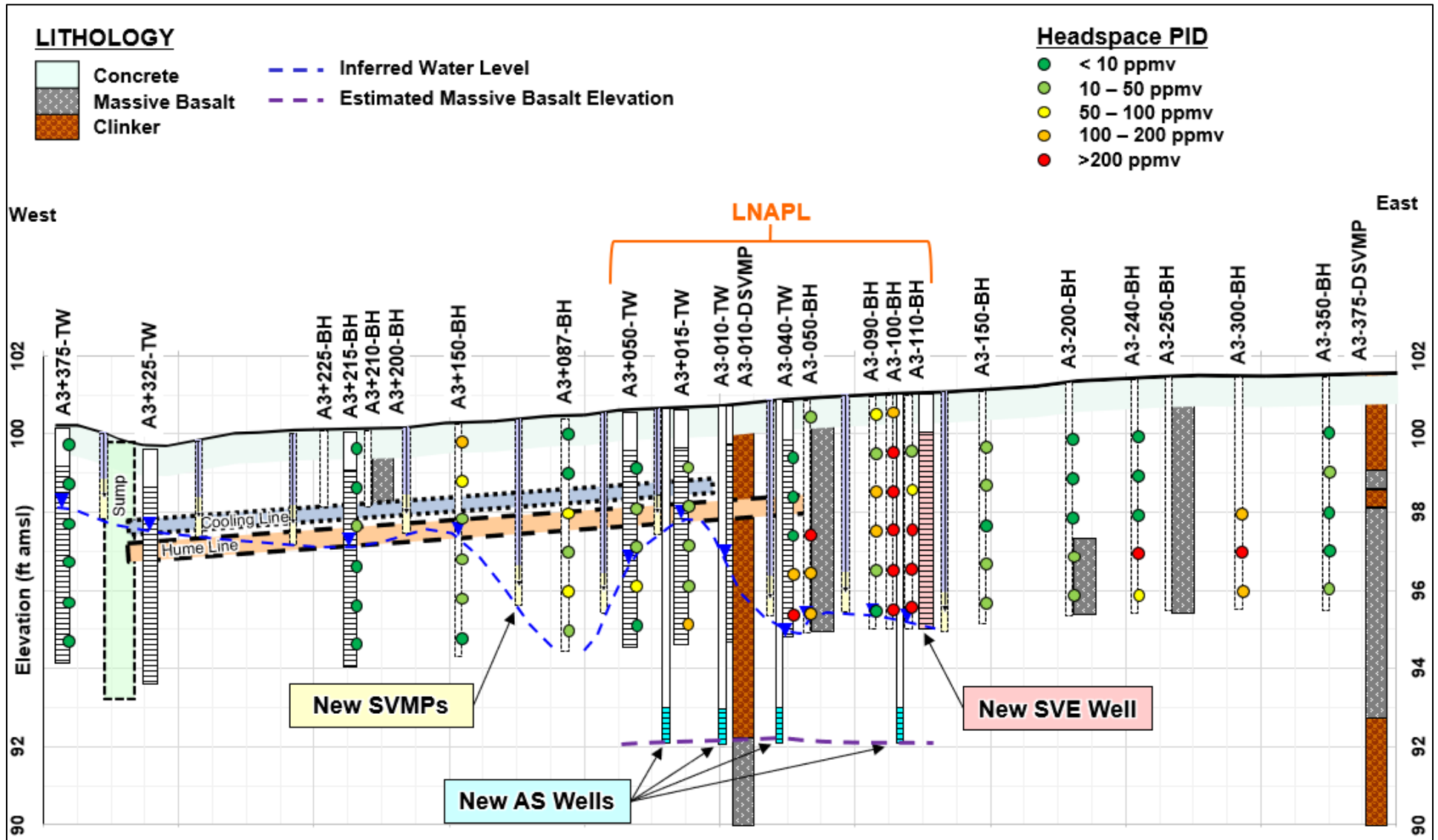


Figure 3: Proposed AS Injection, SVE Wells, and SVMP Locations

6.4 SHALLOW SOIL VAPOR MONITORING LOCATIONS

AECOM will work with Pacific Commercial Services, a Navy-approved subcontractor, to install 10 shallow soil gas monitoring points. Two monitoring points will be installed adjacent to each terminal end of the Hume Line investigation area and the other 8 at regular intervals along the Hume Line, depending on accessibility. Based on initial estimates, the remaining 8 SVMPs points will likely be spaced approximately evenly adjacent to the Hume Line (Figure 3) and advanced to a depth of approximately 3–5 feet btf, based on the depth to water. AECOM will use these shallow gas monitoring points to monitor the effect of the AS and SVE on the subsurface.

AECOM plans to install 2.5-inch diameter shallow soil gas monitoring points using a hammer drill to a completion depth of approximately 3–5 feet btf. The hammer drill will use 120 V electricity supplied by outlets located in the tunnel. Water is available from a 0.75-inch spigot located along the eastern wall of the pump station.

Soil gas monitoring points will be constructed by deploying a permanent dedicated vapor probe, or similar product, with 1/4-inch Teflon tubing to 3 to 5 feet btf based on geologic conditions. Transducer data and field observations will be relied on to ensure that the vapor probes are not submerged during the duration of the pilot study. The SVMPs will be backfilled with 1 foot of sand and hydrated bentonite to the surface to limit the potential for any vapor release. The shallow vapor points will be kept in place through the duration of the pilot study.

Materials:

- AMS gas vapor dedicated tip (or similar model)
- 1/4-inch Teflon tubing
- 1/4-inch ball valve
- Swagelok hardware for connection of SVMP tubing to ball valve
- Bentonite
- Sand (US Mesh 20-40)

6.5 SVE EXTRACTION POINT

6.5.1 Hume Line Investigation and SVE Point Installation

An initial access point to the Hume Line was installed in April 2022. The Hume Line was identified approximately 3 feet btf and a sewer camera inspection tool was used to evaluate the current condition of the Hume Line at approximately A3-010. The visual inspection tool was used to evaluate the Hume Line approximately 60 feet east and 60 feet west where an obstruction was encountered. The access point was completed with a saddle fitting and 4 inch stick up PVC. The excavation was backfilled and completed to the tunnel floor with the use of a traffic rated vault to allow for traffic movement over the Hume Line while also keeping it accessible.

A secondary access point is planned for installation at the Hume Line to access the western terminus near the sump. An exact location cannot be presented in this plan because the orientation of the Hume Line near the sump is unknown. Exploratory work will be completed to identify where the Hume Line is located and where an access point can be installed based on access limitations associated with a 24-inch HDPE groundwater conveyance line that was installed in the tunnel to route pumped groundwater to the external granular activated carbon treatment system.

A Navy-approved subcontractor will cut out a 2-foot × 2-foot access point to the Hume Line and excavate the cutout till the Hume Line is uncovered. After the concrete is cut and removed, hand tools will be used to dig the remaining 3–4 feet required to access the Hume Line. Soil samples will be screened using a PID, visually inspected and evaluated using an oil in soil test. A hole saw will be used to open the Hume Line. Once access is obtained to the Hume Line, we will evaluate the condition of the Hume Line and check for the presence of water. A sewer inspection camera will be used to record the condition and establish whether the westernmost end of the Hume Line would adequately serve as a SVE extraction point. If conditions do not appear favorable for installing a SVE point, the video will be reviewed to determine whether alternative locations along the western Hume Line might be more favorable.

The Hume Line cutout will be secured with a water-tight, traffic-rated access point. AECOM will install a saddle fitting to secure the utility piping to the Hume Line access point. A 4-inch PVC pipe will be secured to the saddle fitting and either a fernco cap, well cap or similar equipment will be used to seal the PVC.

The SVE access point will be constructed as follows:

1. A 2-foot × 2-foot concrete cutout will be performed by an Navy approved contractor.
2. The cutout will be excavated to approximately 3.5 feet below the tunnel floor.
 - A soil sample will be collected using multi-increment sampling (MIS) techniques for analysis of total petroleum hydrocarbons-gasoline, TPH-D, naphthalene, and 1 and 2-methylnaphthalene around the Hume Line. A total of 30 increments are estimated for each MIS sample.
3. The Hume Line will be cut into using a hole saw no larger than 4 inches in diameter.
4. A sewer inspection camera will be used to evaluate the opening and the integrity of the Hume Line.
5. A 2-inch airtight fitting will be secured to the Hume Line.
6. Each SVE point will be constructed with a quick cam and grove connection (or similar quick connection fittings) to allow for simple disassembly of the piping connection at each SVE location. The trunk line will have dedicated piping which will include a magnahelic vacuum gauge (0–5 pounds per square inch [psi]), flow measurement device, sample port, and other various completion piping to be finalized once utility locate has cleared the chosen locations.

All field measurements of existing conditions and extraction point monitoring will be conducted using a gas extraction monitor, PID and a manometer.

6.5.2 SVE Well Construction

When reviewing the historical borings and the access available via the Hume Line, a dedicated SVE well is recommended at approximately A3-100 based on the impacts identified during the Adit-3 Tunnel site investigation. Soil samples collected at A3-100 and A3-110 appear to have elevated PID readings (above 200 ppm) when performing headspace readings and appear to be consistent at every interval screened as well as elevated TPH-G in the soil sample analyzed. This suggests potential infiltration at this location and potentially a preferential pathway for extraction of vapors.

It is anticipated that a 2-inch SVE well will be installed in the tunnel floor using an electronic drilling tool. Site characterization is currently underway in the Adit 3 Tunnel with additional monitoring

planned in the vicinity of A3-100. The investigation will assist in determining the terminal depth of the well, which is anticipated to be approximately 5–6 feet btf. The terminal depth will be dependent on the presence of perched water to allow for screening just above the water table. The SVE well will be completed below the tunnel floor and secured with a watertight traffic rated access point.

The SVE well will be constructed as follows:

1. An electronic drilling apparatus will be used to drill to an estimated depth of 5–6 feet btf with a 2-inch diameter drill bit.
2. A soil sample will be collected at the final screening interval and analyzed for TPH-G, TPH-D, naphthalene, BTEX and 1 and 2-methylnaphthalene.
3. A 2–3 feet (based on terminal depth of the well) prepacked well screen.
4. A 2-inch PVC riser pipe will be used to connect the screen to the vault.
5. A sand backfill will be installed around the screen and extend approximately 6 inches above the screen with the remaining portion of the hole sealed using bentonite and concrete to the traffic rated vault.
6. A quick connect fitting will be used to allow for easy disconnection and limit the hardware below ground.
7. The trunk line to this well will also have a dedicated flow measurement device, vacuum gauge, sample port and various piping completions which will be finalized when the location has been cleared of utilities.

Materials:

- 2-inch prepacked 0.010-inch screen (2–3-foot)
- 2-inch × 3–5-foot PVC Riser Sch 40
- Sand (US Mesh 20-40)
- Bentonite and cement
- Traffic rated vault

All field measurements of existing conditions and extraction point monitoring will be conducted using a gas extraction monitor, PID and a manometer.

6.6 MOBILIZATION OF SVE SKID AND GENERATOR

AECOM will work alongside the Navy to identify an ideal location to stage the Navy's former Onizuka Village SVE system. Once a location has been identified by the Navy AECOM will work to identify all groundwork and permitting required for the area.

AECOM will also rent a 24-kilowatt 3-phase diesel generator to be staged at the paved Adit 3 entrance. The generator will be mounted on a collapsible spill containment apparatus during the duration of the pilot study.

The proposed SVE system has the capacity to run at 275 standard cubic foot per minute at approximately 3.4 psi and requires 230 V 3-phase power. An operations and maintenance manual for this system is attached as Appendix C.

6.6.1 Utility Connections

A 6-inch diameter extraction pipe will be installed from the Adit 3 entrance through the tunnel to the easternmost SVE points using existing piping conduit supports. AECOM anticipates using schedule 40 PVC with high-strength flexible piping to connect each SVE point. The connection between the 6-inch piping in the tunnel and the SVE system will be made using vacuum-rated flexible hose and/or PVC piping. It is anticipated that the 6-inch pipe will be reduced to 2-inch vapor extraction conveyance lines plumbed to each extraction point using a combination of schedule 40 PVC and flexible hosing to establish the final connection to each extraction point.

6.7 MOBILIZATION OF AS EQUIPMENT

A rotary vane blower has been specified for the AS system. The blower has the capacity to produce approximately 20 cubic feet per minute air flow at 10 psi pressure. Mobilization of the AS equipment is currently planned through Adit 6 and via train to access Adit 3. If the train is not available, hand carts, dollies or similar equipment will be used move the AS equipment through the tunnel. AECOM plans to assemble the blower, piping and associated flow regulation equipment within the tunnel. This AS blower assembly will be a generally small set up and need to be mounted to a secure surface. AECOM will stage the AS equipment at approximately A3-010 or as close to the study area as possible to avoid unnecessarily long piping runs. It should also be noted that AECOM anticipates the ability to wire the AS system to tunnel power using a 120-volt receptacle. Piping runs to the various injection wells is anticipated to be completed using 2-inch steel piping to construct an air flow manifold with termination using 2-inch flexible hosing for completion at each injection location. The exact placement of the piping runs will depend on field conditions, utility clearance as well as the final location of the injection wells.

6.8 BASELINE MONITORING

Current subsurface conditions will be evaluated prior to initiating any portion of the pilot study to establish and evaluate the baseline conditions of the soil and perched water. The initial subsurface vacuum, soil gas composition, and water quality condition/parameters will provide beneficial insight on the effectiveness of extraction/volatilization of subsurface gases as well as the potential effectiveness of enhanced biodegradation by both the injection of air in the subsurface and the removal of hydrocarbons via volatilization and extraction.

AECOM will measure the following parameters in the existing temporary wells, open boreholes and proposed sparging wells to document the current groundwater conditions,:

- Field parameters (fluid levels, dissolved oxygen, oxidation-reduction potential, pH, conductivity, and temperature)
- Dissolved petroleum hydrocarbons
 - TPH-D (EPA 8015)
 - TPH-G (EPA 8260)
 - BTEX (EPA 8260)
 - Naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene (EPA 8270)
- Geochemical parameters, as follows:
 - Nitrate (EPA 300.0)
 - Sulfate (EPA 300.0)

- Dissolved Iron (EPA 6020)
- Dissolved Manganese (EPA 6020)
- Dissolved Methane (e.g., EPA RSK-175)

Additionally, baseline soil gas screening will be completed at monitoring points, temporary wells, and open boreholes located within the study area. Differential pressure gauges will be used at each vadose zone monitoring point to evaluate the initial gas pressure distribution in the unsaturated zone. Soil gas composition screening will be completed using a PID and a landfill gas meter to measure concentrations of volatile organic compounds (VOCs), oxygen, methane, and carbon dioxide in soil gas. A water trap and a particulate filter will be installed between the tubing and the gas meter to protect the instruments from water and dust, and an activated carbon filter will be used on the landfill gas meter intake to remove VOCs from the gas sample to prevent VOCs from triggering a false or elevated methane reading. Soil gas will be purged using the internal pump on the field gas analyzers, and readings will be recorded every 30 seconds until stable concentrations are achieved (defined as three consecutive readings within 10 percent of each other with no consistent increasing or decreasing trend).

6.9 SOIL VAPOR EXTRACTION

The pilot study is currently set for two phases: the evaluation of SVE and the evaluation of shallow SVE with AS. The objectives of the SVE extraction portion of the pilot study are to evaluate the effectiveness of the Hume Line to facilitate the extraction of volatilized hydrocarbons and evaluate the subsurface permeability and ability to transfer volatilized hydrocarbons. The initial steps are to evaluate the flow and suction pressure which can be achieved through the Hume Line as well as begin to quantify the radius of influence in the subsurface. When a maximum extraction rate is quantified, these rates will be tested for an extended period to further evaluate the mass removal. These phases are known as the Step-Test and Constant-Rate Test.

6.10 OPERATIONAL PHASE

During the remainder of field activities, the SVE and AS/SVE technologies will be operational at varying degrees to evaluate the feasibility of the application of each respective technology.

6.10.1 SVE Step-Test

To begin, a step test will be performed using the SVE system to evaluate for the maximum extraction flow rates that can be achieved; concentrations of petroleum hydrocarbon and fixed gases (e.g., oxygen, carbon dioxide, and methane) in extracted gas, changes in perched groundwater levels, and the vacuum distribution along the length of the Hume Line. AECOM will evaluate the flow rates to determine what is the maximum vacuum that can be achieved on the Hume Line while maintaining a laminar flow (Beckett and Huntley 1994).

During the step test, vacuum and flow will be monitored until stabilization is achieved. Data will be collected every 10 minutes to measure for stabilization, which is achieved after three consecutive measurements are within 10 percent of each other. Additionally, a PID and landfill gas meter (GEM or equivalent) will be used to assess the VOCs, oxygen, methane and carbon dioxide in the soil gas exhaust. A total of 3 extraction flow rates (steps) is anticipated but this may change due to environmental responses such as limited suction on SVE point or inability to maintain stabilization parameters.

Table 3 lists the measurements that will be collected during the Step Tests.

Table 3: Step Test Measurements

Parameter	Anticipated Frequency (Step-Test)
Extraction point vacuum	Approximately every 10 mins
Vapor extraction flow rate	Approximately every 10 mins
Vacuum measurements at wells/SVMPs	Approximately every 10 mins
Influent and effluent VOCs readings at the SVE SKID	Approximately every 30 mins
Methane, oxygen, carbon dioxide	Approximately every 30 mins

6.10.2 SVE Constant Rate Test

Upon completion of the step test, a constant rate test will be completed after the evaluation of the step-test field measurements. AECOM will identify the maximum extraction rate achieved at these SVE points while maintaining maximum vacuum influence and VOC extraction rate as well as laminar flow. During this portion of the test, a consistent airflow rate will be maintained from the extraction points. The subsurface response will be monitored throughout the test as well as the flow rate and vacuum at each extraction point. Field measurements will be collected every 30 minutes and will continue until stabilization occurs, defined as at least three consecutive readings within 10 percent of each other. Once stabilization occurs, two rounds of gas samples will be collected pre-GAC filtration and post-GAC filtration within the SVE skid. These samples will be collected immediately after stabilization and the second round will be collected at least 4 hours after stabilization has occurred. These gas samples will be analyzed for EPA Method TO-17, TO-15, and TO-3.

Table 4 lists the measurements that will be collected during the constant rate test.

Table 4: Constant Rate Test Measurements

Parameter	Anticipated Frequency (Step-Test)
Extraction point vacuum	Approximately every 30 mins
Vapor extraction flow rate	Approximately every 30 mins
Vacuum measurements at wells/SVMPs	Approximately every 30 mins
Influent and effluent VOCs readings	Approximately every 30 mins
Methane, oxygen, carbon dioxide	Approximately every 30 mins
TO-17, TO-15, TO-3 samples	Once stabilization occurs and at least 4 hours after stabilization

Note: TO-17 is recommended as it captures a wider range of heavier distillates and will assist in calculating a more accurate estimate of mass removal

TO Toxic organic

6.10.3 Air Sparge and SVE

The second phase of the pilot study will evaluate the AS and SVE technologies together. Similar to the SVE test, the AS and SVE pilot tests will evaluate for mass removal due to volatilization of hydrocarbons. However, additional pressurized atmospheric air will be introduced below the identified impacted perched water zone. The injection wells will aid in the volatilization of hydrocarbons in the impacted zone and introduce oxygen to the subsurface to potentially enhance natural microbial activity. Both mass removal via the SVE system and enhance biodegradation markers will be evaluated

to determine the effectiveness of these technologies. Similar to the previous phase, there are two steps in the evaluation of the AS/SVE system.

1. The First is AS/SVE Step Test, which will evaluate various flow rates into the injection wells to maximize the radius of influence and determine the optimal AS injection pulse cycle timing and maintain adequate vapor capture from the SVE System.
2. The second is the AS/SVE Constant Rate Test, to test the SVE and AS systems under continuous optimal vapor extraction, air injection flow rate, and air injection pulse cycle timing conditions based on determinations made after the Step Test.

Ambient air will be monitored continuously to verify that volatilized gas is adequately captured, and that short circuiting does not occur.

6.10.4 AS/SVE Step Test

Similar to the SVE step test, the AS/SVE step test will be performed to evaluate the environmental response to the operation of the four AS injection wells and SVE system. During this portion of the step test the SVE vacuum will be maintained at the maximum extraction rate as determined by the SVE constant rate test. A minimum of 3 injection flow rates will be tested during the Step Test. Flow and pressure will be monitored at each injection point every 10 minutes until stabilization occurs, which is a minimum of 3 consecutive readings within 10 percent of each other.

To inject air into the saturated zone, it is necessary to overcome the sum of the hydrostatic pressure of the overlying groundwater, the air-entry pressure of the filter pack materials, and the air-entry pressure of the formation. Per USACE (2013), the contribution from the hydrostatic pressure is calculated based on the distance from the water table to the top of the injection well screen, where each foot of water is equal to a pressure of approximately 0.43 psi. Air-entry pressures for filter pack and formation materials are expected to be small compared to the contribution from the hydrostatic pressure. The air-entry pressure of the filter pack is typically less than 0.14 psi for uniform sands commonly used as filter pack (USACE 2013), and air-entry pressures of formation materials range from negligible for coarse-textured media, such as coarse sands and gravels, to greater than 1.4 psi for medium-textured soils, such as silts (USACE 2013). The sum of the hydrostatic pressure and the air-entry pressures represents the minimum air pressure required for the AS system to deliver air to a particular depth in the aquifer.

To prevent creation of secondary permeability fractures that may limit air distribution, maximum air injection pressures will not exceed 80 percent of the total overburden pressure (USACE 2013). The maximum injection pressure for each air injection well will be calculated based on final construction details using a soil grain density of 2.65 grams per cubic centimeter (density of quartz) and a conservative porosity (40 percent), as described in USACE guidance (USACE 2013).

AS wells will be operated in pulse mode, i.e., a period of air injection followed by a period of no air injection, resulting in “pulsing” of the air injection. The advantage of pulsing is to minimize formation of preferential air flow paths and to optimize transfer of oxygen from injected air to groundwater. Continuous sparging typically results in the establishment of preferential air flow pathways that can reduce the overall transfer of VOCs into injected air and transfer of oxygen from injected air into groundwater. Pulsing allows the preferential pathways to collapse, increasing the pathway variability through the radius of influence. Pulsed operation improves the efficiency of oxygen transfer to groundwater by causing local groundwater mixing within the zone of influence (McKay and Acomb 1996).

Air flow into the formation is initiated when the air injection pressure exceeds the minimum air injection pressure, as defined above. As the injected air establishes continuous air-filled channels and air begins to emerge from the saturated zone into the vadose zone, the injection pressure decreases and the hydraulic head at the injection point gradually returns to pre-sparging conditions (Johnson et al. 2001). A corresponding temporary hydraulic head depression is observed once air injection ceases and the air-filled channels collapse and fill with groundwater. The transient water-level response to air injection will be monitored using pressure transducers. The optimal pulse cycle time (the duration of air injection) will be set to maintain groundwater pressures above pre-sparging conditions (i.e., between the time required for groundwater pressures to peak and the time to reach pre-sparging hydrostatic levels) to maximize groundwater mixing (Neriah and Paster 2018).

In addition to the monitoring established during the SVE rate tests, the seven microwells currently in Adit 3 will also be monitored to document any mounding, along with collecting water quality parameters throughout the step test. Due to access limitations of the microwells, single parameter downhole meters will be used to measure water quality parameters in the microwells. These meters are anticipated to test for oxygen, oxidation-reduction potential, and temperature. Additionally, the seven microwells currently on-site have transducers (Van Essen Micro-Divers), which will be adjusted to collect readings every 2 minutes during the AS testing to evaluate changes in groundwater pressure during air injection. Atmospheric pressure data will be recorded using two existing Barologgers deployed on-site. One is located in the tunnel at A3+000 and will record air pressure fluctuations within the tunnel; the second Barologger is located outside the tunnel near Adit 3 and will record atmospheric pressure change.

Table 5: Parameter and Frequency of Measurements During Step Test

Parameter	Frequency (Step-Test)
Extraction point vacuum	Approximately every 10 mins
Extraction point flow	Approximately every 10 mins
Injection well pressure	Approximately every 10 mins
Injection well flow	Approximately every 10 mins
Temporary wells water quality parameters (limited)	Approximately every 30 mins
Temporary wells water levels/pressure	Approximately every 30 mins
Influent and effluent VOCs readings	Approximately every 30 mins
Measure VOCs in ambient tunnel air	Approximately every 30 mins
Vacuum/pressure at all shallow wells and SVMs	Approximately every 30 mins

6.10.5 AS/SVE Constant Rate Test

The AS/SVE constant rate test will use the rates established during the SVE constant rate test and the AS step test to identify a constant flow that will be targeted for both extraction and injection at each point. Field parameters will be collected every 30 minutes and will continue till stabilization occurs. Immediately after stabilization, a round of vapor samples will be collected pre- and post-GAC filtration. The systems will continue to run with a second round of sampling collected at least 4 hours after stabilization.

Table 6: Parameter and Frequency Measurements During Constant Rate Test

Parameter	Frequency (Step-Test)
Extraction point vacuum	Approximately every 30 mins
Extraction point flow	Approximately every 30 mins

Parameter	Frequency (Step-Test)
Injection well pressure	Approximately every 30 mins
Injection well flow	Approximately every 30 mins
Temporary wells water quality parameters (limited)	Approximately every 30 mins
Temporary wells water levels/pressure	Approximately every 30 mins
Influent and effluent VOCs readings	Approximately every 30 mins
Measure VOCs in ambient tunnel air	Approximately every 30 mins
Vacuum/pressure at all shallow wells and SVMPs	Approximately every 30 mins
TO-17, TO-15, TO-3 samples	Once stabilization occurs and at least 4 hours after stabilization

TO task order

*TO-17 is recommended as it provides a wider capture range of heavier distillates and will assist in calculating a more accurate estimate of mass removal

6.11 SHORT TERM OPERATION OF SHALLOW SVE/AS

Upon completion of the pilot study field activities, AECOM will continue operation of the SVE/AS equipment under conditions to be determined after the evaluation of the data collected during the pilot study. This operation is estimated to continue for approximately 2–4 months while construction activities are completed within Adit 3 for the deep remedial pilot study testing and operation.

7. Data Evaluation

Data collected from each pilot test will be used to evaluate the effectiveness of using SVE and AS technologies to remove volatile hydrocarbons by phase transfer and by introducing atmospheric air into the subsurface to enhance biodegradation. The primary criteria that need to be met to consider SVE and AS effective technologies that should be considered for full-scale implementation (i.e., success criteria) are proposed as:

1. Achieving measurable airflow through the saturated and unsaturated zones where petroleum hydrocarbons are present (as demonstrated by the Constant Rate SVE and AS/SVE tests).
2. Demonstrating that the technologies can be applied to deplete the mass of petroleum hydrocarbons in the shallow, perched groundwater zone.

If either of these criteria are not demonstrated, then SVE and AS technologies may be deemed inappropriate and/or infeasible for application to the shallow study area.

7.1 SVE DATA EVALUATION

The SVE zone of influence will be evaluated based on measured changes in subsurface gas pressure and soil gas composition at pilot test monitoring points screened above the perched water table in response to changes in vapor extraction flow rate. Installation of additional vertical SVE points may be considered if soil gas monitoring points located within the target remediation zone do not exhibit evidence of induced air flow during the pilot testing activities (e.g., no measurable vacuum response and no change in oxygen content in soil gas).

Pneumatic permeability values will be estimated from pressure drops between vacuum monitoring points located at different distances from vapor extraction points at the measured extraction rate using a modified form of Darcy’s law. Additionally, differences in vacuum response as a function of depth will be evaluated using measurements from vapor monitoring points screened at different depth intervals (i.e., subslab and at the base of the vadose zone) to give an indication of air leakage through the tunnel floor and vertical-to-horizontal permeability ratios.

Vapor extraction flow rates for longer-term SVE operation will be determined through evaluation of the pneumatic response data, changes in soil gas composition from vadose zone monitoring points, and mass removal rate trends observed in the SVE off-gas (see Section 7.3 below). Vapor extraction rates will be determined based on achieving a pore volume exchange rate that is frequent enough to maintain a low extraction concentration relative to initial, subsurface source vapor concentrations to optimize mass transfer in diffusion-limited zones and to ensure that the subsurface is not oxygen-limited to maintain high rates of aerobic biodegradation.

7.2 AS DATA EVALUATION

Monitoring data collected from wells screened within the perched groundwater unit, including changes in dissolved oxygen and oxidation-reduction potential to determine AS zone of influence and changes in hydraulic head to evaluate the effects of soil heterogeneity on air distribution in the saturated zone (Johnson et al. 2001) and to assess optimal pulse cycle timing (USACE 2013).

Air injection flow rates for longer-term operation during the AS/SVE study will be determined based on review of trends of dissolved oxygen versus distance from air injection points as a function of air injection flow rate. The air injection pulse duration will be set based on the time to reach peak groundwater pressures in the vicinity of the air injection wells, indicative of the time required for air-filled channels to emerge from the saturated zone into the vadose zone (Johnson et al. 2001). The off-cycle timing (the period with no air injection between pulses) will be adjusted based on the observed oxygen decay rate to maintain aerobic conditions within the zone of influence.

7.3 ANALYSIS OF MASS REMOVAL

Removal rates for volatile hydrocarbons by mass transfer into the vapor phase will be calculated by multiplying the concentration of volatile petroleum hydrocarbons in the extracted vapor (mass of petroleum hydrocarbons per unit volume of extracted vapor) by the measured volumetric vapor extraction flow rates (volume of extracted vapor per unit time), as indicated in Equation 1:

$$\text{Equation 1: } Q_M = Q_V \cdot C_{HC}$$

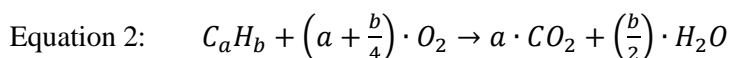
Where:

$$Q_M = \text{Petroleum hydrocarbon mass removal rate (M/T)}$$

$$Q_V = \text{Volumetric vapor extraction flow rate (L}^3\text{/T)}$$

$$C_{HC} = \text{Concentration of volatile petroleum hydrocarbons measured in extracted vapor (M/L}^3\text{)}$$

Additionally, mass removal by aerobic biodegradation (consumption of oxygen and/or production of carbon dioxide) will be calculated based on stoichiometric relationships derived from the prevailing aerobic biodegradation reactions that deplete petroleum hydrocarbons. The flow of oxygen-rich atmospheric air into the subsurface provides oxygen to naturally occurring microorganisms that obtain energy for cell growth and maintenance through the transfer of electrons from electron donors (e.g., LNAPL hydrocarbon constituents and/or naturally occurring soil organic carbon) to terminal electron acceptors, such as oxygen, nitrate, manganese oxides, iron oxides, and sulfate. In the presence of oxygen, as in the case of an active SVE system, these biodegradation reactions result in the production of carbon dioxide and water according to the following stoichiometric relationship, where “a” and “b” represent the number of carbon and hydrogen atoms in a given hydrocarbon compound, respectively:



The stoichiometric relationship from Equation 2 for aerobic mineralization of various hydrocarbon compounds (different values for a and b) can be expressed in terms of the mass of hydrocarbon (HC) degraded per unit mass of oxygen utilized (g-HC/g-O₂), or per unit mass of carbon dioxide (CO₂) gas produced (g-HC/g-CO₂). The mass ratio of hydrocarbon degraded to oxygen utilized or carbon dioxide produced is relatively invariant for a broad range of hydrocarbons. Using decane (C₁₀H₂₂) as a representative compound for the hydrocarbon impacts at the site, the resulting stoichiometric coefficient for aerobic oxidation of the hydrocarbon (S_{O_2} ; 0.29 g-C₁₀H₂₂/g-O₂) and CO₂ production (S_{CO_2} ; 0.32 g-C₁₀H₂₂/g-CO₂) were calculated using molecular weights for each of the compounds represented in Equation 2 (Haynes, 2012).

With the above stoichiometric coefficients, mass removal by aerobic biodegradation will be calculated using Equation 3:

$$\text{Equation 3: } R_{bio} = Q_V \cdot \left(\frac{C_i - C_i^{bkgd}}{100} \right) \cdot \rho_i \cdot S_i$$

Where:

R_{bio} = Rate of petroleum hydrocarbon mass removal rate (M/T)

C_i = Concentration of O₂ or CO₂ in extracted soil gas (vol%)

C_i^{bkgd} = Background concentration of O₂ or CO₂ (20.9 and 0.04 vol%, respectively)

ρ_i = Density of O₂ or CO₂ gas at normal temperature and pressure (M/L³)

8. Project Schedule and Reporting

Based on initial estimates, AECOM has updated a project schedule with proposed field activities (see Appendix E). The initial estimates are assuming ideal conditions with limited delays. Proposed field activities are under review by the Navy and State of Hawaii, Department of Health. Field activities are estimated to begin in late January 2023 and proceed through May 2023. A technical memorandum will be submitted four weeks after the completion of the shallow SVE/AS pilot study field activities.

9. Sample Details

Additional details about collecting subsurface unconsolidated material, water, and vapor samples are presented in Appendix B.

Table 7: Sample Type and Matrix Identifiers

Identifier	Sample Type	Matrix
SO	Subsurface unconsolidated material	Unconsolidated material
WG	Groundwater	Water
WS	Surface water	Water
GS	Soil vapor	Gas
WQ	QC water	Water
SQ	QC soil	Unconsolidated material
QC	quality control	

Table 8: Field QC (SACODE) Type Identifiers

Identifier	Field or QC Sample Type	Description
N	Primary sample	All field samples, except QC samples
FD	Duplicate	Co-located for unconsolidated material
EB	Equipment blank	Water
TB	Field blank	Water

Table 9: Sample Depth Identifiers

Identifier	Field or QC Sample Type	Description
###.#-###.#	Beginning depth interval to end depth interval	Top and bottom of soil interval sampled

Table 10: Sample Date

Identifier	Field or QC Sample Type	Description
YYMMWK#	Sample collection date (expressed as week of sampling to allow pre-naming and flexibility in sampling activity)	<ul style="list-style-type: none"> • YY = Year • MM = Month • WK# = Week of the month

9.1 HANDLING, SHIPPING, AND CUSTODY

All samples collected for analysis will be recorded in the field logbook in accordance with Procedure III-D, *Logbooks* (DON 2015). All samples will be labeled and recorded on chain-of-custody forms in accordance with Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody* (DON 2015). Samples will be handled, stored, and shipped in accordance with Procedure III-F, *Sample Handling, Storage, and Shipping* (DON 2015). All samples collected on this project will be shipped to the analytical laboratory via overnight airfreight.

All samples received at the analytical laboratory will be managed in accordance with laboratory SOPs for receiving samples, archiving data, and sample disposal and waste collection, as well as storage and disposal per Section 5.8, "Handling of Samples," of the Department of Defense *Quality Systems Manual (QSM)* v. 5.4 (DoD and DOE 2021).

9.2 LABORATORY QUALITY CONTROL SAMPLES

Laboratory quality control samples will be prepared and analyzed in accordance with the methods and procedures listed in Appendix B.

10. References

Beckett, G. D., and D. Huntley. 1994. *Characterization of Flow Parameters Controlling Soil Vapor Extraction: Ground Water*. Vol. 32. No. 2, pp. 239–247.

Department of Defense and Department of Energy, United States (DoD and DOE). 2021. *Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories*. DoD/DOE QSM Ver. 5.4. Prepared by DoD Environmental Data Quality Workgroup and DOE Consolidated Audit Program Operations Team.

- Department of the Navy (DON). 2007. *Red Hill Bulk Fuel Storage Facility Final Technical Report, Pearl Harbor, Hawaii*. Prepared by TEC, Inc. Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific. August.
- . 2015. *Final Project Procedures Manual, U.S. Navy Environmental Restoration Program, NAVFAC Pacific*. JBPHH HI: Naval Facilities Engineering Command, Pacific. May.
- . 2018. *Seismic Profiling to Map Hydrostratigraphy in the Red Hill Area, Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, O'ahu, Hawai'i; March 30, 2018, Revision 00*. Prepared by Lee Liberty and James St. Claire, Boise State University, Boise, ID, for AECOM Technical Services, Inc., Honolulu, HI. Boise State University Technical Report BSU CGISS 18-01. Prepared for Defense Logistics Agency Energy, Fort Belvoir, VA, under Naval Facilities Engineering Command, Hawaii, JBPHH HI.
- . 2022. *Site Characterization Plan, Moderate Depth SVMP Addendum Red Hill Bulk Fuel Storage Facility (November 2021 Release, U.S. Navy Well 2254-01) Joint Base Pearl Harbor-Hickam Oahu HI*. Prepared by AECOM Technical Services, Inc. JBPHH HI: Naval Facilities Engineering Systems Command, Hawaii. May.
- Giambelluca, T. W., M. A. Nullet, and T. A. Schroeder. 1986. *Rainfall Atlas of Hawaii*. Report R76. Honolulu, HI: Department of Land and Natural Resources, Division of Water and Land Development. June.
- Hunt Jr., C. D. 1996. *Geohydrology of the Island of Oahu, Hawaii*. Professional Paper 1412-B. Regional Aquifer-System Analysis—Oahu, Hawaii. U.S. Geological Survey.
- Izuka, S. K. 1992. *Geology and Stream Infiltration of North Halawa Valley, Oahu, Hawaii*. Prepared in cooperation with the State of Hawaii Department of Transportation. Honolulu, HI. Water-Resources Investigations Report 91-4197. U.S. Geological Survey.
- Johnson, R.L., P.C. Johnson, T.L. Johnson, N.R. Thomson, and A. Leeson. 2001. "Diagnosis of In Situ Air Sparging Performance Using Transient Groundwater Pressure Changes during Startup and Shutdown." *Bioremediation Journal* 5 (4): 299–320.
- Macdonald, G. A., A. T. Abbott, and F. L. Peterson. 1983. *Volcanoes in the Sea: The Geology of Hawaii*. 2nd ed. Honolulu, HI: University of Hawaii Press.
- McKay, D.J., and L.J. Acomb. 1996. "Neutron Moisture Probe Measurements of Fluid Displacement During In Situ Air Sparging." *Groundwater Monitoring and Remediation*, no. Fall: 86–94.
- Neriah, A.B., and A. Paster. 2018. "Enhancing Groundwater Remediation in Air Sparging by Changing the Pulse Duration." *Groundwater Monitoring and Remediation* 39 (1): 43–53.
- United States Army Corps of Engineers (USACE). 2013. *In-Situ Air Sparging*. EM 200-1-19. Washington, DC: Department of the Army. December.

United States Department of Agriculture, Soil Conservation Service (USDA SCS). 1972. *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*. In cooperation with the University of Hawaii Agricultural Experiment Station. Washington, DC. August. <https://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=HI>.

Wentworth, C. K., and G. A. Macdonald. 1953. *Structures and Forms of Basaltic Rocks in Hawaii*. Geological Survey Bulletin 994. U.S. Geological Survey.

**Appendix A:
Standard Operating Procedures**

I. Field Procedures

Procedure I-A Planning

Procedure I-A-1 Development of Project Quality Objectives

Procedure I-A-5 Utility Clearance

Procedure I-A-6 Investigation-Derived Waste Management

Procedure I-A-8 Sample Naming

Procedure I-B Sampling

Procedure I-B-1 Soil Sampling

Procedure I-B-2 Geophysical Testing

Procedure I-B-5 Surface Water Sampling

Procedure I-C Well Construction and Well Development

Procedure I-C-1 Monitoring Well Installation and Abandonment

Procedure I-C-2 Monitoring Well Development

Procedure I-D Miscellaneous Sampling

Procedure I-D-1 Drum Sampling

Procedure I-E Soil and Rock Classification

Procedure I-F Equipment Decontamination

Procedure I-I Land Surveying

II. Data Validation Procedures

Procedure II-A Data Validation

III. QC Procedures

Procedure III-A Laboratory QC Samples (Water, Soil)

Procedure III-B Field QC Samples (Water, Soil)

Procedure III-D Logbooks

Procedure III-E Record Keeping, Sample Labeling, and Chain-of-Custody

Procedure III-F Sample Handling, Storage, and Shipping

This page intentionally left blank

Development of Project Quality Objectives

1. Purpose

This standard operating procedure establishes standard guidelines for the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel for the development of project quality objectives (PQOs) for a contract task order (CTO). These procedures will help ensure that CTOs meet the purpose and objectives of the task order, as well as the necessary documentation of the environmental decisions that need to be made and the level of data quality needed to ensure that those decisions are based on sound scientific data. The PQOs will be used to develop the work plan (WP), which provides the detailed project-specific objectives, specifications, and procedures needed to conduct a successful data collection activity. Data will be collected according to specifications set forth in the WP, and a data quality assessment will be performed to determine whether PQOs have been satisfied.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program. As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

ARARs include cleanup or control standards, regulatory requirements, or limitations promulgated under federal or state environmental laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance that applies to a particular CTO.

3.2 ANALYTES

Analytes are contaminants that might be present at a site as well as other chemical and physical properties for which the laboratory will analyze samples.

3.3 ANALYTICAL METHODS

Analytical methods are standardized procedures used to identify and quantify analytes in environmental samples.

3.4 PQOs

PQOs are qualitative and quantitative statements derived from a systematic planning process (e.g., U.S. Environmental Protection Agency [EPA] *Guidance on Systematic Planning Using the Data*

Quality Objectives Process (EPA 2006) that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors. PQOs will be used as the basis for establishing the quality and quantity of data needed to support decisions.

3.5 PQO PROCESS

The PQO process is a systematic planning tool based on the scientific method for establishing criteria for data quality and for developing a data collection design.

3.6 ACTION LEVEL

Action levels (ALs) are analyte concentrations that if exceeded in site media, indicate that some action is needed to address hazards associated with onsite contamination.

4. Responsibilities

The prime contractor CTO Manager is responsible for ensuring that development of PQOs is performed in compliance with this procedure and for identifying instances of noncompliance. The CTO Manager is responsible for ensuring that all personnel involved in sampling and/or testing shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

5. Procedures

PQOs shall be developed following performance of the site reconnaissance and prior to development of the WP for all CTOs. When critical environmental decisions need to be made, (e.g., final decision-making or compliance with a standard), the project team should follow a formal systematic planning process such as the data quality objectives (DQO) process described in the *Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4* (EPA 2006). The formal DQO process as described in EPA QA/G-4 requires statistical expertise to define the amount of error acceptable when making an environmental decision and includes the following seven steps:

1. State the problem.
2. Identify the goals of the study.
3. Identify information inputs.
4. Define the study boundaries.
5. Develop the analytic approach.
6. Specify performance or acceptance criteria.
7. Develop the plan for obtaining data.

Graded Approach

For data collection activities that are either exploratory or small in nature, or where specific decisions cannot be identified, the formal process is not necessary. For these projects, the project

team should use an abbreviated systematic planning process (e.g., Steps 1-4) to help identify the PQOs and action limits, and to select appropriate sampling, analytical and assessment activities.

Incremental Sampling Approach

Incremental sampling methodology (ISM) is such an integral part of environmental investigations in Hawaii, and therefore, a discussion of ISM PQOs is necessary. The State Department of Health strongly encourages the use of incremental sampling (IS) to enhance the sample representativeness during environmental investigations when appropriate (DOH 2009). IS is a structured sampling protocol that enhances sample representativeness and reduces data variability in the investigation of contaminated soil. The objective of IS is to obtain a single sample for analysis that has an analyte concentration representative of a decision unit within the error limitations required for the project. IS improves the reliability and defensibility of sampling data by reducing variability when compared to conventional discrete sampling strategies. An IS approach requires site-specific information to be considered during the planning process. Therefore, the steps necessary to complete the DQO process as they apply to investigations where IS is used is detailed in Attachment I-A-1-1.

5.1 STEP 1: STATE THE PROBLEM

The first step of the PQO process is to state the problem. Clearly define the problem once it has been identified. Assemble a planning team to completely assess the problem. Designate one member of the planning team as the primary decision maker. The planning team shall compile and evaluate available information to develop a concise description of the problem and a conceptual site model (CSM). The CSM describes exposure pathways and exposure scenarios, facilitates identification of decisions that must be made, and identifies deficiencies in the existing information. Prepare a brief summary of the problem once these have been identified.

5.1.1 Identify Members of the Planning Team

The members of the planning team shall be appropriate for the size and complexity of the problem. PQO development requires that the data users be involved in the planning of CTO activities. Because of the interdisciplinary nature of activities, it is important to obtain the appropriate technical expertise in developing PQOs. Data users normally consist of the primary decision maker, and primary and secondary data users.

Primary data users generally consist of those individuals involved in the ongoing CTO activities. The CTO Manager must identify those technical staff needed for the project and involve them in the planning process. For example, if groundwater contamination is a concern, hydrogeologists must be involved. Persons with expertise in analytical chemistry must be involved to specify the type of analyses that may be used and the limitations of these analyses. Toxicologists or others familiar with risk assessment must also be involved to ensure that migration and exposure pathways, potential receptors, and contaminants and levels of concern are considered.

Secondary data users are those that use data to support their activities. These include Navy personnel, and state and federal regulatory enforcement agencies. The roles and responsibilities shall be determined for each member of the planning team. The objectives of the team are to develop a concise description of the problem, specify resources that are available, and determine deadlines for the study.

5.1.2 Identify the Primary Decision Makers

Identify the primary decision makers for the planning team. These individuals have the ultimate authority for making final decisions based on recommendations from the planning team. Examples of primary decision makers are the Navy personnel who must determine what the site will ultimately be used for and the project manager who determines how the investigation should be conducted to meet the investigation objectives.

5.1.3 Develop a Concise Description of the Problem

The planning team shall prepare a brief summary that concisely describes the problem and the conditions or circumstances that are causing the problem. This summary should be based on a site reconnaissance, and a review of site history and potential sources of contamination. Procedure Number I-A-4, *Site Reconnaissance* provides the procedures for conducting a site reconnaissance. Review literature and studies to ensure that the problem is correctly defined and has not been previously solved. Information regarding site history and potential sources of contamination can be obtained from previous studies and investigations.

The CSM may be helpful in developing a description of the problem. The Department of the Navy Environmental Restoration Program manual (DON 2006) and Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA 1988) provide a general discussion about the development and use of the CSM. Additional CSM tools are available through the navy's Environmental Restoration Technology Transfer Tool (DON 2010). If a CSM already exists, it may need to be refined. A CSM describes the site and its surroundings, potentially complete and complete exposure pathways for the particular media for both human and ecological receptors, and exposure pathways. It also presents hypotheses regarding the contaminants present, their routes of migration, and their potential site impact. The hypotheses are tested, refined, and modified through the WP activities, which shall be referenced by the CSM.

The areas to be assessed during development of the CSM include the following:

- Population, environmental, and welfare concerns
- Potential exposure routes and contaminant transport pathways
- Nature and extent of contamination at the site
- Extent to which the contamination has been defined and can be defined in the future
- Potential for migration from the site (if known)
- Extent to which site contamination levels have exceeded ARARs or other related environmental or public health standards or criteria (if known)

A complex problem may require division into separate studies.

5.1.4 Specify Available Resources and Relevant Study Deadlines

Specify the budget, personnel, and projected deadline in the summary. Discuss time constraints, such as base closures, if appropriate.

5.2 STEP 2: IDENTIFY THE GOALS OF THE STUDY

The second step of the PQO process is to identify the goals of the study. Identify relationships between this decision and any other current or subsequent decisions.

5.2.1 Identify the Principal Study Question

Identify a principal study question based on the problem. The principal study question focuses on pertinent information that is necessary to resolve the problem. State the principal study question as specifically as possible. In general, the question is whether the site poses a threat to human health and/or the environment. Specific examples are as follows:

- Does the contaminant concentration in groundwater exceed acceptable levels?
- Does the pollutant concentration exceed the National Ambient Air Quality Standard?
- Does a contaminant pose a human health or ecological risk?
- Is the contaminant concentration significantly above background levels (suggesting a release)?

5.2.2 Define Alternative Actions that Could Result from Resolution of the Principal Study Question

Possible answers to the study question could result in one or more alternative actions including no action. The following example illustrates how alternative actions are defined based on possible answers to the principal study question: “Does a contaminant pose a human health or ecological risk?” If the answer is yes, alternative actions could be site remediation through removal of contaminated soil, contaminant removal through a soil vapor extraction system, or bioremediation. A quarterly groundwater program may also be implemented to monitor the effect of the site contamination on groundwater. If the answer is no, then the site investigation will go to No Further Response Action Planned.

5.2.3 Combine the Principal Study Question and Alternative Actions into a Decision Statement

Create a decision statement by combining the principal study question with alternative actions. The format may be as follows: “Determine whether or not [unknown environmental conditions/issues/criteria from the principal study question] require (or support) [taking alternative actions].” Using the example above, the decision statement could be “Determine whether or not volatile organic constituent contamination from the site poses a risk to groundwater and requires quarterly groundwater sampling. If the answer is no, then no further action is required.”

5.2.4 Organize Multiple Decisions

If multiple decision statements are necessary to resolve the problem, they should be organized and prioritized. Describe the decision-making process, taking into account how the data from a previous phase will affect the following phase. Implement a phased approach to sampling if relationships exist between this decision and other current or subsequent decisions. A flowchart or diagram may be helpful.

5.3 STEP 3: IDENTIFY INFORMATION INPUTS

The third step of the PQO process is to identify the information needed and sources for each information input. Determine contaminant-specific ALs, sampling techniques, and analytical methods during this step.

5.3.1 Identify the Information Required To Resolve the Decision Statement

Collect various types of information in order to resolve the decision statement. Information types include data uses and types of data. Data uses can be described in terms of general categories, which include the following:

- Identification of the presence or absence of contamination at a site
- Site characterization (delineation of the nature and extent of contamination)
- Assessment of immediate public health or worker health and safety concerns for site investigation activities
- Completion of a risk assessment
- Evaluation and design of remedial action alternatives

Acquire information using either a monitoring or modeling approach, or a combination of both. Use this information with existing site information and the CSM to determine what type of data is required to meet the CTO objective. Data types generally consist of types of samples that need to be collected (soil, groundwater, aquifer hydraulic conductivity, and geotechnical), as well as sample analytes. Refer to Procedure Number I-A-2, *Selection of Analytes*, for procedures on selection of sample analytes.

5.3.2 Determine Sources for Each Informational Input

Identify and qualitatively evaluate for appropriateness the sources for each informational input. Information input sources include previous investigative results, historical records, regulatory guidance, professional judgment, or scientific literature. List those inputs that are obtained through environmental measurements.

5.3.3 Determine the Necessary Information for Establishing Action Levels

Determine the basis for establishing contaminant-specific ALs. The AL is the threshold value that provides the criterion for selecting an alternative action. Derive contaminant-specific action levels from regulatory thresholds or standards, technology based limits, or exposure assessment analysis.

ALs directly affect data quality requirements, in that the analytical methods chosen must have reporting limits that are well below the AL. Reporting limits depend upon the parameter and analytical method being considered.

5.3.4 Identify Potential Sampling Techniques and Appropriate Analytical Methods

Identify potential sampling techniques and appropriate analytical methods for environmental measurements that were previously listed. Use the Project Procedures Manual as the protocol for sampling, and identify significant deviations. Determine the detection limit, limit of detection, and limit of quantitation for each analytical method.

5.4 STEP 4: DEFINE THE STUDY BOUNDARIES

The fourth step of the PQO process is to define the spatial boundaries of the study and the temporal boundaries of the decision. The boundaries ensure that the data collection design incorporates the time periods during which the study shall be implemented, populations and geographic areas that shall be sampled, and the applicable time period. The study area may be stratified into subpopulations in order to reduce the complexity of the problem. The spatial boundaries or geographical region of the general study area may expand or contract with each phase of sampling and may include focused areas of sampling or hot spots. Define practical constraints on data collection during this step.

5.4.1 Specify the Characteristics that Define the Population of Interest

Specify the characteristics that define the population of interest. For example, Aroclor-1260 is more specific than polychlorinated biphenyls (PCBs), and adult construction worker receptor is more specific than human receptor.

5.4.2 Define the Geographic Area Applicable to the Decision(s)

Define the geographic area that is applicable to the decision. The property boundary, depth below ground surface, or natural habitat range for a particular animal species may define a specific geographic area.

5.4.3 Divide the Population into Strata with Relatively Homogeneous Characteristics

The population of the study area may be stratified into subpopulations with relatively homogeneous characteristics in order to reduce the complexity of the problem. Examples of characteristics include specific contaminants, age, and species type.

5.4.4 Determine the Decision Timeframe

Determine the timeframe to which the decision applies. Define time frames for the overall population and for any subpopulation of interest; then address discrepancies that may arise from the short time frame of data collection relative to the long time periods for implementing decisions.

5.4.5 Determine When to Collect Data

Determine the data collection time based upon the most favorable conditions. These conditions include weather, temperature, humidity, wind, or amount of sunlight. For example, a quarterly groundwater monitoring program could be implemented because seasonal changes could affect groundwater concentrations.

5.4.6 Determine the Scale of Decision Making

Determine the most appropriate scale of decision-making based on the spatial or temporal boundaries. For example, in a study where the decision statement is, "Determine whether volatile organic constituent contamination from the site is a risk to groundwater and requires quarterly groundwater monitoring," the geographic area is the site boundary, and the population is benzene, toluene, ethyl benzene, and xylene (BTEX). The scale of decision-making could be set to a particular chemical that is associated with BTEX, such as benzene, which is a known carcinogen. A scale of decision-making based on temporal boundaries could specify the time between groundwater sampling events.

5.4.7 Identify Practical Constraints on Data Collection

Identify practical constraints that could potentially interfere with data collection, such as seasonal or meteorological conditions, access to property or buildings, time, or unavailable personnel.

5.5 STEP 5: DEVELOP THE ANALYTIC APPROACH

The fifth step of the PQO process is to develop the analytic approach. This procedure involves identifying the statistical parameter that characterizes the population of interest, specifying the ALs for the decision, and combining the outputs from the previous PQO steps in order to develop decision rules.

5.5.1 Specify the Statistical Parameter of the Population of Interest

Specify statistical parameters that characterize the population or parameter of interest. The parameter may be the mean, median, or percentile that will be used by the decision maker. Statistical parameters may be specified by the regulatory agency or the risk assessment analysis.

Using the mean as the statistical parameter is useful when the AL is based on long-term, average health effects, when the population is uniform, and generally requires fewer samples than the other statistical parameters. However, this may not be a representative measure for highly skewed populations or populations that contain a large number of nondetect measurements.

Using the median as the statistical parameter is useful when the AL is based on long-term, average health effects, is more representative than the mean when the population is skewed or contains a large number of nondetect measurements, and relies on few statistical assumptions. However, this approach may be impacted by extreme values and is still not a representative measure for highly skewed populations.

Using the upper proportion or percentile statistical parameter is useful for protection against extreme health effects, provides the best control of extreme values for highly variable populations, is useful for skewed distributions, may be appropriate for populations that contain a large number of nondetect measurements (provided the detection limit is less than the AL), and relies on few statistical assumptions. However, this approach requires larger sample sizes than the mean statistical parameter.

5.5.2 Specify the Action Level for the Study

The decision maker shall specify the AL for the study. For example, if the trichloroethene (TCE) concentration in groundwater samples exceeds the drinking water criteria of 5 micrograms per liter ($\mu\text{g/L}$), a particular action may be specified. If TCE is detectable at levels below 5 $\mu\text{g/L}$, another action may be specified. Specify the procedure for establishing background levels in this step.

5.5.3 Combine Outputs from the Previous PQO Steps into a Decision Rule

Incorporate the parameter of interest and action levels into a decision rule or an “if...then...” statement. If a parameter of interest exceeds a specified AL, then an alternative action will result. For example, if the concentration of TCE in groundwater samples exceeds 5 $\mu\text{g/L}$, then the production well that distributes this groundwater to the population for consumption will be shut off. If the production well is shut off due to elevated TCE concentrations, then remediation of groundwater may be necessary using a water treatment system.

5.6 STEP 6: SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA

When required by the project objectives, the sixth step is to specify performance or acceptance criteria. This step involves determining the possible range of the parameter of interest, defining the potential consequences of both types of decision errors, specifying a range of minor consequences for decision errors, assigning probability values to reflect the acceptable probability for decision errors to occur, and ensuring that decision errors accurately reflect consequences.

5.6.1 Determine the Possible Range of the Parameter of Interest

Determine the possible range of the parameter of interest by establishing upper and lower boundaries or control limits. Historical data may be used to establish the range of the parameter of interest. For example, the mean concentration of TCE may be between 0.5 and 10 µg/L based on quarterly groundwater sampling results. Only the range of parameters that are expected to drive risk is defined. In some instances, this will not be known and should be so stated.

5.6.2 Define the Potential Consequences of Decision Errors

Environmental sample data has inherent uncertainty associated with it. The uncertainty can be described in terms of sampling design error and measurement error. Sample design error is associated with both random and systematic errors at different stages of the sample acquisition.

Sampling design error arises when sampling plans don't allow for complete variability of the site, thus not allowing an appropriate decision to be made for the site. This type of error can result in data variability or imprecision (random error) and bias data (systematic error).

Measurement error is variability resulting from imperfections in the measurement and analysis system. This type of error is introduced during sample collection, handling, preparation, and analysis. Other contributors to measurement error include data reduction, transmission, and storage.

Sampling design error together with measurement error is defined as "total study error" or "total variability." It is necessary to manage the total study error by rigorous evaluation of the sample design and measurement systems to control decision errors to acceptable levels.

Perform the management of decision error through the use of hypothesis testing. Hypothesis testing requires that a baseline condition (i.e., contaminants are below the AL) and an alternative condition (i.e., contaminants exceed the AL) be defined. This test can be used to show that there is insufficient evidence to indicate that the baseline condition is false (acceptance that the baseline condition is true), or that the baseline condition is probably false (acceptance that the alternative condition is true). This process places the burden of proof on rejecting the baseline condition unless there is substantial evidence that the baseline condition is not true.

The two types of decision errors are false rejection errors and false acceptance errors. A false rejection error occurs when the limited amount of sample data leads to the belief that the baseline condition is probably false when it is really true. A false acceptance error occurs when the data leads to the belief that the baseline condition is true when it is really false. Define the false rejection and false acceptance errors for each decision rule and describe the potential consequences of each. For example, the baseline condition could be that a particular site has PCB contamination below AL; a false rejection error (of the baseline condition) could occur when PCB concentrations are determined to be above the AL, when the true PCB concentrations are below the AL. A false acceptance error

(of the baseline condition) could occur when the PCB concentrations are determined to be below the AL when the true PCB concentrations are above the AL. Define and evaluate the potential consequences of each of these in terms such as human health and ecological risks, economic and social costs, and political and legal ramifications.

Decision errors can never be completely eliminated from environmental investigations but they can be managed. Careful evaluation of the sampling design and measurement methods will help ensure an adequate number of samples are collected utilizing the appropriate protocol and analyzing with the appropriate technique.

A comprehensive discussion of decision errors can be found in Section 6 Specify Tolerable Limits on Decision Errors in *Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G-4*. (EPA 2006).

5.6.3 Specify a Range of Minor Consequences for Decision Errors

Specify a broad range of minor consequences or a gray region for decision errors when statistical sampling is used. The gray region is a range of possible parameter values where the consequences of false rejection or acceptance decision errors are relatively minor.

5.6.4 Assign Limits to Reflect the Acceptable Probability for Decision Errors to Occur

For statistical sampling, assign probability values to points above and below the gray region that reflect the decision maker's tolerable limits for making an incorrect decision. At a minimum, the decision maker shall specify a false rejection decision error limit at the AL and a false acceptance decision error limit at the lower end of the gray range. Aggressive identification of reasonably high levels of error is recommended because the risk assessment procedures are relatively conservative.

5.6.5 Ensure that Decision Errors Accurately Reflect Consequences

For statistical sampling programs, check the limits on decision errors to ensure that they accurately reflect the relative consequences for each type of decision error.

5.7 STEP 7: DEVELOP THE PLAN FOR OBTAINING DATA

When required by the project objectives, the seventh step of the PQO process is to develop the plan for obtaining data. This procedure involves reviewing the PQO outputs and existing environmental data, developing general sampling and analysis design alternatives, verifying that PQOs are achieved for each design, selecting the most resource-effective design that satisfies all of the PQOs, and documenting the details and assumptions in the sampling and analysis plan.

5.7.1 Review PQO Outputs and Existing Environmental Data

Review the PQO outputs from the previous steps for internal consistency. Also review existing data and identify data significant to the design.

5.7.2 Develop General Sampling and Analysis Design Alternatives

Develop general sampling and analysis design alternatives based on the PQO outputs and other relevant information. These alternatives shall be cost effective and balance the sample size and measurement performance with the sample collection techniques and analytical methods available. Factors to be considered in this step include the phase, media, sample type, number of samples,

sampling locations, analytical methods, and QA/quality control requirements. Also develop a schedule for all sampling activities. The output of this process is a well-defined WP.

For nonstatistical sampling programs, present a justification for using purposive sampling, as well as identification and rationale for using a phased approach and other sampling strategies that are somewhat unusual. Discuss alternative analytical and field sampling strategies and provide rationales for using them. Develop and describe several different sampling scenarios for statistically based plans.

5.7.3 Verify that PQOs Are Achieved for Each Design

Briefly show that the sampling design will achieve the PQOs. For statistically based plans, define a method for testing the hypothesis and a corresponding sample size formula (e.g., T-test), develop a statistical model that describes the relationship between the measured value and the true value, and develop a cost function that relates the number of samples to the total cost of sampling and analysis.

5.7.4 Select the Most Resource-Effective Design that Satisfies all of the PQOs

Evaluate each design option in order to select the most resource-effective and/or cost-effective design that satisfies all of the PQOs.

5.7.5 Document Details and Assumptions in the Work Plan

Document the operational details and theoretical assumptions of the selected design in the WP.

6. Records

None.

7. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2006. *Department of the Navy Environmental Restoration Program Manual*. Alexandria, VA: Naval Facilities Engineering Command. August.

———. 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Environmental Protection Agency, United States (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. Interim Final. EPA/540/G-89/004. Office of Emergency and Remedial Response. October.

———. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*. EPA QA/G-4. EPA/240/B-06/001. Office of Environmental Information. February.

Naval Facilities Engineering Command (NAVFAC). 2010. *NAVFAC Technology Transfer (T2) Program*.

Procedure I-A-2, *Selection of Analytes*.

Procedure I-A-4, *Site Reconnaissance*.

8. Attachments

Attachment I-A-1-1: DQO Process Using IS Approach

Attachment I-A-1-1
DQO Process Using IS Approach

This page intentionally left blank

The State of Hawaii, Department of Health, Hazard Evaluation and Emergency Response Office strongly encourages the use of incremental sampling (IS) to enhance sample representativeness in the investigation of contaminated soil (DOH 2009). IS is a structured composite sampling and processing protocol that reduces data variability and provides a reasonably unbiased estimate of mean contaminant concentrations in a volume of soil targeted for sampling. IS provides representative samples of specific soil volumes defined as decision units (DUs) by collecting numerous increments of soil (typically 30–100 increments) that are combined, processed, and subsampled according to specific protocols (DOH 2009 and ITRC 2012).

Similar to other sampling designs, systematic planning must be conducted and used to develop the scope of the investigation. The following subsections detail the steps needed to complete the data quality objective (DQO) process (EPA 2006) as they apply to IS investigations.

1. Define the problem that is prompting the investigation. This step should include:
 - A description of the problem
 - Development of a conceptual site model for the issue being investigated
 - Identification of the types of data needed along with alternative approaches
 - Identification of planning team members
 - A schedule, including constraints and deadlines, for the project
2. Identify the goals of the investigation. This step should include identification of the principle study questions (PSQs) and alternative outcomes for each PSQ. Decision statements can then be written based on the PSQs and various outcomes.
3. Identify what information is needed to address the problem statement and associated PSQs. This should include the environmental parameters or characteristics (i.e., data) that will be needed to answer the questions being asked at a site. The data could be historical or it could be that new, better, or additional data is needed. This should be identified in the sampling plan. Details of the specific data may include, but are not limited to the following:
 - Chemical parameters
 - Physical parameters
 - How many DUs
 - What size DUs are needed
 - How many replicate samples are needed
 - How many increments per sample are necessary (Anything less than 30 increments should have a full justification)

Also included in this section is the type of data needed to meet the performance criteria for the site. The number and location of DUs proposed for field replicate sampling and the number of replicates for those DUs must be included. In addition to the field replicates, it must be determined whether laboratory replicates should be collected on the project. Laboratory replicates are used to determine the source of sampling error (i.e., field or laboratory) once your data is received from the laboratory.

4. Define the boundaries of the investigation. There is typically a spatial and temporal boundary for the investigation. This is where the target population of interest is identified which informs the size and thickness of the DUs, which is identified here. Also included in this section is the smallest unit on which decisions will be made. This is normally equal to the size of your DUs. Lastly, factors or site features that restrict the ability to collect all the data specified in step three above, should be identified here. These are usually access limitations, either physical or legal.
5. This section should introduce the decision rules for the investigation. These are comprised of a series of “if...then” statements. These if/then statements will be generated using the action level or screening criteria selected for the project and identified in your Uniform Federal Policy for Quality Assurance Project Plans Sampling and Analysis Plan (SAP).
6. This step should specify the acceptance criteria for the study. Acceptance criteria will typically be based on an evaluation of the total study error, which includes the field sampling error and the total laboratory error. The total study error is measured using the relative standard deviation (RSD) of the field replicates. The acceptance criterion should be an RSD less than or equal to 35 percent RSD. If the data do not meet this criterion, they will have to be evaluated further by the project stakeholders to decide whether the DQOs have been met. One factor for evaluating the data is whether the result is within an order of magnitude of the screening level. Data more than an order of magnitude from the screening level are unlikely to be affected sufficiently to prevent a good decision from being made. Another method to assist stakeholders with data that don't meet the acceptance criterion is to calculate a 95 percent upper confidence limit (UCL). Use of the 95 percent UCL rather than the laboratory reported value will give an additional level of confidence to decision makers that the reported values are protective of the receptors. In addition to the acceptance criterion, the detection limit, limit of detection, and limit of quantitation for the various analytes needed to achieve the performance objectives for the project should be provided in Worksheet #15 of the SAP.
7. The last step must include a compilation of all the information generated in the first six steps. This information should then be used to identify alternative sampling and analysis designs that meet the project objectives. This section should lay out how the samples will be collected, the size, shape, and depth of the DUs, reference to the sampling procedures that will be followed, the sampling instruments that will be used as well as the laboratory containers that will be used to send samples to the laboratory for analysis. Also, reference to the laboratory processing and sub-sampling procedures should be documented in this section. If the soil type at the site is unknown, it is recommended that at least one backup type of sampling tool be kept available in case the primary tool proves unusable for some reason. For instance, if the SAP called for a hand tool (e.g., slide hammer driven soil corer) and the soil turns out to be very hard, the project team should have a backup method to collect the increments such as some kind of power tool or direct push rig.

DU size, depth, and location will determine whether the data is able to satisfy your project objectives. It is imperative that your DUs are suitable for achieving these project objectives.

Things to consider when deciding DU size:

- If you need to make a decision about whether unrestricted use is appropriate for a site, then the DUs should be no larger than 5,000 square feet (default residential lot in Hawaii) unless regulators and Navy agree it can be larger.
- If commercial/industrial use is intended, then DUs can be larger than 5,000 square feet. The size of DUs should be agreed upon by project stakeholders upfront in the planning phase (e.g., SAP or work plan). Also, any land use other than unrestricted use will require LUCs on the property.
- Depending on the needs or goals of the investigation, DUs can be reduced in size to whatever is needed (e.g. DUs for remediation or confirmation sampling).
- Involve a risk assessor if risk assessment is planned with the data. You will need to determine what receptors and pathways will be evaluated in the risk assessment and the data must be able to satisfy those objectives. Risk assessment needs will often impact the size, location, and depth of your DUs.

Things to consider when deciding where to place DUs (Many of these same criteria should also be used to determine which DUs should have replicate samples collected, when less than 100 percent of the DUs will have replicate samples collected):

- Evaluate historical land use.
- Evaluate site features such as geology to identify different soil types or possible transport mechanisms.
- Identify potential source areas (current and past).
- Evaluate fate and transport properties of the chemicals of potential concern.
- Evaluate existing sampling data from the site.
- Consult a risk assessor if the data will be used in a risk assessment. Again, receptors and pathways must be evaluated to ensure the DUs will provide data to meet the risk assessment and project objectives. Risk assessors can also provide input on which DUs and how many should have replicate samples collected.
- Evaluate site access restrictions due to current site use that could affect where DUs are placed.

References

- Department of Health, State of Hawaii (DOH). 2009. *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*. Interim Final. Honolulu: Office of Hazard Evaluation and Emergency Response. 21 June. <http://www.hawaiidoh.org/tgm.aspx>.
- Environmental Protection Agency, United States (EPA). 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*. EPA QA/G-4. EPA/240/B-06/001. Office of Environmental Information. February.
- Interstate Technology and Regulatory Council (ITRC). 2012. *Incremental Sampling Methodology*. February.

This page intentionally left blank

Utility Clearance

1. Purpose

This standard operating procedure describes the process for determining the presence of subsurface utilities and other cultural features at locations where planned site activities involve the physical disturbance of subsurface materials. The procedure applies to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring and extraction wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities. The primary purpose of the procedure is to minimize the potential for damage to underground utilities and other subsurface features, which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.

2. Scope

This procedure applies to all United States Navy Environmental Restoration (ER) Program projects performed in the Naval Facilities Engineering Command, Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 UTILITY

For this procedure, a utility is defined as a manmade underground line or conduit, cable, pipe, vault or tank that is, or was, used for the transmission of material or energy (e.g., gas, electrical, telephone, steam, water or sewage, product transfer lines, or underground storage tanks).

3.2 AS-BUILT PLANS

As-built plans are plans or blueprints depicting the locations of structures and associated utilities on a property.

3.3 ONE-CALL

The Utility Notification Center is the one-call agency for Oregon, Washington, Montana, and Hawaii. The Utility Notification Center is open 24 hours a day, and accepts calls from anyone planning to dig in. The phone number for the Hawaii One Call Center is 1-866-423-7287 (or 811). Additional information can be found at <http://www.callbeforeyoudig.org/hawaii/index.asp>.

Calling before you dig ensures that any publicly owned underground lines will be marked, so that you can dig around them safely. Having the utility lines marked not only prevents accidental damage to the lines, but prevents property damage and personal injuries that could result in breaking a line.

The following information will need to be provided when a request is placed to One-Call:

- Your name, phone number, company name (if applicable), and mailing address.
- What type or work is being done. This should be a description of the specific reason for the work, not the method used.
- Who the work is being done for.
- The county and city the work is taking place in.
- The address or the street where the work is taking place.
- Marking instructions, (specific instructions as to where the work is taking place).

Under normal circumstances it takes between 2 days to 5 days from the time you call (not counting weekends or holidays) to have the underground lines marked. Because these laws vary from state to state, exactly how long it will take depends on where your worksite is located. You will be given an exact start time and date when your locate request is completed, which will comply with the laws in your area.

In the event of an emergency (any situation causing damage to life or property, or a service outage), lines can be marked sooner than the original given time if requested, but must be handled via voice contact with One-Call.

3.4 TONING

Toning is the process of surveying an area utilizing one or more surface geophysical methods to determine the presence or absence of underground utilities. Typically, toning is conducted after identifying the general location of utilities and carefully examining all available site utility plans. Each location is marked according to the type of utility being identified. In addition, areas cleared by toning are flagged or staked to indicate that all identified utilities in a given area have been toned.

4. Responsibilities

The prime contractor CTO Manager is responsible for verifying that these utility locating procedures are performed prior to the initiation of active subsurface exploration. The CTO Manager is responsible for ensuring that all personnel involved in sampling and/or testing shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The onsite Field Manager (FM) and Site Safety and Health Officer (SSHO) are responsible for planning utility clearance and for locating and marking underground utilities according to this procedure.

Field personnel are responsible for the implementation of this procedure.

5. Procedures

Follow the following steps at all sites where subsurface exploration will include excavations, drilling, or any other subsurface investigative method that could damage utilities at a site. In addition to the steps outlined below, always exercise caution while conducting subsurface exploratory work.

5.1 PREPARE PRELIMINARY SITE PLAN

Prepare a preliminary, scaled site plan depicting the proposed exploratory locations as part of the work plan. Include as many of the cultural and natural features as practical in this plan.

5.2 REVIEW BACKGROUND INFORMATION

Search existing plan files to review the as-built plans and available geographic information system databases to identify the known location of utilities at the site. In addition, the contractor should contact the Navy RPM to obtain the most updated GIS layers. Plot the locations of utilities identified onto a preliminary, scaled site plan. Inform the CTO Manager if utilities lie within close proximity to a proposed exploration or excavation location. The CTO Manager will determine if it is necessary to relocate proposed sampling or excavation locations.

Include the utility location information gathered during investigation (e.g., remedial investigation or remedial site evaluation) work in the project design documents for removal or remedial actions. In this manner, information regarding utility locations collected during implementation of a CTO can be shared with the other contractors during implementation of a particular task order. In many instances, this will help to reduce the amount of additional geophysical surveying work the other contractor may have to perform.

Conduct interviews with onsite and facility personnel familiar with the site to obtain additional information regarding the known and suspected locations of underground utilities. In addition, if appropriate, contact shall be made with local utility companies to request their help in locating underground lines. Pencil in the dimensions, orientation, and depth of utilities, other than those identified on the as-built plans, at their approximate locations on the preliminary plans. Enter the type of utility, the personnel who provided the information, and the date the information was provided into the field log.

During the pre-fieldwork interviewing process, the interviewer will determine which site personnel should be notified in the event of an incident involving damage to existing utilities. Record this information in the field logbook with the corresponding telephone numbers and addresses.

5.3 DIG PERMIT

Prior to all activities requiring excavation work that may disrupt utility services, vehicular or aircraft traffic flow, protection provided by fire and intrusion alarm systems, or routine activities at Navy bases (including Joint Base Pearl Harbor-Hickam and Naval Base Guam), as well as intrusive work at Marine Corps Base Hawaii, current procedures shall be followed. The dig permit process tries to identify, as much as practical, any known, potentially hazardous work condition related to excavation activities and is intended to prevent accidents. It also informs key Navy personnel of the digging work and coordinates the required work with these activities to minimize inconveniences (JBPHH 2013).

5.4 SITE VISIT – LOCATE UTILITIES – TONING

Prior to the initiation of field activities, the field task manager or similarly qualified staff personnel shall visit the site and note existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depression. Compare notes of the actual site configuration to the preliminary site plan. Note deviations in the field logbook and on the preliminary site plan. Accurately locate or survey and clearly mark with stakes, pins, flags, paint, or other suitable devices all areas where subsurface exploration is proposed. These areas shall correspond with the locations drawn on the preliminary site plan.

Following the initial site visit by the FM, a trained utility locator will locate, identify, and tone all utilities depicted on the preliminary site plan. The locator should use appropriate sensing equipment to attempt to locate utilities that might not have appeared on the as-built plans. This may involve the use of surface geophysical methods (Procedure I-B-2, *Geophysical Testing*). At a minimum, use a utility locator, metal detector, and/or magnetometer; however, it is important to consider the possibility that non-metallic utilities or tanks might be present at the site. Use other appropriate surface geophysical methods, such as Ground Penetrating Radar, if non-metallic cultural features are likely to be present at the site. Clear proposed exploration areas of all utilities in the immediate area where subsurface exploration is proposed. Clearly tone all anomalous areas. Clearly identify all toned areas on the preliminary site plan. After toning the site and plotting all known or suspected buried utilities on the preliminary site plan, the utility locator shall provide the FM with a copy of the completed preliminary site plan. Alternatively, the FM or designee shall document the results of the survey on the preliminary site plan.

Report to the FM anomalous areas detected and toned that are in close proximity to the exploration or excavation areas. The FM shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate proposed exploration or excavation areas. If this is required, the FM or a similarly qualified individual shall relocate them and clearly mark them using the methods described above. Completely remove the markings at the prior location. Plot the new locations on the site plan and delete the prior locations from the plan. In some instances, such as in areas extremely congested with subsurface utilities, it may be necessary to dig by hand to determine the location of the utilities.

5.5 PREPARE SITE PLAN

Prior to the initiation of field activities, draft a final site plan that indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Provide copies of this site plan to the Contracting Officer's Representative (COR), the CTO Manager, and the subcontractor who is to conduct the subsurface exploration/excavation work. Review the site plan with the COR to verify its accuracy prior to initiating subsurface sampling activities.

6. Records

Keep a bound field logbook detailing all activities conducted during the utility locating procedure. The logbook will describe any changes and modifications made to the original exploration plan. The trained utility locator shall prepare a report and keep it in the project file. Also keep a copy of the final site plan on file.

7. Health and Safety

Field personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Joint Base Pearl Harbor-Hickam (JBPHH). 2013. *Dig Permit Requests*. JBPHH Instruction 11013.1. 15 March 2013.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-B-2, *Geophysical Testing*.

9. Attachments

None.

This page intentionally left blank

Investigation-Derived Waste Management

1. Purpose

This standard operating procedure describes the activities and responsibilities of the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific with regard to management of investigation-derived waste (IDW). The purpose of this procedure is to provide guidance for the minimization, handling, labeling, temporary storage, inventory, classification, and disposal of IDW generated under the ER Program. This procedure will also apply to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste generated during implementation of removal or remedial actions. The information presented will be used to prepare and implement work plans (WPs) for IDW-related field activities. The results from implementation of WPs will then be used to develop and implement final IDW disposal plans.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

This procedure focuses on the requirements for minimizing, segregating, handling, labeling, storing, and inventorying IDW in the field. Certain drum inventory requirements related to the screening, sampling, classification, and disposal of IDW are also noted in this procedure.

3. Definitions

3.1 IDW

IDW consists of all materials generated during site investigations that might be contaminated with chemicals of concern. IDW might consist of many types of potentially contaminated materials, including but not limited to, PPE, disposable sampling and decontamination equipment, investigation-derived soil, sludge, and sediment, well development and purge water, and decontamination fluids.

3.2 PPE

PPE, as defined in this procedure, refers to all disposable materials used to protect personnel from contact with potentially contaminated site media, such as inner and outer gloves, Tyvek suits and overboots, and disposable respirator cartridges. Non-consumable items, such as steel-toe boots, respirators, and hard hats are not included in this procedure.

3.3 DISPOSABLE SAMPLING EQUIPMENT

Disposable sampling equipment consists of all single-use equipment that might have come in contact with potentially contaminated site media, including sample bailers, Draeger air monitoring tubes, used soil sampling trowels and spatulas, plastic drop cloths, plastic bags and bucket liners, and sample containers from field analytical test kits.

3.4 INVESTIGATION-DERIVED SOIL, SLUDGE, AND SEDIMENT

Investigation-derived soil consists of all potentially contaminated soil that is disturbed as part of site investigation activities. The most commonly encountered form of IDW soil is drill cuttings brought to the ground surface by drilling. Other forms of disturbed soil, including trenching spoils and excess soil remaining from surface sampling, should not be stored as IDW. Excavated soil should be returned to its source if site conditions permit.

Investigation-derived sludge consists of all potentially contaminated sludge materials generated or disturbed during site investigation activities. Generated sludge might consist of drilling mud used or created during intrusive activities. Other sludge might include solvents or petroleum-based materials encountered at the bottom of storage tanks and grease traps.

Investigation-derived sediment consists of all potentially contaminated sediments that are generated or disturbed during site investigation activities. Generated sediments might include solids that settle out of suspension from well development, purge, or decontamination water (see Definitions 3.5 and 3.6) while stored in 55-gallon drums or during sample filtration. Disturbed sediments might also consist of catch basin sediments or excess sediment from surface water activities.

3.5 WELL DEVELOPMENT AND PURGE WATER

Development water consists of groundwater withdrawn from newly installed monitoring wells in preparation for well purging or pump testing. Monitoring well development methods are discussed in Procedure I-C-2, *Monitoring Well Development*.

Purge water consists of groundwater that is removed from monitoring wells immediately prior to sampling. Well purging methods are discussed in Procedure I-C-3, *Monitoring Well Sampling*. Groundwater derived during aquifer testing shall be addressed on a site-specific basis. Procedures for handling groundwater generated during aquifer testing shall be included in the WP or equivalent document for the CTO.

3.6 DECONTAMINATION FLUIDS

Decontamination fluids consist of all fluids used in decontamination procedures conducted during site investigation activities. These fluids consist of wash water, rinse water, and solvents used for the decontamination of non-consumable PPE, sampling equipment, and drilling equipment. Decontamination procedures are discussed in Procedure I-F, *Equipment Decontamination*.

3.7 NON-IDW TRASH

Non-IDW trash is all waste materials, such as waste paper, drink containers, food, and packaging, generated in the support zone that have not come in contact with potentially contaminated site media.

3.8 NON-INDIGENOUS IDW

Non-indigenous IDW consists of all waste materials from offsite sources that are generated in the transition or contamination reduction zones and have not come in contact with potentially contaminated site media. Non-indigenous IDW includes materials, such as PPE from “clean” field activities (e.g., field blank generation, water sampling events) and refuse from monitoring well installation (e.g., unused sections of well casing, used bentonite buckets, sand bags, and cement bags).

Non-indigenous waste does not include material/waste that is abandoned at the ER site (including the IDW waste storage area) by other parties not associated with the ER work. Disposal of abandoned material/waste in the vicinity of IDW is the responsibility of the property owner (e.g., Navy Region Hawaii) or party responsible for abandoning the material/waste. The ER contractor shall notify the Contracting Officer’s Representative (COR) of the situation as soon as possible so that recovery actions can be coordinated by the Government.

3.9 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) HAZARDOUS WASTE

Under the RCRA, a solid waste that is not excluded from regulation is defined as hazardous if it:

- Is “listed” as a hazardous waste in Chapter 40, Code of Federal Regulations (CFR), Parts 261.31 through 261.33
- Exhibits any of four hazardous “characteristics”—ignitability, corrosivity, reactivity, or toxicity (as determined using the Toxicity Characteristic Leachate Procedure [TCLP]) (40 CFR 261.20-24)
- Is subject to certain “mixture” or “derived-from” rules (40 CFR 261.3).

Under certain circumstances, petroleum- or polychlorinated biphenyl (PCB)-contaminated wastes are not considered RCRA hazardous when they only exhibit toxicity characteristic (40 CFR 261.4(b)(10) and 261.8). If IDW is determined to be RCRA hazardous waste, then RCRA storage, transport, and disposal requirements shall apply unless exempt.

3.10 RCRA LAND DISPOSAL RESTRICTIONS (LDR)

Land disposal, as defined in RCRA, is any placement of RCRA hazardous waste on the land in a waste pile, landfill, impoundment, well, land treatment area, etc. LDRs are regulatory restrictions placed on land disposal, including pre-treatment standards, engineered containment, capacity constraints, and reporting and permitting requirements.

3.11 AREA OF CONTAMINATION (AOC)

The U.S. Environmental Protection Agency (EPA) considers the RCRA AOC to be a single land-based disposal unit, usually a “landfill,” and includes non-discrete land areas in which there is generally dispersed contamination. Storing IDW in a container (i.e., portable storage devices, such as drums and tanks) within the AOC and returning it to its source, whether RCRA hazardous or not, does not trigger RCRA LDRs. In addition, sampling and direct replacement of wastes within an AOC do *not* constitute land disposal.

3.12 CERCLA HAZARDOUS SUBSTANCES

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances are listed in 40 CFR Table 302.4 and include substances regulated by the RCRA Subtitle C, Clean Water Act (CWA), Clean Air Act (CAA), and Toxic Substances Control Act (TSCA). The CFR is updated annually; therefore, the most recent CFR should be referenced for the CERCLA hazardous waste list.

CERCLA hazardous substances are defined independent of their concentration level (i.e., any detection of a listed CERCLA constituent is considered a “CERCLA hazardous substance”). “Reportable quantities” identified for chemicals in 40 CFR Table 302.4 concern only CERCLA and RCRA requirements for notification to EPA when a release has occurred; they do not dictate whether a chemical is a hazardous substance.

The definition of CERCLA hazardous substances excludes “petroleum, including crude oil or any fraction thereof;” natural gas; natural gas liquids; liquefied natural gas; and synthetic gas usable for fuel, unless specifically listed or designated under the act. Excluded fractions of crude oil contain hazardous substances, such as benzene, that are indigenous in those petroleum substances or that are normally mixed with or added to petroleum during the refining process. However, hazardous substances that are (1) added to petroleum after the refining process, (2) increase in concentration as a result of contamination of the petroleum during use, or (3) commingled with petroleum after a release to the environment, are not considered part of the petroleum exclusion provision, and therefore, are regulated under CERCLA. In addition, some waste oils are regulated under CERCLA because they are specifically listed.

The scope of CERCLA hazardous substances includes the smaller subsets of RCRA hazardous wastes, PCB Aroclors, and other constituents. Therefore, a RCRA hazardous waste is always considered a CERCLA hazardous substance for a CERCLA-driven response action; however, a CERCLA hazardous substance is not always a RCRA hazardous waste.

CERCLA only regulates releases or threats of releases of hazardous substances into the environment. If there is no evidence that (1) a release has occurred (based on site history, visual observations, background metals evaluation), (2) there is a threat of release (as from abandoned, discarded, or non-maintained chemical receptacles), or (3) the release has entered the environment (as defined below), then CERCLA does not regulate the constituent even though it is identified on the CERCLA hazardous substance list.

3.12.1 CERCLA Hazardous Substances: TSCA/PCBs

PCBs are a CERCLA hazardous substance. PCBs belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned in 1979. They have a range of toxicity and vary in consistency from thin, light-colored liquids to yellow or black waxy solids. Due to their non-flammability, chemical stability, high boiling point, and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications. Although no longer commercially produced in the United States, PCBs may be present in products and materials produced before the 1979 PCB ban.

If PCBs are detected at concentrations equal to or greater than 50 parts per million (ppm), the sample is considered TSCA-regulated. Current PCB regulations can be found in the CFR at 40 761. The EPA Q and A Manual (EPA 2009), referring to CFR 761.61 explains PCB remediation waste must be managed and disposed of based on the concentration at which the PCBs are found. It is unacceptable to dilute the as-found concentration of the contaminated soil by mixing it with clean soil during excavation or other IDW management activities.

3.13 ENVIRONMENT

Environment means navigable waters, ocean waters, surface water, groundwater, drinking water supply, land surface or subsurface strata, and ambient air, within the U.S. or under federal jurisdiction (see Section 101(8) of CERCLA or 40 CFR 300.5 for complete definition).

3.14 ONSITE AREA

The CERCLA onsite area is defined in 40 CFR 300.400(e)(1) as an area that includes:

- AOC
- All suitable areas in very close proximity to the contamination that are necessary for the implementation of the response action

The delineation of the onsite area is further discussed in Volume 55 Federal Register (FR) Page 8688 and EPA guidance.

Neither CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan, nor RCRA define the terms “area of contamination” or “contamination.” However, the area of contamination is interpreted as containing “varying types and concentrations of contaminants” (55 FR 8760) that may or may not pose a risk to human health or the environment.

The onsite area may also include several noncontiguous aerial extents of contaminations if they share a common nexus (55 FR 8690).

3.15 OFFSITE AREA

The offsite area consists of all areas outside the onsite area.

3.16 CERCLA OFFSITE RULE

The CERCLA offsite rule (400 CFR 300.440) states that IDW containing CERCLA hazardous substances (at any concentration) must be stored, treated, or disposed of offsite only at facilities having current EPA approval to accept such CERCLA wastes. RCRA-permitted facilities (Subtitle C and D) must also have specific EPA approval to accept waste generated at a CERCLA site (even if the waste is RCRA hazardous).

With some restrictions, the offsite rule does not apply to the following:

- Wastes generated during non-CERCLA actions
- Treatability study samples

- Wastes generated during emergency response actions
- Laboratory samples

CERCLA allows IDW to be managed, stored, and disposed of onsite within or near the AOC without the need for EPA approval (i.e., CERCLA facility approval) or RCRA permits. If IDW is to be stored or disposed of on site, the onsite area (and the AOC) should be delineated on a figure in the project field book and revised, based on best professional judgment, as site data become available.

4. Responsibilities

The prime contractor CTO Manager is responsible for preparing WPs and IDW disposal plans and reports in compliance with this procedure, and is responsible for documenting instances of noncompliance. The CTO Manager is responsible for ensuring that all personnel involved in sampling and/or testing shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager is responsible for implementing this IDW procedure and ensuring that all project field staff follow these procedures.

Field personnel are responsible for the implementation of this procedure.

5. IDW Management Procedures

The procedures for IDW management in the field are described below.

5.1 PLANNING FOR IDW MANAGEMENT

The project team should begin planning for IDW issues early in the site investigation planning stage. The proper management of IDW involves all of the following tasks:

- Obtain Navy approval for a designated IDW storage area prior to commencement of field work
 - Complete Navy form, including IDW Tracking Sheet and provide to remedial project manager (RPM) for processing
- Waste generation and minimization
- Chemical screening and characterization of the waste
- Waste handling, storage, and associated maintenance in compliance with all regulations (prepare an IDW drum inventory, ensure storage areas are compliant with type of waste [double containment, TSCA requirements, etc.] maintain condition of drum and labeling, maintain safety and assess controls, comply with permit requirements [for offsite storage])
- Waste transport and disposal within required holding times
- Waste tracking, documentation, record keeping, and reporting

As part of IDW planning, the CTO Manager should consult with the COR and environmental regulatory agencies to clearly identify the primary federal or state regulatory authority that is driving the site investigation. This authority may be CERCLA, RCRA (Subtitle C), RCRA (subtitle D), TSCA, CWA, or an equivalent state program. The primary investigation authority and regulations promulgated under this authority set forth requirements for IDW management. These requirements may differ under the various response authorities. For CERCLA-driven actions, IDW storage and disposal should comply with all applicable or relevant and appropriate requirements (ARARs) and to-be-considered (TBC) criteria to the extent practicable.

Lastly, the CTO Manager should consider the disposal criteria of the anticipated disposal facility when developing the sampling and analysis plan (SAP). Some offsite facilities do not accept waste that is characterized by association with samples collected from the investigation site or they may require analytical data for chemicals that are not of potential concern at the site. Facility disposal criteria may dictate laboratory reporting limits.

If unknown waste is observed onsite, notify the project RPM and COR for further instructions.

5.2 IDW MINIMIZATION

Field managers (FMs) and their designates shall minimize the generation of onsite IDW to reduce the need for special storage or disposal requirements that might result in substantial additional costs and provide little or no reduction in site risks (EPA 1992b). Reduce the volume of IDW by applying minimization practices throughout the course of site investigation activities. These minimization strategies include substitution of biodegradable raw materials; using low-volume IDW-generating drilling techniques; where possible, returning excess material to the source location; using disposable sampling equipment versus generating more decontamination fluids from reusable sampling equipment; using bucket and drum liners; and separating trash from IDW.

Material substitution consists of selecting materials that degrade readily or have reduced potential for chemical impacts to the site and the environment. An example of this practice is the use of biodegradable detergents (e.g., Alconox or non-phosphate detergents) for decontamination of non-consumable PPE and sampling equipment. In addition, field equipment decontamination can be conducted using isopropyl alcohol rather than hexane or other solvents (for most analytes of concern) to reduce the potential onsite chemical impacts of the decontamination solvent. Select decontamination solvents carefully so that the solvents, and their known decomposition products, are *not* potentially RCRA hazardous waste, unless absolutely necessary.

Give priority to drilling methods that minimize potential IDW generation. Select hollow-stem auger and air rotary methods, where feasible, over mud rotary methods. Mud rotary drilling produces waste drilling mud, while hollow stem and air rotary drilling methods produce relatively low volumes of soil waste. Use small-diameter borings and cores when soil is the only matrix to be sampled at the boring location; however, the installation of monitoring wells requires the use of larger-diameter borings.

If possible, return soil, sludge, or sediment removed from borings, containment areas, and shallow test trenches to the source immediately after sampling and/or geological logging of the soils (EPA 1991, 1992b). Immediate replacement of solid waste in the source location during investigation activities avoids RCRA LDRs, which permit movement of IDW within the same AOC without considering land disposal to have occurred, even if the IDW is later determined to contain RCRA

hazardous material (EPA 1991). Place soil IDW from borings and trenches on polyethylene sheeting (e.g., Visqueen) during excavation and segregate it by approximate depth and any apparent contamination (i.e., visible staining). Following excavation, replace the soil IDW from above the saturated layer into the boring or trench and compact it, if possible. Efforts should be made to return the waste to the approximate depth from which it was generated. Soil and sludge IDW generated at or below the saturated layer of a boring or trench should be placed in drums and not returned to the source area. Suspected contaminated soil and sludge IDW generated above the saturated layer of a boring or trench should not be returned below the saturated layer.”

Often monitoring wells are constructed outside the area of concern for soil contamination to sample for potential groundwater contamination or collect characteristic background data. At these locations, soil cuttings generated from above the saturation zone may be immediately disposed of near the wellhead in a shallow pit covered with natural topsoil from the site, and compacted. Contain soil and sludge IDW generated at or below the saturated layer in drums.

Reduce the quantity of decontamination rinse water generated by using dedicated and disposable sampling equipment, such as plastic bailers, trowels, and drum thieves that do not require decontamination. In general, decontamination fluids, and well development and purge water should not be minimized because the integrity of the associated analytical data might be affected.

Minimize the storage of visibly soiled PPE and disposable sampling equipment IDW by implementing decontamination procedures. If, based upon the best professional judgment of the FM, the PPE and disposable sampling equipment can be rendered non-contaminated after decontamination, then double-bag the PPE and disposable sampling equipment and dispose of it off site at a (RCRA Subtitle D) municipal solid waste disposal facility at the end of each work day (EPA 1991, 1992b). Since the decontaminated waste does not contain CERCLA hazardous substances, it need not be disposed of at a CERCLA-approved disposal facility in accordance with the CERCLA offsite rule.

Bucket liners can be used in the decontamination program to reduce the volume of solid IDW generated, and reduce costs on larger projects. The plastic bucket liners can be crushed into a smaller volume than the buckets, and only a small number of plastic decontamination buckets are required for the entire project. The larger, heavy-duty, 55-gallon drum liners can be used for heavily contaminated IDW to provide secondary containment, and reduce the costs of disposal and drum recycling. Drum liners may extend the containment life of the drums in severe climates and will reduce the costs of cleaning out the drums prior to recycling.

All waste materials generated in the support zone are considered non-IDW trash. To minimize the total volume of IDW, separate all trash from IDW, seal it in garbage bags, and properly dispose of it off site as municipal waste at the end of each work day.

Keep excess cement, sand, and bentonite grout prepared for monitoring well construction to a minimum. FMs shall observe well construction to ensure that a sufficient, but not excessive, volume of grout is prepared. Some excess grout may be produced. Unused grout (that should not come in contact with potentially contaminated soil or groundwater) shall be considered non-hazardous trash, and the drilling subcontractor shall dispose of it off site. Surplus materials from monitoring well installation, such as scrap plastic sections, used bentonite buckets, and cement/sand bags that do not

come in contact with potentially contaminated soil, shall be considered non-IDW trash, the drilling subcontractor shall dispose of it off site.

Following proper segregation procedures, as discussed in the next section, can minimize the quantity of contaminated IDW generated.

5.3 SEGREGATION OF IDW BY MATRIX AND LOCATION

It is necessary to properly segregate IDW in order to:

- Avoid commingling contaminated waste with clean waste, thereby creating a larger volume of waste that must be treated as contaminated
- Facilitate the sampling, screening, classification, and disposal of waste that may require different management methods

Take efforts to segregate IDW even when these activities will increase storage container and storage space requirements. These efforts will drastically reduce the sampling and documentation required for characterizing the waste and their associated costs.

In general, segregate IDW by matrix and source location and depth at the time it is generated. IDW from only one matrix shall be stored in a single drum (e.g., soil, sediment, water or PPE shall *not* be mixed in one drum). Groundwater and decontamination water should not be commingled; however, development and purge water from the same well may be stored together.

In general, IDW from separate sources should not be combined in a single drum or stockpile. Take efforts to segregate waste by increments of depth below ground surface. Most importantly, segregate soil IDW generated at or from below the saturated zone from soil generated above this zone (soil below this zone might be impacted by contaminated groundwater, whereas soil above the zone may be “clean”). Similarly, segregate soil above and below an underground storage tank (UST). Label each drum of soil to indicate the approximate depth range from which it was generated; this task may require cuttings to be segregated on plastic sheeting as they are generated or drums to be filled during the trenching or boring operation if this can be done in a safe manner.

It is possible that monitoring well development and purge water will contain suspended solids, which will settle to the bottom of the storage drum as sediment. Include significant observations on the turbidity or sediment load of the development or purge water in the logbook see Procedure III-D, *Logbooks* and Section 5.5). To avoid mixed matrices in a single drum (i.e., sediment and water), it may be necessary to decant the liquids into a separate drum after the sediments have settled out. This segregation may be accomplished during subsequent IDW sampling activities or during consolidation in a holding tank prior to disposal.

Place potentially contaminated well construction materials in a separate drum. No soil, sediment, sludge, or liquid IDW shall be placed in drums with potentially contaminated waste well construction materials. In addition, potentially contaminated well construction materials from separate monitoring wells shall not be commingled.

Store potentially contaminated PPE and disposable sampling equipment in drums separate from other IDW. Segregate PPE from generally clean field activities, such as water sampling, from visibly

soiled PPE, double-bag it, and dispose of it off site as municipal waste. Disposable sampling equipment from activities, such as soil, sediment, and sludge sampling, includes plastic sheeting used as liner material in containment areas around drilling rigs and waste storage areas, disposable sampling equipment, and soiled decontamination equipment. If, according to the Field Manager's best professional judgment, the visibly soiled PPE can be decontaminated and rendered non-hazardous, then double-bag the decontaminated PPE and disposed of it off site as municipal waste (EPA 1991, 1992b). PPE and disposable sampling equipment generated on separate days in the field may be combined in a single drum, provided clean and visibly soiled IDW are segregated as discussed above.

IDW generated from the use of field analytical test kits consists of those parts of the kit that have come into contact with potentially contaminated site media, and used or excess extracting solvents and other reagents. Contain potentially contaminated solid test kit IDW in plastic bags and store it with contaminated PPE or disposable sampling equipment IDW from the same source area as soil material used for the analyses. Segregate the small volumes of waste solvents, reagents, and water samples used in field test kits, and dispose of it accordingly (based upon the characteristics of the solvents as described in this procedure). Most other test kit materials should be considered non-IDW trash, and be disposed of as municipal waste.

Store decontamination fluids in drums separate from groundwater and other IDW. If practical, decontamination fluids generated from different sources should not be stored in the same drum. If decontamination fluids generated over several days or from different sources are stored in a single drum, record information about the dates and IDW sources represented in the drum. Note this information in the field notebook, on the drum label (Section 5.4.3), and in the drum inventory (Section 5.5).

The FM and designated personnel should separate the liquid and sediment portions of the equipment decontamination fluid present in the containment unit used by the drilling or excavation field crew. The contents of this unit normally consist of turbid decontamination fluid above a layer of predominantly coarse-grained sediment. When the contents of the containment unit are to be removed for storage in IDW drums, the FM shall instruct the field crew to place as much of the liquid into drums as possible and transfer the remaining solids into separate drums. Note observations of the turbidity and sediment load of the liquid IDW in the field notebook, on the drum label (Section 5.4.3), and in attachments to the drum inventory (Section 5.5). It is likely that decontamination fluids will contain minor amounts of suspended solids that will settle out of suspension to become sediment at the bottom of IDW storage drums. As noted above, it may be necessary to segregate the drummed water from sediment during subsequent IDW sampling or disposal activities.

Documentation for waste storage containers should include IDW source and segregation information and be maintained as follows:

1. Field logbook should be updated, at least weekly, with all IDW drum additions – update storage area location map to include new drum position and drum number.
2. External drum log (hard copy and electronic copy) should be updated with each IDW drum addition (drum numbers, source, and generation date) and closure of drum (fill date).

5.4 DRUM FILLING, HANDLING, AND LABELING, AND INVENTORYING

Drum handling consists of those actions necessary to prepare an IDW drum for labeling. Drum labeling consists of those actions required to legibly and permanently identify the contents of an IDW drum.

5.4.1 Drum Filling

Each drum of solid IDW shall be completely filled, when possible. For liquid IDW, drums should be left with headspace of approximately 5 percent by volume to allow for expansion of the liquid and potential volatile contaminants.

5.4.2 Drum Handling

IDW shall be containerized using U.S. Department of Transportation-(DOT) approved drums. The drums shall be made of steel or plastic, have a 55-gallon capacity, be completely painted or opaque, and have removable lids (i.e., United Nations Code 1A2 or 1H2). Drums having removable lids with bung holes are preferred to facilitate verification of drum contents. Typically 55-gallon drums are used, however small drums may be used depending on the amount of waste generated. New steel drums are preferred over recycled drums. Recycled drums should not be used for hazardous waste, PCBs or other regulated shipments. For short-term storage of liquid IDW prior to discharge, double-walled bulk steel or plastic storage tanks may be used. For this scenario, consider the scheduling and cost-effectiveness of this type of bulk storage, treatment, and discharge system versus longer-term drum storage.

The Guam Environmental Protection Agency may require double-walled drums or other secondary containment for the storage of liquid IDW. For long-term IDW storage at other project locations, the DOT-approved drums with removable lids are recommended. Verify the integrity of the foam or rubber sealing ring located on the underside of some drum lids prior to sealing drums containing IDW liquids. If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, select another drum lid with a sealing ring that is in sound condition.

To prepare IDW drums for labeling, wipe clean the outer wall surfaces and drum lids of all material that might prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, wipe that material from the drum, and segregate the paper towel or rag used to remove the material with visibly soiled PPE and disposable sampling equipment. Label all IDW drums and place them on appropriate pallets prior to storage.

5.4.3 Drum Labeling

Proper labeling of IDW drums is essential to the success and cost-effectiveness of subsequent waste screening and disposal activities (see Attachment I-A-6-1 and Attachment I-A-6-2). Labels shall be permanent and descriptive to facilitate correlation of field analytical data with the contents of individual IDW drums. Label all IDW drums using the **three distinct labeling methods** described below to ensure durability of the information. These three methods are completing and affixing preprinted NAVFAC Pacific ER Program labels; marking information on drum surfaces with paint; and, affixing aluminum tags to the drum. **Use of the preprinted labels, painted labeling, and aluminum tags is mandatory.** These methods are described below.

5.4.3.1 PREPRINTED LABELS

Complete **two** preprinted NAVFAC Pacific ER Program drum labels as described below and presented in Attachment I-A-6-1. Seal both labels in separate heavy-duty, clear plastic bags, or use permanent markers on weatherproof stickers, to prevent moisture damage.

1. Place one label on the outside of the drum with the label data facing outward. Affix the bag/sticker to the drum at the midpoint of the drum height using a sufficient quantity of adhesive tape (e.g., duct tape, packing/strapping tape) so the bag will remain on the drum as long as possible during storage.
2. Affix the second label (sealed as mentioned above) to the underside of the drum lid, sealing it inside the drum when the lid is replaced.

The use of two or more preprinted labels for outer IDW drum identification purposes should be considered as a short-term backup to the information on the aluminum tags discussed below.

Print the requested information legibly on the drum labels in black, indelible ink. Instructions for entering the required drum-specific information for each label field are presented below:

CTO: Enter the four-digit number of the CTO for the project during which the IDW was generated. Include any initial zeroes in the CTO number (e.g., CTO 0047).

Activity-Site: Enter the name of the Navy activity responsible for the project site (e.g., Naval Supply Center, Naval Facilities Engineering Command Hawaii) and the name of the site where the project is taking place (e.g., Orote, Landfill, Building [Bldg.] 18).

Drum#: Enter the drum identification number according to the convention described below.

(xxxx-AA-DMzzz);

Where:

xxxx represents the four-digit CTO number

AA represents the unique site identifier assigned by the CTO Manager for multiple site CTOs (e.g., for CTO 0047, OW denotes Old Westpac, OR denotes Orote)

DM represents a *drum* identification number

zzz the sequential drum number for the site, beginning with 001

Date Collected: Enter the date the IDW was generated and placed in the drum. If IDW was generated over a number of days, enter the start and end dates for the period.

Contents: Record the source identification number on the label. Enter a “√” in the box corresponding to the type of IDW placed in the drum. For “Soil” and “Water,” use the line provided to record observations on the condition of the drum contents (e.g., diesel odor, high turbidity, specific liquid IDW type). Check “Solid Waste” for PPE and indicate that PPE is present in the drum. Check

“Other” for disposable sampling equipment and potentially contaminated monitoring well construction materials, and indicate the type of waste on the line provided.

Project Type: Enter a “√” in the box corresponding to the type of investigation. Choices are Remedial Investigation, RCRA Facility Inspection, UST, and Other. If “Other” is specified, indicate the type of project in the “Comments” area, as described below.

Comments: Enter any additional information regarding the drum contents that will assist individuals who will characterize and dispose of the contents of the drum. “Other” project types include Site Inspection, Feasibility Study, Removal/Remedial Action, and Emergency Response activity. In addition, use this space on the label to complete any descriptions that were too large to fit in preceding label fields, such as the turbidity of decontamination water or the site activities from which the PPE was generated.

For Information Contact: Enter the project COR activity / code, address, and phone number.

It is essential that all relevant information recorded on individual drum labels be repeated in the field notebook for later development of the drum inventory database (see Section 5.5 and Procedure III-D, *Logbooks*).

5.4.3.2 PAINTED LABELS

The second method for labeling drums is to paint label information directly on the outer surface of the drum. At a minimum, the information placed on the drum shall include the CTO number, the drum number (following the numbering convention given above), the source identification number and type, the generation date(s), and the telephone number provided at the bottom of the preprinted label appropriate for the project location. The drum surface shall be dry and free of material that could prevent legible labeling. Confine label information to the upper two-thirds of the total drum height. The top surface of the drum lid may be used as an additional labeling area, but this area should only be used *in addition* to the upper two-thirds of the sides of the drum. The printing on the drum shall be large enough to be easily legible. Yellow, white, black, or red paint markers (oil-based enamel paint) that are non-photodegradable are recommended to provide maximum durability and contrast with the drum surface.

5.4.3.3 ALUMINUM TAGS

The third method for labeling drums is to affix an aluminum tag to the drum with neatly printed information that shall consist of the **CTO number**, the **drum identification number**, the **type of contents**, the **generation date(s)**, the **source** identification number and type, and the **telephone number** provided at the bottom of the appropriate preprinted label. Attachment I-A-6-2 to this procedure presents an example of the aluminum tag, which shall measure approximately 1 inch by 3 inches, or larger. When a ballpoint pen is used to fill out the aluminum tag, the information is permanently recorded as indentations on the tag. A fine ballpoint pen shall be used, and block-printed lettering is required for legibility. Indentations on the tag shall be sufficiently deep to be legible after the label has been exposed to weathering for an extended period.

Complete aluminum tags after the drum has been sealed. Affix the tags to the drum using a wire, which passes through predrilled holes in the label and shall be wrapped around the bolt used to seal the drum lid. The wire is the most likely part of the aluminum tag to decay during exposure. Use of

plastic insulated, copper-core electrical wire of appropriate diameter is recommended if long-term exposure to severe weathering is anticipated.

5.4.3.4 WASTE LABELS

Standard green and white non-hazardous and/or other hazardous waste stickers may be used in conjunction with, but not in lieu of, the above labeling procedures.

5.5 DRUM INVENTORY

Accurate preparation of an IDW drum inventory is essential to all subsequent activities associated with IDW drum tracking and disposal. Prepare an inventory for each project in which IDW is generated, stored, and disposed of. This information provided in the inventory report constitutes the results of preparing and implementing an IDW sampling, screening, characterization, and disposal program for each site.

The drum inventory information shall include 10 elements that identify drum contents and indicate their outcome. These elements are discussed in Sections 5.5.1 through 5.5.10.

5.5.1 Navy Activity (Generator)/Site Name

Inventory data shall include the Navy activity and the site name where the IDW was generated (e.g., Fleet Industrial Supply Center Pearl/Red Hill, Naval Magazine Headquarters/USTs).

5.5.2 CTO Number

Inventory data shall include the four-digit CTO number associated with each drum (e.g., 0089) and contract number as necessary.

5.5.3 Drum Number

Include the drum number assigned to each drum in the inventory database. Drum numbers shall adhere to the numbering convention presented in Section 5.4.3.1 (e.g., 0091-LF-DM006).

5.5.4 Storage Location Prior to Disposal

Include the storage location of each drum prior to disposal in the inventory database (e.g., Bldg. 394 Battery Disassembly Area, or Adjacent to West end of Bldg. 54). As part of the weekly inventory, a site visit to the IDW storage location shall be performed to observe the condition of the drums and covers. Drums and covers are considered acceptable when the integrity of the drums and covers are structurally intact, drum identification is legible, and the location of the drum storage is secure. An unacceptable classification will require recommendations to remedy the unacceptable classification.

5.5.5 Origin of Contents

Specify the source identification of the contents of each IDW drum in the inventory database (e.g., soil boring number, monitoring well number, sediment sampling location, or the multiple sources for PPE- or rinse water-generating activities).

5.5.6 IDW Type

Inventory data shall include the type of IDW in each drum (e.g., soil, PPE, disposable sampling equipment, sludge, sediment, development water, steam cleaning water, decontamination rinse water).

5.5.7 Waste Volume

Specify the amount of waste in each drum in the inventory database as a percentage of the total drum volume or an estimated percentage-filled level (e.g., 95 percent maximum for liquid IDW).

5.5.8 Generation Date

Inventory data shall include the date IDW was placed in each drum. If a drum contains IDW generated over more than one day, the start date for the period shall be specified in dd-mmm-yy format. This date is *not* to be confused with a RCRA hazardous waste accumulation date (40 CFR 262).

5.5.9 Expected Disposal Date

Specify the date each drum is expected to be disposed of as part of the inventory in mmm-yy format. This date is for the Navy's information only and shall not be considered contractually binding.

5.5.10 Actual Disposal Date

The actual drum disposal date occurs at the time of onsite disposal, or acceptance by the offsite treatment or disposal facility. Enter this date in the drum inventory data base only when such a date is available in dd-mmm-yy format.

Information required to complete all 10 of the inventory elements for the monthly inventory report described above and summarized in Attachment I-A-6-3, will be located on the IDW labels or provided by the CTO Manager.

Actual disposition of the IDW drum contents will be provided to the Navy.

5.6 IDW CLASSIFICATION

In general, the CTO Manager should follow IDW classification guidance contained in the *Generic IDW Disposal Plans* for Hawaii and Guam (Ogden 1994, 1995) and EPA guidance (EPA 1991, 1992a). The IDW classification process consists of chemical screening and characterization of the waste.

Various federal and state laws and guidance contain requirements for IDW management (handling, storage, transport, disposal, and recordkeeping) based on the type(s) and concentrations of chemicals present in the waste. To ensure that IDW is managed in compliance with these requirements and to evaluate disposal options, the CTO Manager should

- Directly sample and analyze the IDW or associate it with historical data, observed site conditions, and/or samples collected on site at the source of the waste
- Screen the waste to identify the maximum concentrations of individual chemicals in, or associated with, the waste

- Screen waste constituents against chemical background data, if available
- Characterize the waste based on regulated groups of chemical constituents present in the waste
- Screen waste constituents against risk-based health criteria, ARARs, and TBC criteria for onsite disposal, or disposal facility criteria for offsite disposal

Each of the above steps is distinct and should be performed separately to avoid potential mistakes in the IDW classification process. The following subsections discuss these steps in greater detail.

5.6.1 IDW Sampling and Chemical Screening

IDW should be screened to identify chemicals present in the waste and their maximum concentrations. Screening may be facilitated by (1) directly sampling the waste, (2) associating the waste with analytical results from samples collected at the source of the IDW (e.g., a well boring), (3) visual observation of the waste, (4) historical activity data from the site, or (5) a combination of these methods (e.g., association with limited sampling). Composite sampling may be required if the unit volume of IDW is non-homogeneous. Data from samples collected directly from the IDW should take precedence over associated site sample data when making waste management decisions. Procedure I-D-1, *Drum Sampling* discusses methods for drum sampling.

Typically, IDW is screened for chemicals of potential concern at the site and against background data if available. If IDW is generated from outside the suspected AOC (e.g., soil cuttings from the installation of a background monitoring well), assume it is clean, and dispose of it accordingly.

The CTO Manager should consider the disposal criteria of any offsite disposal facility anticipated to be used when developing the SAP. Some offsite facilities do not accept waste that is characterized by association with samples collected from the investigation site or they may require analytical data for chemicals that are not of potential concern at the site. Direct sampling and analysis of the waste may be required for these other constituents. Some disposal facilities prefer to collect and analyze the samples themselves. In addition, disposal facility criteria may dictate laboratory reporting limits. When possible, the CTO Manager should coordinate sampling and data requirements with the disposal subcontractor and anticipated disposal facility. Such efforts may allow IDW sampling to be conducted while the field team is mobilized for the site investigation, rather than conducting a separate IDW sampling event later.

5.6.2 IDW Characterization

Various federal and state laws and guidance contain requirements for IDW management (handling, storage, transport, disposal, and recordkeeping) based on the particular constituent or *group(s) of chemical constituents* present in the waste. Therefore, to ensure that IDW is managed in compliance with these requirements, characterize IDW based on the chemical screening results to determine whether any of the following regulated constituents are present in the waste:

- Petroleum hydrocarbons (regulated by RCRA Subtitle I when released from a UST; see 40 CFR Part 280)
- Hazardous wastes (regulated by RCRA Subtitle C; see 40 CFR 261-299)
- Non-hazardous, solid wastes (regulated by RCRA Subtitle D; see 40 CFR 257-258)

- Hazardous substances and commingled petroleum (regulated by CERCLA; see 40 CFR 300.400 and 302.4)
- PCBs (regulated by TSCA; see 40 CFR 700)
- Asbestos (regulated by CAA for disposal; see 40 CFR 61, Subpart M)
- Radioactive wastes (regulated by the Nuclear Regulatory Commission; see 10 CFR [various parts], 40 CFR, Subchapter F, and other applicable laws)

EPA regulations and guidance do not require IDW to be tested to properly characterize it. Instead waste may be characterized based on historical site data, site observations, analytical data from the source of the IDW, and professional judgment (EPA 1991). Specifically, the EPA has indicated that IDW may be assumed not to be “listed” wastes under RCRA unless available information about the site suggests otherwise (53 FR 51444). Similarly, RCRA procedures for determining whether waste exhibits RCRA hazardous characteristics do not require testing if the decision can be made by “applying knowledge of the hazard characteristic in light of the materials or process used” (40 CFR 262.11(c); EPA 1991). If applicable, the disposal plans and reports should state, “there is no evidence based on site data and observations that the IDW contains listed RCRA wastes or exhibits RCRA characteristics.”

For soil IDW, the potential for exhibiting toxicity may be determined by comparing constituent concentrations in the waste against screening values that are 20 times the TCLP criteria as specified in Section 1.2 of EPA Method Solid Waste-846 1311 *Toxicity Characteristic Leaching Procedure* (EPA 2007). Otherwise, samples associated with the soil can be tested using the TCLP.

5.7 IDW STORAGE

In general, the CTO Manager should follow IDW storage guidance contained in the *Generic IDW Disposal Plans* for Hawaii and Guam (Ogden 1994, 1995) and EPA guidance (EPA 1990, 1991, 1992a).

Always store IDW in a manner that is secure, protected from weather, and protective of human health and the environment. It is preferable to store IDW within the AOC(s) or on site; however, the Navy may assign a specific IDW storage area away from the project site.

If the IDW is determined to be RCRA hazardous, then RCRA storage, transport, and disposal requirements may apply, including a limited **90-day** storage permit exemption period prior to required disposal. If onsite disposal is an option, store RCRA waste within the AOC so that RCRA LDRs will not apply in the future. LDRs may be triggered if the waste is stored within the onsite area, but outside of the AOC or if the waste is removed from and later returned to the AOC for disposal. The AOC concept does not affect the approach for managing IDW that did not come from the AOC, such as PPE, decontamination equipment and fluids, and groundwater. If RCRA hazardous, these wastes must be managed under RCRA and drummed and disposed of off site (EPA 1991).

RCRA waste should not be stored within the AOC prior to disposal when professional judgment suggests the IDW might pose an immediate or permanent public endangerment (EPA 1991b).

Offsite storage of CERCLA waste must comply with the CERCLA offsite rule (40 CFR 300.440).

If the IDW is determined to be TSCA-regulated, then TSCA storage requirements as described in CFR 764.65, transport, and disposal requirements apply, including a limited **30-day** storage period prior to required disposal. Storage requirements are as follows:

1. Storage facilities must provide an adequate roof and walls to prevent rain water from reaching the stored PCBs.
2. Storage facilities must provide an adequate floor that has continuous curbing with a minimum 6-inch-high curb.
3. Storage facilities must contain no drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from the curbed area.
4. Storage facilities must provide floors and curbing constructed of continuous smooth and impervious materials to minimize penetration of PCBs.
5. Storage facilities must not be located at a site that is below the 100-year flood water elevation.
6. PCBs in concentrations of 50 ppm or greater must be disposed of within 1 year after being placed in storage.

PCB waste can also be stored in a RCRA-approved waste storage area for 30 days from date of generation.

NAVFAC Pacific requires that all CERCLA, RCRA, and other types of waste be removed from JBPHH areas within 90 days of its generation, particularly within the shipyard area, and 30 days of generation for TSCA waste. Efforts should also be made to dispose of IDW within the 30- and 90-day periods at other Navy installations, unless the IDW will be managed with remediation waste to be generated during a cleanup action in the near future. The Navy may approve extensions of the storage time limit for wastes that are non-hazardous on a project-specific basis.

5.7.1 Drum Storage

Implement drum storage procedures to minimize potential human contact with the stored IDW and prevent extreme weathering of the stored drums. Place all IDW drums upright on pallets before the drums are stored. RCRA storage requirements include the following: containers shall be in good condition and closed during storage; wastes shall be compatible with containers; storage areas shall have a containment system; and spills or leaks shall be removed as necessary.

Place all IDW drums generated during field activities at a single AOC or designated IDW storage area together in a secure, fenced onsite area to prevent access to the drums by unauthorized personnel. When a secure area is not available, place drums in an area of the site with the least volume of human traffic. At a minimum, place plastic sheeting (or individual drum covers) around the stored drums. Post signage at the IDW storage area stating that drums should not be removed from the area without first contacting the Navy COR.

Liquid IDW drums must be stored under secondary containment (either secondary containment pallets or handmade plastic sheeting/polyvinyl chloride frame containment) and all IDW drums (soil

and water) must utilize secondary containment when stored within 15 feet of a surface water body or storm drain inlet.

Drums from projects involving multiple AOCs shall remain at the respective source areas where the IDW was generated. IDW should not be transferred off site for storage elsewhere, except under rare circumstances, such as the lack of a secure onsite storage area.

Implement proper drum storage practices to minimize damage to the drums from weathering and possible human exposure to the environment. When possible, store drums in dry, shaded areas and cover them with impervious plastic sheeting or tarpaulin material. Make every effort to protect the preprinted drum labels from direct exposure to sunlight, which causes ink on the labels to fade. In addition, store drums in areas that are not prone to flooding. Secure the impervious drum covers appropriately to prevent dislodging by the wind. It may be possible to obtain impervious plastic covers designed to fit over individual drums; nonetheless, repeat the labeling information on the outside of these opaque covers.

Drums in storage shall be placed with sufficient space between rows of drum pallets and shall not be stacked, such that authorized personnel may access all drums for inspection. Proper placement will also render subsequent IDW screening, sampling, and disposal more efficient when individual drum removal is necessary. It is recommended that IDW drums be segregated in separate rows/areas by matrix (i.e., soil, liquid or PPE/other).

If repeated visits are made to the project site, inspect the IDW drums to clear encroaching vegetation, check the condition and integrity of each drum, secondary containment if applicable, check and replace aluminum tags as necessary, and replace or restore the tarpaulin covers.

5.7.2 IDW Stockpiles

Consider IDW stockpiling only when a very large quantity of IDW will be generated. Segregate stockpiled IDW, and inventory it by source location and depth to the extent practicable. Stockpiling and media mixing should not be used as methods to dilute chemical concentrations in the waste. Line stockpiles on the bottom, cover it with sturdy plastic, and locate it in areas where weather elements (e.g., wind, rainfall runoff) will not cause migration of the waste. Never dispose of liquid IDW on a stockpile; drum or store liquid waste in other appropriate containers. Follow applicable regulation and guidance when sampling stockpiled waste for characterization purposes.

5.8 IDW DISPOSAL

Various methods and requirements for onsite and offsite disposal of IDW are discussed in the *Generic IDW Disposal Plans* for Hawaii and Guam (Ogden 1994, 1995) and EPA guidance (EPA 1990, 1991, 1992b). This section explains the disposal evaluation process and highlights some of the more important requirements for onsite and offsite IDW disposal options.

IDW sampling, characterization, and disposal analysis, particularly for onsite disposal, can be unexpectedly complex and require compliance with many different laws (that act as ARARs for IDW management and disposal). Before preparing the IDW disposal plan, compare estimated costs for onsite vs. offsite disposal. Offsite disposal may be more cost effective than devising and documenting the justification for onsite disposal when the quantity of IDW is small (less than 10 drums) and/or the waste fails the initial conservative screening against conservative risk-based

criteria. Also weigh cost savings against the policy preference of the EPA and State of Hawaii Department of Health to manage and dispose of IDW on site, when possible.

5.8.1 Onsite Disposal

In general, the EPA preference is to dispose of IDW on site when the disposal action:

- Does not pose an unacceptable long-term risk to human health and the environment
- Is in accordance with chemical-, location- and action-specific ARARs “to the extent practicable” (40 CFR 300.415(i); 55 FR 8756)
- Does not introduce contaminants into clean soil or other site media
- Does not mobilize or significantly increase concentrations of any hazardous constituents already present in the environment
- Is consistent with the final remedy planned for the site
- Takes into account any community concerns regarding waste storage and the disposal method

Base onsite disposal options on best professional judgment and available site-specific data. For some projects, it may be prudent to store the waste temporarily until additional site data become available (e.g., sample analytical data, preliminary risk-assessment results, AOC delineation, and establishment of background values). Factors to consider include, but are not limited to the following:

- The detected or suspected contaminants, their concentrations, and total volume of IDW
- Media potentially affected (e.g., groundwater drinking source)
- Background metals data for site media
- Site access, conditions, and potential receptors
- Current and future land use
- Public perceptions (especially if drum storage and/or disposal takes place in open view)
- Time limits for IDW storage
- Potential requirements to treat waste before disposing of it on site
- Lack of unpaved areas to disposed of waste on site
- Potential wind, erosion, runoff, or flood conditions that might cause offsite migration of disposed waste
- Proximity to the ocean, surface water, or environmentally sensitive habitats
- Natural attenuation processes
- Need for additional utility survey before excavating to backfill waste
- Need for land use controls required to limit exposure pathways (e.g., backfill waste, provide permanent security around site, replant site to prevent erosion)

Protection of human health can be evaluated by comparing chemical concentrations in the waste to the more conservative of EPA residential regional screening levels), environmental action levels, and chemical-specific ARARs and TBC criteria. Ecological receptors can be protected by screening the IDW against EPA ecological soil screening levels. Onsite disposal of surface and groundwater IDW can be evaluated by initially screening against EPA tap-water PRGs, State Safe Drinking Water Standards (maximum contaminant levels and non-zero maximum contaminant level goals), and/or State Surface Water Quality Standards. These criteria are not always ARARs for the disposal method or site conditions; however, they may be useful to affirmatively show that the disposal is protective. Alternatively, the IDW may be associated with human-health and eco-risk assessment results for the site if the onsite placement of IDW is consistent with exposure pathway assumptions made during the risk assessment (e.g., contaminated soil might not present an unacceptable health risk at depth, but could pose such a risk if disposed of at the ground surface).

In general, return IDW consisting of environmental media to or near its source, and return waste generated from depth to its original depth, if possible and approved by NAVFAC in advance. Bury all contaminated soil and water IDW to be disposed of on site below grade at a depth of at least 3 feet and cover it with clean soil to reduce the potential for future exposure to human and ecological receptors.

Dispose of non-indigenous IDW and contaminated decontamination fluids off site. The cleaning detergent Alconox, often used in the decontamination process, is itself non-hazardous and biodegradable. Small quantities of clean decontamination water containing Alconox may be disposed of to clean areas on site. If onsite disposal is appropriate for RCRA IDW, this waste should be disposed of within the AOC to avoid the need to comply with LDRs.

IDW from several non-contiguous onsite areas may be consolidated and disposed of at one of the areas, provided a nexus exists between the wastes generated and response projects (55 FR 8690-8691).

IDW may also be temporarily disposed of back to the AOC without detailed analysis or documentation if the waste will be addressed with other site contamination during a future response action and will not present a significant short-term threat to human health and the environment.

5.8.2 Offsite Disposal

If onsite disposal is not a viable option, dispose of the IDW at an appropriate offsite treatment and/or disposal facility. Offsite transport and disposal of IDW must comply with all applicable laws and criteria specific to the chosen disposal facility. These requirements may include, but are not limited to the following:

- RCRA LDRs
- RCRA waste storage permits and time limits
- National Pollutant Discharge Elimination System and sewer disposal criteria
- CERCLA offsite rule
- TSCA treatment requirements
- DOT hazardous material transport packaging, manifesting, and security provisions

- International Maritime Organization ocean transport rules
- Certifications and training for waste transport contractors
- State notification requirements when importing certain types of waste

The CERCLA offsite rule (40 CFR 300.440) requires that CERCLA waste be disposed of only at facilities specifically approved by the EPA to receive such waste for treatment, storage, or disposal. The acceptability status of a disposal facility can change quickly (e.g., if there is a release at the facility); therefore, the CTO Manager should contact the EPA Region 9 CERCLA Offsite Rule Coordinator no more than 60 days prior to disposal of the IDW to verify the facility's approval status. The offsite rule applies to any CERCLA-driven remedial or removal action involving the offsite transfer of waste containing hazardous substances regardless of the concentrations present.

RCRA hazardous waste manifests must always be signed by authorized Navy personnel. In some cases, the Navy may authorize contractors to sign non-hazardous manifests. Navy authorization to allow contractor signature of non-hazardous manifests shall be based upon a Navy review of the contractor's RCRA and DOT training records. In addition, the Navy shall always be allowed the opportunity to review/approve non-hazardous manifests and waste profiles prior to waste disposal efforts.

Disposal of liquid IDW into the Navy sanitary sewer shall occur only if first approved by the Navy. Requests for disposal to Navy facilities should be coordinated through the COR. Discharge to the public sewer system is discouraged and should occur only if approved by state and local government agencies.

5.9 RECORDS

The CTO Manager is responsible for completing and updating the site-specific IDW drum inventory spreadsheet and submitting it as needed, and reviewing the IDW disposal plan (IDW disposal paperwork).

FMs and designates are responsible for documenting all IDW-related field activities in the field notebook including most elements of the IDW drum inventory spreadsheet. The correct methods for developing and maintaining a field notebook are presented in Procedure III-D, *Logbooks*.

Guidance related to preparing an IDW disposal plan (if required) is presented in the *Generic IDW Disposal Plans* for Hawaii and Guam (Ogden 1994, 1995).

5.9.1 IDW Disposal Documentation

Upon receipt of analytical data from the investigation or from IDW-specific analytical data, the generator information request form will be completed and provided to the IDW subcontractor to begin IDW characterization. Completed IDW disposal paperwork received from the IDW subcontractor should be reviewed for accuracy prior to submitting for Navy review.

The CTO Manager is responsible for submitting backup documentation (actual site or drum sampling results) along with the IDW disposal paperwork to the Navy.

Navy-approved contractor personnel may sign non-hazardous waste IDW documentation. Hazardous waste IDW documentation must be signed by an authorized Navy Environmental Coordinator.

All manifests (non-hazardous and hazardous) must be tracked, and if completed manifests (signed by disposal facility) are not received within 30 days of initial transportation, then contractor must notify the RPM weekly of the shipping status (e-mail is acceptable). Hazardous waste must be disposed of within 45 days of initial transportation. If not, specific IDW transportation details must be supplied to the Navy in order to prepare and file an exception report.

TSCA-regulated waste must be physically destroyed and or buried within 1 year of generation (date placed in IDW drum). Disposal certificates should be provided by the waste facility to the IDW subcontractor and Navy contractor.

Following disposal of IDW, the CTO Manager should prepare a short IDW disposal report summarizing the disposal operation and appending any associated records (e.g., final drum log, waste profiles, transport manifests, bills of lading, disposal facility certifications). Minimal topics to include in the report:

- IDW inventory and storage
- IDW chemical screening and characterization
- IDW transport and disposal
- Manifests
- Drum storage photographs
- Site figure

6. Health and Safety

Field Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

7. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Environmental Protection Agency, United States (EPA). 1990. *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*. EPA/540/G-90-007. OSWER 9355.4-01. Office of Solid Waste and Emergency Response. August.

———. 1991. *Management of Investigation-Derived Wastes During Site Inspections*. EPA-540-G-91-009. Office of Emergency and Remedial Response. May.

———. 1992a. *Guidance for Performing Site Inspections under CERCLA*. EPA/540/R-92/021. Office of Emergency and Remedial Response. September.

———. 1992b. *Guide to Management of Investigation-Derived Wastes*. Quick reference fact sheet. OSWER Dir. 9345.3-03FS. Office of Solid Waste and Emergency Response. January.

———. 2007. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846*. 3rd ed., Revision 6. Office of Solid Waste. November. On-line updates at: <http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm>.

———. 2009. *Revisions to the PCB Q and A Manual*. January.

Ogden Environmental and Energy Services Company, Inc. (Ogden). 1994. *Final Generic IDW Screening, Sampling, Analysis, and Disposal Plan for Various Guam Naval Installations*. Pearl Harbor, HI: Pacific Division, Naval Facilities Engineering Command. September.

———. 1995. *Generic IDW Screening, Sampling, Analysis, and Disposal Plan for Various Hawaii Naval Installations*. Pearl Harbor, HI: Pacific Division, Naval Facilities Engineering Command. April.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-C-2, *Monitoring Well Development*.

Procedure I-C-3, *Monitoring Well Sampling*.

Procedure I-D-1, *Drum Sampling*.

Procedure I-F, *Equipment Decontamination*.

Procedure III-D, *Logbooks*.

8. Attachments

Attachment I-A-6-1: IDW Drum Label

Attachment I-A-6-2: Drum Label – Aluminum Tag

Attachment I-A-6-3: Monthly IDW Drum Inventory Updates

**Attachment I-A-6-1
IDW Drum Label**

This page intentionally left blank

IDW Drum Label

Contract #:

CTO #:

ACTIVITY SITE: _____

DRUM # (_ _ _ _ - _ _ - D M _ _)

DATE COLLECTED

CONTENTS: (please ✓ and explain)

Soil _____

Water _____

Solid Waste _____

Other _____

PROJECT TYPE

RI RFI UST Other

COMMENTS:

FOR INFORMATION CONTACT:

COR Activity/ Code:

Address:

Telephone:

This page intentionally left blank

**Attachment I-A-6-2
Drum Label - Aluminum Tag**

This page intentionally left blank

Drum Label - Aluminum Tag



This page intentionally left blank

**Attachment I-A-6-3
Monthly IDW Drum Inventory Updates**

This page intentionally left blank

Table I-A-6-1: Monthly IDW Drum Inventory Updates

Navy Activity / Site Name (Generator Site)	CTO Number (0bbb)	Drum Number (xxxx-AA-DMzzz)	Drum Storage Location	Origin of Contents (Source ID #)	IDW Type	Waste Volume (Fill level %)	Waste Generation Date (dd-Mon-yy)	Expected Disposal Date (Mon-yy)	Actual Disposal Date (dd-Mon-yy)
Inspector:									
Date of Inspection:									
NSC Pearl Harbor/ Landfill	0068	0068-LF-DM001	NSC, Bldg 7	SB-1	Soil Cuttings	100	16-Dec-92	Dec-93	N/A
		0068-LF-DM002	N/A	MW-1 MW-2 MW-3	Purge Water	75	20-Dec-92	Jul 93	26-Jul-93
		0068-LF-DM003	N/A	MW-1 MW-2 MW-3	Decon. Water	95	20-Dec-92	Jul-93	26-Jul-93
		0068-LF-DM004	NSC, Bldg.16	SB-1 SB-2 SB-3 SB-4 MW-1 MW-2 MW-3	PPE	50	16-Dec-92	Oct-93	N/A
NAVSTA Guam/ Drum Storage	0047	0047-DS-DM001	Hazmat Storage Area	SB-1 SB-2	Soil Cuttings	100	18-Feb-93	Sep-93	N/A

N/A Not Applicable

This page intentionally left blank

Sample Naming

1. Purpose

This standard operating procedure describes the naming convention for samples collected and analyzed, and whose resulting data will be stored in the database for the United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific projects. Unique sample names are used to facilitate tracking by laboratory personnel and project personnel, and for purposes of storing, sorting, and querying data in the database.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 CHAIN OF CUSTODY SAMPLE NUMBER

The chain of custody (COC) sample number is a five-character identification number that is used by the laboratory and project personnel for tracking purposes. A unique COC sample number must be used for each sample collected from a particular location at a particular time. It is useful for the first two characters to be letters unique to a particular site or project, while the remaining three characters may be digits from 001 to 999 (e.g., AA001). The COC sample number is the only identifier that should be presented to the laboratory.

3.2 SAMPLE IDENTIFICATION NUMBER

The sample identification number is a unique multi-alpha, multi-numeric identifier that is used by the field team to associate sampling results to the particular sampling location, sample type, number of times the location has been sampled, and depth. To avoid potential bias in sample analysis, the sample identifier is not provided to the laboratory. The sample identification number shall be recorded in the field logbook concurrently with the COC sample number.

4. Responsibilities

The prime contractor CTO Manager shall ensure that a proper sample naming convention is identified in the field sampling plan. The Field Quality Control (QC) Supervisor or other field-sampling leader shall ensure that the sample naming convention is implemented. The laboratory coordinator, CTO Manager, and/or other designated personnel shall ensure on a daily basis that unique, appropriate COC sample numbers and sample identifiers have been assigned. The prime

contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The prime contractor Technical Director will designate one person in each office (e.g., the laboratory coordinator) to track site designations used in the COC sample number.

5. Procedures

A COC sample number and sample identifier shall be assigned as described below. It is critical that each sample name have a unique COC sample number and sample identifier; otherwise, data cannot be properly stored and tracked in the database.

5.1 COC SAMPLE NUMBER

Use the following format for the COC sample number:

abccc

Where:

- a = A letter indicating the office managing the CTO
 - b = A letter indicating the project or site, for example
 - A = first site
 - B = second site
 - C = third site, etc.
 - ccc = Chronological number, for example
 - 001 = first sample from the site
 - 002 = second sample from the site
 - 105 = 105th sample from the site
- Field QC samples should be included in this chronological sequence

For example, the 23rd sample from the Carpentry Shop Dip Tank site (assigned project “A” for b above; the office will be assigned “D”) being investigated would be referred to as “DA023.” This might be a soil sample, water sample, trip blank, equipment blank, field duplicate, or other sample type. Using this COC sample number, the samples will be submitted to the laboratory “blind,” that is, the laboratory should not know whether each sample received is a site or field QC sample.

If a sample is lost during shipping, the replacement sample must be assigned a new COC sample number. If different containers for the same sample are shipped on different days, a new COC sample number must be assigned.

When numbering reaches the letter Z, the 26th site, it may begin with a new first letter “a,” which must be coordinated with the prime contractor QA Manager or Technical Director and Coordinator or designee to ensure that it has not been used by another CTO.

Alternatively, the “ab” designators can serve to identify a unique project field, such as “RH” for the Red Hill site.

5.2 SAMPLE IDENTIFICATION NUMBER

The following format is provided as a suggested guidance. Individual site objectives may necessitate variations to the suggested guidance. Coordinate with the prime contractor QA Manager or Technical Director when considering deviating from this guidance.

AA-bbcc-dee-Dff.f

Where:

- AA** = Designates the site identification
- bb** = Sample type and matrix (see Table I-A-8-1)
- cc** = Location number (e.g., 01, 02, 03)
- d** = Field QC sample type (see Table I-A-8-2)
- ee** = Chronological sample number from a particular sampling location (e.g., 01, 02, 03)
- D** = The letter “D” denoting depth
- ff.f** = Depth of sample in feet bgs (to the measured decimal place). For field blanks, trip blanks and equipment blanks, the depth field will contain the month and date of collection.

For example, the first subsurface soil sample collected from the Foundry Building (FB) borehole location four at a depth of 10 feet would be designated “FB-BS04-S01-D10.0.” These characters will establish a unique sample identifier that can be used when evaluating data.

Table I-A-8-1 presents the character identifiers to be used in the sample and matrix portion of the sample identification number. In all cases, the second letter indicates the sample matrix. Note grab, composite, and undisturbed sample designations in the field logbook.

Table I-A-8-1: Sample Type and Matrix Identifiers

Identifier	Sample Type	Matrix
SS	Surface Soil	Soil
IS	Surface Soil (ISM)	Soil
IB	Subsurface Soil (ISM)	Soil
BS	Subsurface Soil	Soil
BG	Subsurface Soil (Geotechnical)	Soil
SD	Sediment	Sediment
GW	Groundwater	Water
SW	Surface Water	Water
FP	Free Product	Oil
WQ	Water Blanks	Water
SG	Soil Gas	Soil gas
CC	Concrete Chips	Concrete

Identifier	Sample Type	Matrix
WS	Waste (IDW)	Soil
WW	Waste (IDW)	Water

IDW investigation-derived waste
ISM incremental sampling methodology

Table I-A-8-2 describes the field QC designator types. These field QC designators clarify the type of sample collected.

Table I-A-8-2: Field QC Sample Type Identifiers

Identifier	QC Sample Type	Description
S	Normal (Primary) Sample	All non-field QC samples
D	Duplicate	Collocate (adjacent liners)
R	Triplicate	Replicate
E	Equipment Rinsate	Water
B	Field Blank	Water
T	Trip Blank	Analytical-laboratory-prepared sample -Water
M	Trip Blank	Analytical-laboratory-prepared sample – Methanol
L	Batch Test Sample	Batch Test Leaching Model Sample
P	Blind Spike	Performance testing sample

6. Records

Sample identifiers (and COC sample numbers, if appropriate) shall be identified in advance if the exact numbers of samples to be collected are known; these numbers may be listed on a spreadsheet along with requested analyses to be used as a reference by field sampling personnel.

The COC/analytical request form must be used to track all sample names. Copies of each COC form shall be sent daily to the CTO Laboratory Coordinator and with the samples to the analytical laboratory. An example of a COC form is included as Attachment III-E-2 of Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*.

In the field, personnel shall record in the field logbook the COC sample number of each sample collected, as well as additional information, such as the sampling, date, time, and pertinent comments.

7. Health and Safety

Not applicable.

8. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*.

9. Attachments

None.

This page intentionally left blank

Soil Sampling

1. Purpose

This section sets forth the standard operating procedure for soil sampling (surface samples, trench samples, and boring samples) to be used by United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the most recent version of the Uniform Federal Policy-Quality Assurance Project Plan (UFP QAPP) Part 1 (DoD 2005a), 2A (DoD 2012), and 2B (2005b), as well as the DoD Quality Systems Manual (DoD 2013). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

None.

4. Responsibilities

The prime contractor CTO Manager is responsible for ensuring that these standard soil sampling procedures are followed during projects conducted under the NAVFAC Pacific ER Program, and that they are conducted or supervised by a qualified individual. A qualified individual for subsurface sampling is defined as a person with a degree in geology, hydrogeology, or geotechnical/civil engineering with at least 1 year of experience in the supervision of soil boring construction. A qualified individual for trenching, excavation (e.g., pit), or surface sampling supervision is one who has sufficient training and experience to accomplish the objectives of the sampling program. The CTO Manager shall also ensure that a qualified person, as defined in Procedure I-E, *Soil and Rock Classification*, conducts soil classification during all types of soil sampling. The CTO Manager is responsible for ensuring that all personnel involved in sampling and/or testing shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager is responsible for ensuring that all project field staff follow these procedures.

Field sampling personnel are responsible for the implementation of this procedure.

5. Procedures

5.1 CONSIDERATIONS FOR MUNITIONS AND EXPLOSIVES OF CONCERN

Potential Munitions and Explosives of Concern (MEC) hazards may be encountered in any area formerly or currently occupied or used by the Department of Defense (DoD). MEC hazards may occur on the ground surface, in the subsurface, and within bodies of water, and may not always be readily observable, or identifiable. As a result, whether or not munitions-related activities ever occurred on the specific work area or within waters in which Navy operations/activities will take place, special care should always be taken when conducting field operations, especially intrusive activities, in the event that MEC may be encountered.

If the site is currently recognized as belonging in the Military Munitions Response Program and has a current, Naval Ordnance Safety and Security-accepted, site-specific Explosives Safety Submission (ESS) (per DON 2010), then field activities, especially intrusive activities, shall adhere to the safety procedures outlined within the ESS.

If suspected MEC is encountered on an active DoD installation, immediately notify your supervisor, DoD Point of Contact, and installation Point of Contact, who will contact and facilitate military Explosive Ordnance Disposal response.

5.2 SUBSURFACE SOIL SAMPLING

The purpose of subsurface soil sampling is to acquire accurate, representative information about subsurface materials penetrated during drilling or trenching. This is accomplished by logging lithologic information, classifying lithologic materials, and collecting lithologic samples for analysis using geotechnical or chemical methods.

5.2.1 Inspection of Equipment

The collection of reliable samples of subsurface materials depends partly on the types of samples that can be collected when using various subsurface exploration techniques. These procedures are described in Section 5.2. In all cases, the equipment shall be inspected prior to commencement of drilling for signs of fluid leakage, which could introduce contaminants into the soil. If, at any time during subsurface exploration, fluid is observed leaking from the rig, operations shall cease and the leak shall be immediately repaired or contained. All soil and other materials affected by the leak will be collected, containerized, and labeled for proper disposal (Procedure I-A-6, *Investigation-Derived Waste Management*).

5.2.2 Preparation of Site

Proper preparation of the site prior to the commencement of subsurface exploration is essential for smooth drilling operations. It is required to protect the health and safety of site personnel. First, the

site shall be inspected to ensure that there are no overhead hazards that could affect subsurface exploration. Then, all subsurface sampling locations shall be assessed using geophysical methods to identify subsurface utilities or hazards. If possible, the area shall be excavated by hand to a depth of 2 to 3 feet before beginning drilling. If surface or shallow samples are required, it is suggested that the hand excavation be done as close to the actual subsurface exploration as possible. The drill rig must have a means to guard against employee contact with the auger (e.g., guard around the auger; barricade around the perimeter of the auger; electronic brake activated by a presence-sensing device). All members of the field crew shall know the location of the kill switch, which must be readily accessible, for the equipment.

The equipment shall be situated upwind or side-wind of the borehole. The area surrounding, and in the vicinity of, the borehole shall be covered with plastic, including the area where cuttings are placed into 55-gallon drums and the equipment decontamination area. The required exclusion zones shall be established by using plastic tape or cones to designate the various areas.

5.2.3 Equipment Decontamination

To avoid cross-contamination, all sampling equipment utilized for borehole drilling and soil sampling that may potentially come into contact with environmental samples shall be thoroughly decontaminated as described in Procedure I-F, *Equipment Decontamination*. All sampling tools shall be decontaminated between each sampling event and between each borehole or trench. At a minimum, all equipment shall be steam-cleaned or undergo the wash-and-rinse process. All wash-and-rinse water shall be collected, containerized, and labeled for proper disposal. Clean equipment (e.g., augers and samplers) shall be protected from contact with contaminated soils or other contaminated materials prior to sample collection. Equipment shall be kept on plastic or protected in another suitable fashion. After a borehole is completed, all augers and contaminated downhole equipment shall be stored on plastic sheeting.

5.2.4 Handling of Drill Cuttings

All soil cuttings from borehole drilling shall be placed into 55-gallon U.S. Department of Transportation (DOT)-approved drums or other appropriate containers, such as a roll-off bin. The containerized cuttings shall be stored in a centralized area pending sample analysis to determine their final disposition. The procedure on investigation-derived waste (IDW) (see Procedure I-A-6, *Investigation-Derived Waste Management*) details drum handling and labeling procedures.

5.3 SUBSURFACE SOIL SAMPLE COLLECTION METHODS

Table I-B-1-1 describes the characteristics of the sampling methods for the drilling techniques frequently used for soil borings and monitoring well installation, as described in Procedure I-C-1, *Monitoring Well Installation and Abandonment*. The split-spoon sampling method is the most commonly used soil sampling technique. However, in certain circumstances, other methods may have to be used to obtain optimal soil sampling results.

Sampling and handling procedures for samples submitted for volatile organic compound (VOC) analyses are provided in Attachment I-B-1-1. Considerations when using incremental sampling (IS) methods are provided in Attachment I-B-1-1.

Table I-B-1-1: Characteristics of Common Subsurface Formation-Sampling Methods

Type of Formation	Sample Collection Method	Sample Quality	Potential for Continuous Sample Collection?	Samples Suitable for Analytical Testing?	Discrete Zones Identifiable?
Unconsolidated	Bulk Sampling (Cuttings)	Poor	No	No	No
	Thin Wall	Good	Yes	Yes	Yes
	Split Spoon	Good	Yes	Yes	Yes
	Trench	Good	No	Yes	Yes
	Core Barrels	Good	Yes	Yes	Yes
Consolidated	Cuttings (direct rotary)	Poor	No	No	No
	Core Barrels	Good	Yes	Yes	Yes

The following text describes the primary soil sampling methods used for the NAVFAC Pacific ER Program.

5.3.1 Split-Spoon Samples

Split-spoon sampling is usually used in conjunction with the hollow-stem or solid-stem auger drilling method and can be used for sampling most unconsolidated and semi-consolidated sediments. It is used less frequently for air and mud rotary, and casing drive methods. It cannot normally be used to sample bedrock, such as basalt, limestone, or granite. The method can be used for highly unconsolidated sands and gravels if a stainless-steel sand catcher is placed in the lower end of the sampler.

The split-spoon sampler consists of a hardened metal barrel, 2 to 3 inches in diameter (2 to 2.5 inches inner diameter) with a threaded, removable fitting on the top end for connection to the drill rods and a threaded, removable “shoe” on the lower end that is used to penetrate the formation. The barrel can be split along its length to allow removal of the sample.

The following steps are required to obtain a representative soil sample using a split-spoon sampler:

- Advance the borehole by augering until the top of the desired sampling interval is reached. Then withdraw the drill bit from the hollow-stem augers.
- Equip the sampler with interior liners that are composed of materials compatible with the suspected contaminants if samples are to be retained for laboratory analytical analysis. Generally, these liners consist of brass or stainless steel and are slightly smaller than the inner diameter of the sampler. It is recommended to use stainless-steel liners rather than

brass if samples are to be analyzed for metals. Always evaluate the composition of the liners with respect to the types of contaminants that are suspected.

- Attach the properly decontaminated split-spoon sampler (equipped with liners) either to the drill rods or to a cable system and lower it to the bottom of the borehole through the augers.
- Drive the sampler into the formation by either a manual or automatic hammer (usually a 140-pound weight dropped through a 30-inch interval). Record the number of blows required to drive the sampler at 6-inch intervals in the boring log since blow counts provide an indication of the density/compaction of the soils being sampled. The field geologist, hydrogeologist, or geotechnical engineer shall carefully observe the internal measuring technique of the driller and keep track of sampling materials to ensure the accurate location of samples. Continuous samples can be collected with the split-spoon method by augering or drilling to the bottom of the previously sampled interval and repeating the operation. Whether continuous or intermittent, this collection method disturbs samples and cannot be used for certain geotechnical tests that require undisturbed samples.
- Bring the split-spoon sampler to ground surface and remove it from the drill rods or cable system following sample acquisition. Loosen the upper and lower fittings and take the sampler to the sample handling area. At the sample handling area, remove the fittings, split the barrel of the sampler, and remove one side of the sampler. At this time, it is important to observe and record the percentage of sample recovery.

Liners—Sampler liners can be used to collect and store samples for shipment to laboratories, for field index testing of samples, and for removing samples from solid barrel type samplers. Liners are available in plastic, Teflon, brass, and stainless steel. Other materials can be used as testing needs dictate. Liners are available in lengths from 6 inches (152.4 millimeters) to 5.0 feet (1.53 meters). Liner material selection often is based on the chemical composition of liner/soil to minimize sample reaction with liner. Most liner use is short-term as samples are subsampled and preserved immediately on site. Teflon may be required for mixed wastes and for long-term storage. Liners generally are split in the field for subsampling. Individually split liners are available in some sizes for field use. The liner should have a slightly larger inside diameter than the soil specimen to reduce soil friction and enhance recovery. When a slightly oversized liner is used, the potential for air space exists around the sample. Certain chemical samples may be affected by the enclosed air. Liners with less tolerance may be required and a shortened sample interval used to reduce friction in the liner. Metal liners can be reused after proper cleaning and decontamination. Plastic liners should be disposed of properly after use (ASTM 2005).

Immediately remove the liners containing the soil samples from the sampler. Generally, the lowermost liner is considered the least disturbed and shall be retained as the analytical laboratory sample. However, in certain circumstances (such as with the use of a sand catcher), other liners may be more appropriate for retention as the laboratory sample. If liners containing the sample material are to be submitted to the laboratory, then cover the ends of the sample liner to be retained as the analytical laboratory sample with Teflon film and sealed with plastic caps. While currently not

preferred by the State of Hawaii, if liners are submitted, the laboratories should be instructed to prepare the soil from the liner as an incremental sample to prevent biasing the results that can occur when discretely collecting the analytical volume. The site geologist, hydrogeologist, or geotechnical engineer shall observe the ends of the liner destined for analytical sampling and describe the physical nature of the sample (e.g., soil or rock type, grain size, color, moisture, as indicated in Procedure I-E, *Soil and Rock Classification*.) Then label the sample according to Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*, and immediately place it on ice in a cooler as described in Procedure III-F, *Sample Handling, Storage, and Shipping*.

- Collect split-spoon soil samples submitted for VOC analysis using the procedure found in Attachment I-B-1-1.
- Collect split-spoon soil samples submitted for non-VOC analysis using the IS procedure found in Attachment I-B-1-1
- Any remaining liners collected from the sample can then be used for other purposes, such as providing a duplicate sample for field quality control or material for lithologic logging. These samples can also be used for headspace analysis as described in Section 5.4.
- Conduct lithologic logging of each sample in accordance with Procedure I-E, *Soil and Rock Classification*, and enter each sample into the boring log presented in Figure I-B-1-1. In most instances, an additional liner full of material is available for this purpose. Check to ensure that all liners contain similar material. If an extra liner full of material is not available, then log by collecting the extra material present in the end of the sampler shoe. Make a comparison to the material visible at the end of the sample liner destined for laboratory analysis to ensure that the entire sample consists of similar material. If not, then describe the different material to the extent possible by relating it to similar material that was encountered previously.
- If VOCs are suspected to be present, screen the sample with an organic vapor monitor (OVM) or equivalent, and collect headspace samples according to Section 5.4.
- Decontaminate all sampling equipment prior to each use according to Procedure I-F, *Equipment Decontamination*.

5.3.2 Thin-Wall Samples

The thin-wall or Shelby tube sampler is usually used in conjunction with the hollow-stem and solid-stem auger drilling methods and is most useful when sampling clay- and silt-rich sediments. It can also be used with air and mud rotary and casing drive drilling techniques. It is amenable only to lithologies that are relatively soft and, in some cases, is not capable of penetrating hard clays or compacted sands. In addition, samples of unconsolidated sands cannot normally be acquired because they cannot be retained within the sampler, although a sand catcher can be utilized, in some cases, with moderate success.

The thin-wall sampler often consists of a single thin tube that is 3 to 4 inches in outer diameter and 1 to 3 feet in length. The upper end of the sampler has a solid metal section with a fitting for drill rods. There is no fitting for the lower end of the sampler, and it is usually open to allow sample acquisition; however, when sampling in poorly consolidated materials, a sand catcher may be placed in the lower end to ensure retention of the sample.

The following steps are required to obtain a representative soil sample using a thin-wall sampler:

- Advance the borehole by augering or drilling until the top of the desired sampling interval is reached. Then withdraw the drill bit from the hollow-stem augers.
- Place the sampler on the end of the drill rods and lower it to the bottom of the borehole.
- Instead of driving the sampler, use the hydraulic apparatus associated with the Kelly bar on the drilling rig to press the sampler into the undisturbed formation. The thin-wall sampler may lack sufficient structural strength to penetrate the materials, in which case another sampling technique may be required. The samples obtained using this method cannot be used for certain geotechnical tests where undisturbed samples are required.
- Thin-wall samples submitted for VOC analysis must be collected using the procedure found in Attachment I-B-1-1.
- Following sample acquisition, bring the thin-wall sampler to the ground surface, remove it from the drill rods, and take it to the sample handling area.
- Immediately cover the ends of the sample with Teflon film and sealed with plastic caps if the sample is to be retained as a laboratory sample. Then label the sample according to Procedure III-E, *Record Keeping Sample Labeling, and Chain of Custody* and immediately place it on ice in a cooler. Extrude the sample from the sampler and inspect it if the sample is to be used only for lithologic logging.
- Conduct lithologic logging of each sample in accordance with Procedure I-E, *Soil and Rock Classification* and enter each sample into the boring log presented in Figure I-B-1-1. If the sample is contained in a sleeve, observe the ends of the sample in the sleeve to assess lithologic and stratigraphic characteristics.
- If VOCs are suspected to be present, screen the sample with an OVM or equivalent, and collect headspace samples according to Section 5.4.
- Decontaminate all sampling equipment prior to each use according to Procedure I-F, *Equipment Decontamination*.

5.3.3 Cores

A core barrel is often used to obtain core samples from harder lithologic materials, such as basalt, granite, and limestone, in instances where undisturbed samples are required for geotechnical testing, and in cases where completely continuous sampling is required. Complete recovery of samples during coring is often difficult when sampling unconsolidated and semi-consolidated lithologies, such as clays, silts, and sands.

Field Log of Boring

BORING NUMBER

SHEET ____ OF ____

PROJECT NAME		PROJECT NUMBER		ELEVATION AND DATUM			LOCATION			
DRILLING COMPANY		DRILLER		DATE AND TIME STARTED			DATE AND TIME COMPLETED			
DRILLING EQUIPMENT		DRILLING METHOD		COMPLETION DEPTH			TOTAL NO. OF SAMPLES			
SIZE AND TYPE OF BIT		HOLE DIAMETER		NO. OF SAMPLES	BULK	SS	DRIVE	PITCHER		
DRILLING FLUID		DRILLING ANGLE		WATER LEVEL	FIRST		AFTER _____ HOURS			
SAMPLE HAMMER		HYDROGEOLOGIST/DATE			CHECKED BY/DATE					
TYPE		DRIVING WT.	DROP							
LITHOLOGY	DEPTH (FEET)	S A M P L E S	R E C O V E R Y	B C L O U N T	DESCRIPTION	USCS SYMBOL	ESTIMATED PERCENT OF			COMMENTS
							GR	SA	FI	

Figure I-B-1-1: Field Log of Boring

ASTM International (ASTM) has standardized rock coring methods (D-2113) (ASTM 2006). Several standardized core sizes for bits, shells, and casings have been established (e.g., RX, NX, SW). Table I-B-1-2 summarizes the various size standards for core barrels and bits.

Table I-B-1-2: Standard Core Barrel Sizes (in inches)

Description	RX or RW	EX or EW	AX or AW	BX or BW	NX or NW	HX or HW	PX or PW	SX or SW	UX or UW	ZX or ZW
Bit Set Normal I.D.	0.750	0.845	1.185	1.655	2.155	3.000	—	—	—	—
Bit Set Normal and Thin-wall O.D.	1.160	1.470	1.875	2.345	2.965	3.890	—	—	—	—
Bit Set Thin-wall. I.D.	0.735	0.905	1.281	1.750	2.313	3.187	—	—	—	—
Shell Set Normal and Thin-wall O.D.	1.175	1.485	1.890	2.360	2.980	3.907	—	—	—	—
Casing Bit Set I.D.	1.000	1.405	1.780	2.215	2.840	3.777	4.632	5.632	6.755	7.755
Casing Bit Set and Shoe O.D.	1.485	1.875	2.345	2.965	3.615	4.625	5.650	6.780	7.800	8.810

I.D. Inner Diameter
O.D. Outer Diameter

The selection of the most practical core barrel for the anticipated bedrock conditions is important. The selection of the correct drill bit is also essential to good recovery and drilling production. Although the final responsibility of bit selection usually rests with the drilling contractor, there is a tendency in the trade to use “whatever happens to be at hand.” The selection of the diamond size, bit crown contour, and number of water ports depends upon the characteristics of the rock mass. The use of an incorrect bit can be detrimental to the overall core recovery. Generally, fewer and larger diamonds are used to core soft formations, and more numerous, smaller diamonds, which are mounted on the more commonly used semi-round bit crowns, are used in hard formations. Special impregnated diamond core bits have been developed recently for use in severely weathered and fractured formations where bit abrasion can be very high.

Core barrels are manufactured in three basic types: single tube, double tube, and triple tube. These basic units all operate on the same principle of pumping drilling fluid through the drill rods and core barrel. This is done to cool the diamond bit during drilling and to carry the borehole cuttings to the surface. A variety of coring bits, core retainers, and liners are used in various combinations to maximize the recovery and penetration rate of the selected core barrel.

The simplest type of rotary core barrel is the single tube, which consists of a case hardened, hollow steel tube with a diamond drilling bit attached at the bottom. The diamond bit cuts an annular groove, or kerf, in the formation to allow passage of the drilling fluid and cuttings up the outside of the core barrel. The single tube core barrel cannot be employed in formations that are subject to erosion, slaking, or excessive swelling, as the drilling fluid passes over the recovered sample during drilling.

The most popular and widely used rotary core barrel is the double tube, which is basically a single tube barrel with a separate and additional inner liner that is available in either a rigid or swivel type of construction. In the rigid types, the inner liner is fixed to the outer core barrel so that it rotates with the outer tube. In contrast, the swivel type of inner liner is supported on a ball-bearing carrier, which allows the inner tube to remain stationary, or nearly so, during rotation of the outer barrel. The sample, or core, is cut by rotation of the diamond bit. The bit is in constant contact with the drilling fluid as it flushes out the borehole cuttings. The addition of bottom discharge bits and fluid control valves to the core barrel system minimizes the amount of drilling fluid and its contact with the sample, which further decreases sample disturbance.

The third and most recent advancement in rotary core barrel design is the triple tube core barrel, which adds another separate, non-rotating liner to the double tube core barrel. This liner, which retains the sample, consists of a clear plastic solid tube or a split, thin metal liner. Each type of liner has its distinct advantages and disadvantages; however, they are both capable of obtaining increased sample recovery in poor quality rock or semi-cemented soils, with the additional advantage of minimizing sample handling and disturbance during removal from the core barrel.

The rotary core barrels that are available range from 1 to 10 inches in diameter, and the majority may be used with water, drilling mud, or air for recovering soil samples. Of the three basic types of core barrels, the double tube core barrel is most frequently used in rock core sampling for geotechnical engineering applications. The triple tube core barrel is used in zones of highly variable hardness and consistency. The single tube is rarely used because of its sample recovery and disturbance problems.

Coring to obtain analytical samples requires only filtered air as the drilling fluid. The core barrel operates by rotating the outer barrel to allow the bit to penetrate the formation. The sample is retained in the inner liner, which in most samplers does not rotate with the outer barrel. As the outer barrel is advanced, the sample rises in the inner liner. In general, a secondary liner consisting of plastic or metal is present within the inner liner to ensure the integrity of acquired samples.

Obtain soil or rock core samples with a core barrel or a 5-foot split-spoon core barrel using the following procedure:

- Drill the core barrel to the appropriate sampling depth. It is important to use only clean, filtered air (i.e., particulate- and petroleum-free) as drilling fluid while coring to obtain samples for laboratory analysis. If necessary, distilled water may be added through the delivery system of the coring device by the driller, provided that the drilling returns cannot be brought to the surface by air alone.
- Retrieve the core barrel from the hole. Use care to ensure that the contents of the core barrel do not fall out of the bottom during withdrawal and handling.
- Open the core barrel by removing both the top and bottom fittings. Then remove the sample within the inner liner from the core barrel and take it to the sample handling area.

- Conduct lithologic logging of each sample in accordance with Procedure I-E, *Soil and Rock Classification*, and enter each sample into the boring log presented in Figure I-B-1-1.
- If VOCs are suspected to be present, screen the sample with an OVM or equivalent, and collect headspace samples according to Section 5.4.

Collect core samples submitted for VOC analysis using the procedure found in Attachment I-B-1-1.

- If rock core samples are to be recovered for analytical laboratory or geotechnical analyses, the core barrel will either be lined with a sample container (e.g. stainless steel or acrylic liner), or the samples will be transferred to an appropriate sample container (e.g. stainless steel / acrylic liner, glass jar). Samples collected or placed in stainless steel or acrylic liners shall have the ends of the liners covered with Teflon film and sealed with plastic end caps. The sample containers shall be labeled in accordance with Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*, and Procedure III-F, *Sample Handling, Storage, and Shipping*, and immediately placed on ice in a cooler.
- Place the samples in core boxes if samples are to be catalogued and stored. Affix the CTO number; site name; borehole number; start depth; end depth; date; and name of the geologist, hydrogeologist, or geotechnical engineer to the core box. Store the samples in a clean, dry area on site during the duration of field sampling; samples shall not be brought back to the office or equipment storage area. Document proper disposal at the completion of field sampling.
- Decontaminate all sampling equipment prior to each use according to Procedure I-F, *Equipment Decontamination*.

5.3.4 Bulk Samples

The term “bulk sample” represents a sample collected from borehole cuttings either from the hollow-stem auger flights or the discharge of any of the rotary or cable tool drilling techniques. This type of sample is useful for describing soils or consolidated materials, where no undisturbed samples representative of a specific depth are being collected. It should be noted that this type of sample is generally considered to be the least acceptable of the types of samples previously described in this section and shall be used only when detailed lithologic data are not needed.

Handling and lithologic logging of bulk samples should be performed in a manner consistent with that used for split-spoon samples. An estimate of the depth (or range of depths) from which the sample was obtained, and date and time of collection should be recorded on the boring log. Samples are usually collected every 5 feet, preferably at several different times during a 5-foot drilling run so that lithologic variations occurring over the drilling interval can be noted. Rock fragments commonly range in size from 1/16 to 1/2 inch, with many fragments larger than 1/4 inch. Larger fragments can often be obtained with reverse circulation rotary drilling. Rotary-tool samples usually contain some caved materials from above and, when drilling with mud or water rotary, the cuttings may contain soil and rock recirculated by the mud/water pump; therefore, care must be exercised when interpreting lithologic logs completed using data from this type of sample.

Because the collection of samples at the surface lags behind the actual drilling of a given lithologic bed at depth, the samples usually represent a depth less than that of the current depth of the drill bit. The amount of lag may be significant in deeper boreholes, but can be eliminated by collecting samples after circulating for a period of time sufficient to permit the most recently drilled materials to reach the surface.

5.3.5 Borehole Abandonment

Following completion of soil sampling, the borehole shall be properly abandoned unless a monitoring well is to be installed. Abandonment shall occur immediately following acquisition of the final sample in the boring and shall consist of the placement of a bentonite-cement grout from the bottom of the boring to within 2 feet of ground surface. The grout mixture shall consist of a mix of 7 to 9 gallons of water per 94-pound bag of Portland Type I or II cement with 3 to 5 percent by weight of powdered bentonite. Other commercial products such as Volclay are also acceptable with approval of the CTO Manager and QA Manager or Technical Director. The bentonite-cement grout shall be placed in one continuous pour from the bottom of the boring to within at least 0.5 foot to 2 feet of ground surface through a tremie pipe or hollow-stem augers. Additional grout may need to be placed if significant settlement occurs. The remaining portion of the boring can be filled with topsoil.

5.3.6 Trenching and Pit Sampling

Trenching is used in situations where the depth of investigation generally does not exceed 10 to 15 feet and is most suitable for assessing surface and near-surface contamination and geologic characteristics. In addition, trenching allows detailed observation of shallow subsurface features and exposes a wider area of the subsurface than is exposed in borings. Pit sampling is typically conducted in conjunction with a removal or remedial action.

A backhoe is usually used to excavate shallow trenches to a depth of no greater than 15 feet. Front-end loaders or bulldozers are used when it is not possible to use a backhoe; for example, when materials lack cohesion or are too stiff, or the terrain is too steep for a backhoe. Larger excavations (i.e., pits) may require additional equipment as described in the CTO work plan (WP) or equivalent document.

Typically, trenches have widths of one to two backhoe buckets and range in length from 5 to 20 feet, although larger trenches can be dug depending on the objectives of the study. Pits will vary in size depending upon the scope of the removal/remedial action. Soils removed from the trench/pit shall be carefully placed on plastic sheeting or other appropriate materials in the order of removal from the trench or excavation. The shallow excavated materials can be placed on one side of the trench/excavation and deeper materials on the other side to allow better segregation of shallow and deep materials.

Soil sampling locations within each trench or pit shall be chosen on the basis of visual inspection and any VOC screening results. Samples shall be collected from either the sidewalls or the bottom of the trenches/excavations. Soil sampling should be conducted outside the trench/excavation, and

personnel generally should not enter a trench or pit if there is any other means (e.g., backhoe buckets, hand augers, shovels, or equivalent) to perform the work. If entry is unavoidable, then a competent person shall first determine acceptable entry conditions including sloping, shoring, and air monitoring requirements, personal protective equipment (PPE), and inspections. In addition, the site-specific health and safety plan must be amended to include applicable requirements of 29 Code of Federal Regulations (CFR) 1910.146.

Equipment used for trench/pit sampling may include hand augers, core samplers (slide hammer), liners inserted manually into the soil, or hand trowels. In addition, samples may be obtained directly from the trench or from the backhoe bucket. All samples shall be properly sealed and labeled according to Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*, and immediately placed on ice in a cooler as indicated in Procedure III-F, *Sample Handling, Storage, and Shipping*. Sample locations and descriptions shall be described and recorded on the field trench/pit log.

Trench or pit samples submitted for VOC analysis must be collected using the procedure found in Attachment I-B-1-1.

The exposed materials shall be observed for lithologic and contaminant characteristics following completion of the excavation activities. Detailed mapping of the exposed walls of the trench shall be conducted, although in no instance shall personnel enter a trench without first determining acceptable entry conditions including sloping, shoring, and air monitoring requirements, PPE, and inspections as defined in 29 CFR 1910.146. A useful mapping technique for extremely long trenches or large pits is to examine the vertical profile of the excavation at horizontal intervals of 5 to 10 feet, in a manner similar to the method typically used for preparation of a geologic cross-section using soil borings. Field observations shall be noted in the field logbook and described in detail on a trench/pit log. An example of a field trench/pit log is presented in Figure I-B-1-2. The lithologic description shall include all soil classification information listed in Procedure I-E, *Soil and Rock Classification*. A cross-section of the trench or pit should also be included on the field trench/pit log. Photographs of the trench/pit are also an excellent way to document important subsurface features.

During backfilling of the excavation, the materials excavated from the greatest depth should be placed back into the excavation first. Lithologic materials should be replaced in 2- to 4-foot lifts and recompacted by tamping with the backhoe bucket. For certain land uses or site restoration, more appropriate compaction methods may be required. These methods shall be described in the CTO WP and design documents. The backfilled trench/pit shall be capped with the original surface soil. If materials are encountered that cannot be placed back in the excavation, they should be placed either in DOT-approved open-top drums or placed on and covered with visqueen or equivalent material and treated as IDW in accordance with Procedure I-A-6, *Investigation-Derived Waste Management*.

5.4 SURFACE SOIL SAMPLING

All surface soil samples shall be accurately located on field maps in accordance with Procedure I-I, *Land Surveying*. Detailed soil classification descriptions shall be completed in accordance with

Procedure I-E, *Soil and Rock Classification* and recorded on the surface and shallow soil sample log (Figure I-B-1-3).

In general, surface soil samples are not to be analyzed for VOCs unless there is sufficient evidence to suggest the presence of such compounds.

Methods commonly used for collection of surface soil samples are described below. Considerations when using IS methods are provided in Attachment I-B-1-1.

5.4.1 Hand Trowel

A stainless-steel or disposable hand trowel may be used for sampling surface soil in instances where samples are not to be analyzed for volatile organics. The hand trowel is initially used to remove the uppermost 2 inches of soil and is then used to acquire a representative sample of deeper materials to a depth of 6 inches. Generally, only samples within the upper 6 inches of soil should be sampled using these methods. The depth of the sample shall be recorded in the surface and shallow soil sample log (Figure I-B-1-3). The soil classification shall include all the information outlined in Procedure I-E, *Soil and Rock Classification*.

Soil samples collected using a hand trowel are usually placed into pre-cleaned, wide-mouth glass jars. The jar is then sealed with a tight-fitting cap, labeled according to Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*, and placed on ice in a cooler in accordance with Procedure III-F, *Sample Handling, Storage, and Shipping*. All sampling equipment must be decontaminated prior to each use according to the methods presented in Procedure I-F, *Equipment Decontamination*.

5.4.2 Hand Auger

A soil recovery hand auger consisting of a metal rod, handle, detachable stainless-steel core barrel, and inner sleeves can be used to obtain both surface soil and trench samples. Multiple extensions can be connected to the sampler to facilitate the collection of samples at depths up to 15 feet below the existing ground surface.

Pre-cleaned sample liners are loaded into the core barrel prior to sampling. In general, these liners are used not only to collect samples, but also to serve as the sample container. Alternatively, in instances where VOCs are not to be analyzed or where not enough samples can be collected to completely fill a liner, samples can be transferred to wide-mouth glass jars. In either case, the sample shall be labeled according to Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody* and immediately placed on ice in a cooler as indicated in Procedure III-F, *Sample Handling, Storage, and Shipping*. To minimize possible cross-contamination, the soil recovery hand auger and sample liners shall be decontaminated prior to each use according to the procedures described in Procedure I-F, *Equipment Decontamination*.

5.4.3 Slide Hammer Sampling

In instances where the soil type precludes the collection of soil samples using the soil recovery hand auger, a manually operated slide hammer can be used to collect relatively undisturbed soil samples from excavations and surface soils. The slide hammer consists of a 6- to 12-inch core barrel that is connected to the slide hammer portion of the device using detachable extensions.

The core sampler is typically loaded with two to four sample liners, depending on the liner length, which are not only used to acquire the samples, but also serve as the sample container. Immediately following acquisition, samples shall be labeled according to Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody* and immediately placed on ice in a cooler as indicated in Procedure III-F, *Sample Handling, Storage, and Shipping*.

All of the sampling equipment that comes into contact with the sample medium shall be decontaminated in accordance with Procedure I-F, *Equipment Decontamination*. Split-barrel slide hammer core samplers, which have recently become available, are much easier to decontaminate than the older, single-piece core barrel, and should be used in place of the older core barrels where possible.

This page intentionally left blank

FIELD LOG OF TRENCH/PIT									
Project							Name		
Trench Number		Project Number		Elevation and Datum			Location		
Equipment Supplier		Operator		Date and Time Started			Date and Time Completed		
Equipment Type		Trench Orientation		Total Depth			Total Number of Samples		
Bucket Width	Trench Length	Trench Width		No. Of Samples	Bulk	Ss	Drive	Hand Auger	
Geologist or Hydrogeologist/Date				Check by/Date					
SOIL DESCRIPTION									
LITHOLOGY	DEPTH (FEET)	DESCRIPTION	USCS SYMBOL	Est. % of			COMMENTS		
				G	S	F			
							Description taken _____ feet		
							from _____ end of trench.		

Figure I-B-1-2: Field Log of Trench/Pit

This page intentionally left blank

SURFACE AND SHALLOW SOIL SAMPLE LOG							
Project	Number	Project Name	Date	Time			
Sample	Identification	Number	and	Time	Checked by		
Sampled	by			Recorded by			
Method	of				Collection		
Surface						Description	
Notes							
Soil Sample Data							
Location							
Coordinates				Elevation			
LITHOLOGY	DEPTH (FEET)	DESCRIPTION	USCS SYMBOL	Est. % of			COMMENTS
				G	S	F	

Figure I-B-1-3: Surface and Shallow Soil Sample Log

This page intentionally left blank

5.4.4 Hand Sampling Using Sample Liners

Surface soil samples can sometimes be collected by hand using just the sample liners. This method can be used in cases where the surface soils are soft or where it is advantageous to minimize the disturbance of the sample (such as when sampling for volatiles). Obtaining surface soil samples with this method consists merely of pushing or driving the sample tube into the ground by hand.

The sample liner (with the collected sample inside) is then removed from the ground and capped with Teflon film and plastic end caps. The sample is labeled according to Procedure III-E, *Record Keeping, Sampling Labeling, and Chain-Of-Custody* and immediately placed on ice in a cooler. All liners shall be decontaminated prior to use in accordance with Procedure I-F, *Equipment Decontamination*. Since the only pieces of equipment used are the sample liners, this method helps to minimize the required amount of equipment decontamination.

5.5 VOLATILE ORGANICS SCREENING AND HEADSPACE ANALYSIS

Volatile organics screening and headspace analysis is performed to preliminarily assess if the sample contains VOCs. Volatile organics screening and headspace analysis of samples shall be performed using a portable organic vapor analyzer (OVA), a portable photoionization detector (PID), or other similar instrument.

Volatile organics screening and headspace analysis is intended as a field screen for the presence of VOCs. The method measures the presence or absence of VOCs in the headspace (air) above a soil sample. Various factors affect the level of VOCs volatilizing from soils, such as concentration in the soil, temperature of the soil and air, organic carbon content of the soil, equilibration time, moisture content of the soil, and the chemical and physical characteristics of the VOCs. Therefore, headspace readings can only be regarded as qualitative assessments of volatiles, and caution should be exercised if using this technique to select samples for analytical testing. OVA and PID readings can vary because the two instruments have different sensitivities to the various VOCs and are usually calibrated relative to different gas standards (i.e., methane for the OVA and isobutylene for the PID).

In order to screen samples for VOCs, the instrument probe shall be inserted into the top of the sample liner immediately after the sampler is opened. The instrument response (normally in parts per million) is then recorded in the field notebook and/or the field log.

For headspace analysis, a portion of the sample is transferred into a zipper storage bag or pre-cleaned glass jar, which is then sealed and agitated. The VOCs are allowed to volatilize into the headspace and equilibrate for 15 to 30 minutes. Next, the instrument probe is then inserted into the container to sample the headspace, and the instrument response is recorded in the field notebook and/or the field log.

6. Records

Soil classification information collected during soil sampling should be documented in borehole, trench, and surface soil log forms. All log entries shall be made in indelible ink. Information

concerning sampling activities shall be recorded on sample log forms or in the field logbook. The CTO Manager or designee shall review all field logs on at least a monthly basis. Procedures for these activities are contained in this manual. Copies of this information should be sent to the CTO Manager and to the project files.

7. Health and Safety

Field Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

ASTM International (ASTM). 2005. *Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations*. ASTM D6282-98. West Conshohocken, PA.

———. 2006. *Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation*. D2113-06. West Conshohocken, PA.

Department of Defense, United States (DoD). 2005a. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

———. 2005b. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2B: Quality Assurance/quality Control Compendium: Minimum QA/QC Activities*. Final Version 1. DoD: DTIC ADA 426957, EPA-505-B-04-900B. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www2.epa.gov/sites/production/files/documents/qaqc_v1_0305.pdf.

———. 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2A: Optimized UFP-QAPP Worksheets*. Revision 1. March.

Department of the Navy (DON). 2007. *Environmental and Natural Resources Program Manual*. OPNAV Instruction 5090.1C. 30 October.

———. 2010. *Ammunition and Explosives Safety Ashore*. NAVSEA OP 5 Volume 1, 7th Revision, Change 11. 0640-LP-108-5790. Commander, Naval Sea Systems Command. July 1. United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-A-6, *Investigation-Derived Waste Management*.

Procedure I-C-1, *Monitoring Well Installation and Abandonment*.

Procedure I-E, *Soil and Rock Classification*.

Procedure I-F, *Equipment Decontamination*.

Procedure I-I, *Land Surveying*.

Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*.

Procedure III-F, *Sample Handling, Storage, and Shipping*.

9. Attachment

Attachment I-B-1-1: Sampling and Handling Procedure: Analysis of Soil for Volatile Organic Compounds

This page intentionally left blank

Attachment I-B-1-1
Sampling and Handling Procedure:
Analysis of Soil for Volatile Organic Compounds

This page intentionally left blank

1. Laboratory Requirements

The laboratory must be capable of performing (1) United States (U.S.) Environmental Protection Agency (EPA) Solid Waste (SW)-846 Method 5035 and (2) Method 8260, 8021, or 8015 (purgeable hydrocarbons), depending on the project objectives (EPA 2007). The laboratory must have method performance data to verify this capability.

Sampling and handling procedures for the analysis of soil for volatile organic compounds (VOCs) will depend on the project objectives and the sampling approach. The laboratory is responsible for providing the necessary sample containers with preservatives (if applicable) that meet consumable certification requirements. The following section describes the consumable options for VOC soil sampling. In addition, sample containers must have a sample label and be weighed prior to shipment to the field for use. The laboratory is responsible for recording the weight of each container before and after sampling. Alternately, EnCore-type samplers may be employed.

The laboratory must provide a minimum of three prepared containers, or EnCore-type samplers, for each soil sample analyzed for VOCs.

2. Supplies

- Disposable coring devices (hereafter referred to as coring devices): either vendor-calibrated sample coring devices, or EnCore-type samplers. One coring device sampler per sampling location, plus additional coring devices (5 percent) in case of breakage.
- The number and type of laboratory prepared sample containers will depend upon the sampling scheme employed.
- For discrete soil VOCs, two 40 milliliter (mL) volatile organic analyte (VOA) vials with 5 mL of ASTM International (ASTM) Type II water, single-use magnetic stir bar with Teflon lined septa cap, one VOA vial with 5 mLs of methanol with a Teflon lined septa cap, and sample label, or three EnCore-type samplers.
- For incremental soil VOC samples, the total number of sample containers will depend upon the number of increments collected. The laboratory shall provide containers which contain a maximum of 30 mL of methanol (or as dictated by Federal Laws for transporting Exempted Limited Quantities of Dangerous Goods (49 CFR 100-185) with a Teflon lined septa cap, and sample label.
- Reagent/trip blanks: laboratory-prepared in identical fashion to sample vials.
- Temperature blanks: laboratory-prepared.
- 2-ounce glass jars with Teflon-lined lid: for dilution purposes and percent moisture determination.
- Nitrile or equivalent gloves.

3. Field Sampling

The following directions apply to all sampling techniques for soil coring devices: For reasons stated in section 3.4 of this attachment and explained in detail in Sections 8.2.1.8 and A7.2 of EPA Method 5035, core-type (i.e., Terra Core, EnCore, etc.) samplers are recommended for sample collection, not sample collection and transport (EPA 2007).

- Always wear clean gloves while handling sample containers to help prevent soil and other debris from adding to the weight of the vial. Always don a new pair of gloves and use a new core sampler for each sampling location.
- Whenever possible, collect the soil samples for VOC analysis in place. If this is not possible, practical, or safe, collect the sample from a sample liner, or if absolutely necessary, from a backhoe bucket. Avoid having particles of soil adhering to the grooves of the screw cap or the container threads.
- Collect VOA samples as quickly as possible to avoid unnecessary VOC losses. EPA Region 9 recommends total exposure of the soil sample to ambient conditions should not exceed 10 seconds.
- Once the soil has been transferred to the sample container, screw the cap back on and mark the sample ID on the label with a ballpoint pen. Do not use a pen that has high solvent concentrations in the ink such as a Sharpie.
- Place the VOA vial inside a cooler containing either wet ice in sealed bags or gel ice.
- Collect the number of sample containers as describe in Section 2 of this standard operating procedure at each sampling location. The same core sampler may be used to prepare all containers. Duplicate samples require collecting additional sample containers. For percent moisture purposes, soil must also be collected in 2-ounce or greater glass jars with Teflon-lined lids at each sampling location. If other analyses are being conducted for the sampling location, then the percent moisture may be obtained from other sample containers. The 2-ounce jar will be completely filled with zero headspace. If other analyses are not being conducted at the sampling location, then an additional sample must be collected in another 2-ounce glass jar for percent moisture.
- When incrementally collecting samples from a liner for non-VOC analysis, a core sampler may be used to obtain equal incremental sample volumes. The liner will have been sliced open prior to incremental sample collection for access to the entire length of the sample.
- Depending on the 1) pre-selected volume to be collected per sample, 2) the sample/liner length available for incremental sampling, and 3) the size of the core tool, collect as many cores from the entire soil sample/liner section that will total to the required sample volume. For example, if 30 grams is the volume to be collected per sample location, the sample/liner length is 6 inches, and a 5 gram core tool is used, then 6 incremental samples, located throughout the sample length to provide adequate, representative coverage of the entire

6 inches of sample, would be collected (i.e., 6 incremental samples could be taken at equally spaced locations across the sample length, totaling 30 grams of sample).

- Collect one equipment blank per laboratory or vendor shipment of Terra Core, as described in Procedure III-B, *Field QC Samples (Water, Soil)*, unless the syringes are certified clean (e.g., certificate of analysis or equivalent documentation) by the vendor.
- Place samples in bubble wrap or other protective covering. Place custody seals on the covering. Custody seals or tape must not be placed directly on the sample vials, as this will interfere with the analytical instrumentation, final weight of the sample, and ultimate sample VOC concentration.

The following additional directions for VOC soil sample collection are taken from EPA SW-846 Method 5035A Appendix A7.0 (EPA 2002).

Collection of Samples for Analysis

After a fresh surface of the solid material is exposed to the atmosphere, the subsample collection process should be completed in the least amount of time to minimize the loss of VOCs due to volatilization. Removing a subsample from a material should be done with the least amount of disruption (disaggregation) as possible. Additionally, rough trimming of the sampling location's surface layers should be considered if the material may have already lost VOCs (been exposed for more than a couple of minutes) or if it might be contaminated by other waste, different soil strata, or vegetation. Removal of surface layers can be accomplished by scraping the surface using a clean spatula, scoop, knife, or shovel (ASTM 2005, Hewitt et al. 1999).

Subsampling of Cohesive Granular but Uncemented Materials Using Devices Designed to Obtain a Sample Appropriate Analysis

Collect subsamples of the appropriate size for analysis using a metal or rigid plastic coring tool. For example, coring tools for the purpose of transferring a subsample can be made from disposable plastic syringes by cutting off the tapered front end and removing the rubber cap from the plunger or can be purchased as either plastic or stainless-steel coring devices. These smaller coring devices help to maintain the sample structure during collection and transfer to the VOA vials, as do their larger counterparts used to retrieve subsurface materials. When inserting a clean coring tool into a fresh surface for sample collection, air should not be trapped behind the sample. If air is trapped, it could either pass through the sampled material causing VOCs to be lost or push the sample prematurely from the coring tool.

The commercially available EasyDraw Syringe, Powerstop Handle, and Terra Core sampler coring devices are designed to prevent headspace air above the sample contents. For greater ease in pushing into the solid matrix, sharpen the front edge of these tools. The optimum diameter of the coring tool depends on the following:

- Size of the opening on the collection vial or bottle (tool should fit inside mouth)
- Dimensions of the original sample, particle size of the solid materials (e.g., gravel-size particles would require larger samplers)
- Volume of sample required for analysis

For example, when a 5-gram (g) subsample of soil is specified, only a single 3-cubic-centimeter (cm³) volume of soil has to be collected (assuming the soil has density of 1.7 g/cm³). Larger subsample masses or more subsample increments are preferred as the heterogeneity of the material increases. After an undisturbed sample has been obtained by pushing the barrel of the coring tool into a freshly exposed surface and then removing the filled corer, quickly wipe the exterior of the barrel with a clean disposable towel.

The next step varies depending on whether the coring device is used for sample storage and transfer or solely for transfer. If the coring tool is used as a storage container, cap the open end after ensuring that the sealing surfaces are cleaned. If the device is to be solely used for collection and not for storage, immediately extrude the sample into a VOA vial or bottle by gently pushing the plunger while tilting the VOA vial at an angle (to avoid splashing any deionized water or methanol). The volume of material collected should not cause excessive stress on the coring tool during intrusion into the material, or be so large that the sample easily falls apart during extrusion. Obtain and transfer samples rapidly (<10 seconds) to reduce volatilization losses. If the vial or bottle contains ASTM reagent Type II water, hold it at an angle when extruding the sample into the container to minimize splashing. Just before capping, visually inspect the lip and threads of the sample vessel, and remove any foreign debris with a clean towel, allowing an airtight seal to form.

Devices that Can Be Used for Subsampling a Cemented Material

The material requiring sampling may be so hard that even metal coring tools cannot penetrate it. Subsamples of such materials can be collected by fragmenting a larger portion of the material using a clean chisel to generate aggregate(s) of a size that can be placed into a VOA vial or bottle. When transferring the aggregate(s), precautions must be taken to prevent compromising the sealing surfaces and threads of the container. Losses of VOCs by using this procedure are dependent on the location of the contaminant relative to the surface of the material being sampled. Therefore, take caution in the interpretation of the data obtained from materials that fit this description. As a last resort, when this task cannot be performed on site, a large sample can be collected in a vapor-tight container and transported to the laboratory for subsampling. Collect, fragment, and add the sample to a container as quickly as possible.

Devices that Can Be Used for Subsampling a Non-cohesive Granular Material

As a last resort, gravel, or a mixture of gravel and fines that cannot be easily obtained or transferred using coring tools, can be quickly sampled using a stainless-steel spatula or

scoop. If the collection vial or bottle contains ASTM reagent Type II water, transfer samples with minimal splashing and without the spatula or scoop contacting the liquid contents. For some solids, a wide-bottom funnel or similar channeling device may be necessary to facilitate transfer to the container and prevent compromising the sealing surfaces of the container. Take caution when interpreting the data obtained from materials that fit this description. Loss of VOCs is likely due to the nature of the sampling method and the non-cohesive nature of the material, which exposes more surface area to the atmosphere than other types of samples. During the sampling process, non-cohesive materials also allow coarser materials to separate from fines, which can skew the concentration data if the different particle sizes, which have different surface areas, are not properly represented in the sample.

Use of the EnCore Sampler (or Equivalent) for Sample Transport and Storage

The EnCore sampler is a sampling device that can be used as both a simultaneous coring tool for cohesive soils and a transport device to a support laboratory (field or off site). The EnCore sampler is intended to be a combined sampler-storage device for soils until a receiving laboratory can initiate either immediate VOC analysis, or preserve extruded soil aliquots for later VOC analysis. It is meant to be disposed of after use. The commercially available device is constructed of an inert composite polymer. It uses a coring/storage chamber to collect either a 5-gram or 25-gram sample of cohesive soils. It has a press-on cap with hermetically a vapor-tight seal and locking arm mechanism. It also has a vapor-tight plunger for the non-disruptive extrusion of the sample into an appropriate container for VOC analysis of soil.

An individual disposable EnCore sampler (or equivalent) is needed for each soil aliquot collected for vapor partitioning or ASTM reagent Type II water sample preparation. Upon soil sample collection, store the EnCore sampler is at 4 ± 2 degrees centigrade ($^{\circ}\text{C}$) until laboratory receipt within 48 hours. Upon laboratory receipt, soil aliquots are extruded to appropriate tared and prepared VOA vials.

Validation data have been provided to support use of the EnCore sampler for VOC concentrations in soil between 5 and 10 parts per million, for two sandy soils, with a 2-day holding time at $4 \pm 2^{\circ}\text{C}$. Preliminary data (Soroni et al. 2001) demonstrate an effective 2-day (48-hour) holding time at $4 \pm 2^{\circ}\text{C}$ for three sandy soil types with VOC concentrations at 100 parts per billion (ppb) (benzene and toluene at 300 ppb), as well as an effective 1- or 2-week holding time at $< -7^{\circ}\text{C}$ (freezing temperature). Recent published work (EPA 2001) neither definitively supports nor shows the EnCore device to be ineffective for sample storage at these preservation temperatures. Soils stored in the EnCore device for 2 calendar days at $4 \pm 2^{\circ}\text{C}$ are subject to loss of benzene, toluene, ethylbenzene, and xylene (BTEX) compounds by biodegradation if the soil is an aerated, biologically active soil (e.g., garden soil) (Soroni et al. 1999), but this BTEX loss is eliminated for up to 48 hours under freezing conditions (Hewitt 1999).

Further details on the EnCore sampler can be found in ASTM D4547-09 (ASTM 2009) or other publications.

Since Naval Facilities Engineering Command, Pacific action levels for VOCs in soil are typically associated with EPA Region 9 preliminary remediation goals for residential exposure scenarios, it is recommended that if EnCore samplers are used, they be frozen on site prior to shipment to the laboratory or extruded into a 40-mL VOA vial before shipment.

4. Sample Shipping and Holding Times

Samples preserved with water may be shipped either at $4 \pm 2^{\circ}\text{C}$ or frozen at -7°C . The primary difference between the two shipping temperatures is the allowable holding time of the sample between sample collection and sample analysis. Samples shipped at $4 \pm 2^{\circ}\text{C}$ must either be received and analyzed by the laboratory within 48 hours of sample collection or be received by the laboratory within 48 hours, frozen upon receipt, and analyzed within 14 days of sample collection. Samples shipped at -7°C and received/maintained by the laboratory in a frozen state must be analyzed within 14 days of sample collection.

If soil samples are to be field frozen, place the frozen samples in a cooler containing fresh, frozen gel packs or an ice and rock salt mixture, and ship the cooler using an overnight carrier. Dry ice may be used as a refrigerant for sample shipment, but must be coordinated with the overnight carrier in advance. The sample vials and caps must never be placed in direct contact with the dry ice since cracking may occur.

Soil or sediment samples contained in methanol and 2-ounce glass jars may be shipped in standard coolers using conventional shipping protocols described in Procedure III-F, *Sample Handling, Storage, and Shipping*, if the sample appears to have a moisture content that might cause the sample to expand and the glass jar to break due to freezing. If soil samples contained in 2-ounce glass jars are shipped in this manner, then trip blanks must accompany them during shipment.

Reagent/trip blanks that contain the same volume of ASTM Type II water and sample label used in the sample VOA vials must be included in each shipment. The reagent/trip blanks will be packaged, shipped, and analyzed in the same manner as field samples. Reagent/trip blanks will be analyzed to evaluate cross-contamination during shipment and to identify potential reagent contamination issues.

5. Laboratory Receipt

Upon receipt by the analytical laboratory, the sample temperature must be measured and recorded. The laboratory should note whether the samples are frozen. The samples must be logged in and assigned an analysis date to ensure that samples are analyzed within the 14-day holding time.

Once the samples have been logged in, they are placed in a freezer at 0°C or colder until they are analyzed. Samples arriving in a non-frozen state (greater than 0°C) are to be frozen upon receipt or

analyzed within 48 hours of sample collection. If the duration of sample shipment exceeds 48 hours, the non-frozen samples should be analyzed on the day of laboratory receipt.

The laboratory will prepare the samples for analysis as dictated by laboratory standard operating procedures and SW-846 Method 5035, and analyzed by Method 8260, 8021, or 8015 (purgeable hydrocarbons), depending on the project objectives.

6. References

49 Code of Federal Regulations (CFR) 100-185. *Hazardous Materials and Oil Transportation*.

ASTM International (ASTM). 2005. *Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations*. ASTM D6282-98. West Conshohocken, PA.

———. 2009. *Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds*. D4547-09. West Conshohocken, PA.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Environmental Protection Agency, United States (EPA). 2002. *Method 5035A Closed System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples*, Draft Revision 1. Office of Solid Waste. July.

———. 2007. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846*. 3rd ed., Revision 6. Office of Solid Waste. November. On-line updates at: <http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm>.

Hewitt, Alan. D. 1999. Frozen Storage of Soil Samples for VOC Analysis. *Environmental Testing & Analysis*, 8 (5), pp. 18–25, 46.

Hewitt, Alan. D. and K. F. Myers. 1999. *Sampling and On-Site Analytical Methods for Volatiles in Soil and Groundwater—Field Guidance Manual*; Special Report 99-16. Hanover, NH: U.S. Army Cold Regions Research and Engineering Laboratory. November.

Soroni, S. S. and J. F. Schaborn. 1999. *Performance of the Disposable EnCore Sampler for Storing Soil for Volatile Organic Analysis*. Proceedings of the 15th Annual Waste Testing and QA Symposium, EPA. Washington. pp. 129-134.

Soroni, S. S., J. F. Schaborn and J. F. Rovani. 2001. *Validation of a New Soil VOC Sampler: Performance of the En Core Sampler for Storage of Low VOC Concentrations and EPA Method 1311 Volatile Organic Analytes*. Topical Report WRI-01-R005; Laramie, WY: Western Research Institute.

Procedure III-B, *Field QC Samples (Water, Soil)*.

Procedure III-F, *Sample Handling, Storage, and Shipping.*

Geophysical Testing

1. Purpose

This section sets forth the standard operating procedure for acquiring surface geophysical data to facilitate the collection of geologic, hydrogeologic, and geotechnical data related to hazardous waste site characterization. This procedure is for use by personnel working on the United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

This procedure has been developed to help personnel: (1) determine whether surface geophysics should be used at a site; (2) choose the most applicable methods for a particular objective; and (3) implement proper field procedures. The specific supporting information explaining how various geophysical techniques will be applied shall be defined in the project-specific work plan (WP).

3. Definitions

For a more complete set of terms and definitions, refer to R. E. Sheriff (1991).

3.1 COUPLING

Coupling is the interaction between systems, and includes the following:

- A device for fastening together, as the plugs for connecting electrical cables.
- Aspects, which affect energy transfer. Thus the “coupling of a geophone to the ground” involves the quality of the plant (how firmly the two are in contact) and also considerations of the geophone’s weight and base area because the geophone-ground coupling system has natural resonances and introduces a filtering action.
- The type of mutual electrical relationship between two closely related circuits. As coupling would exclude dc voltages by employing a series capacitive element. Direct coupling may exclude higher frequency signals by using a capacitive element across the inputs or may allow all components to pass.

- Capacitive coupling may occur because of mutual capacitive impedance, as between the wires in induced polarization (IP) circuits (see Section 3.6) or between a wire and ground.
- Inductive coupling occurs because of mutual inductive impedance, such as between grounded IP transmitter and receiver circuits, especially at higher frequencies, greater distances, or lower earth resistivity. This may give rise to false IP anomalies. Also called electromagnetic (EM) coupling.
- Resistive coupling in IP surveying is due to leakage between wires, between a wire and ground, or through the resistance of the ground itself between two grounded circuits.

3.2 ELECTRICAL LOG

- A generic term that encompasses all electrical borehole logs (spontaneous potential [SP], normal, lateral, laterologs, induction, microresistivity logs).
- Also used for records of surface resistivity surveying; to compare electrical survey.
- Electrolog, a borehole log, which usually consists of SP and two or more resistivity logs, such as short and long normal and long lateral resistivity logs. Electrolog is a Dresser Atlas trade name.

3.3 ELECTRICAL SOUNDING

Electrical sounding is an IP, resistivity method, or electromagnetic method in which electrode or antenna spacing is increased to obtain information from successively greater depths at a given surface location. Electromagnetic sounding can also be done with a fixed spacing by varying the frequency (time-domain technique). Electrical sounding is intended to detect changes in resistivity of the earth with depth at this location (assuming horizontal layering).

Electrical Survey:

- Measurements at or near the earth's surface of natural or induced electrical fields to map mineral concentrations or for geological or basement mapping. (See electrical profiling, electrical sounding, electromagnetic method, resistivity method, self-potential method, induced-polarization method, telluric method, and magnetotelluric method).
- Electrical logs run in a borehole.

3.4 ELECTROMAGNETIC METHODS

A method in which the magnetic or electrical fields associated with artificially generated subsurface currents are measured. In general, EM methods are those in which the electric and magnetic fields in the earth satisfy the diffusion equation (which ignores displacement currents) but not Laplace's equation (which ignores induction effects) nor the wave equation (which includes displacement currents). One normally excludes methods that use microwave or higher frequencies (and that consequently have little effective penetration) and methods that use direct coupling or very low frequencies in which induction effects are not important (resistivity and IP methods). Some methods that employ natural energy as the source, such as Afmag, are usually classified as EM methods, whereas other methods using natural energy, such as the magnetotelluric method, are not.

3.5 GEOPHYSICS

- The study of the earth by quantitative physical methods, especially by seismic reflection and refraction, gravity, magnetic, electrical, and radiation methods.
- The application of physical principles to study the earth. Includes the branches of: (a) seismology (earthquakes and elastic waves); (b) geothermometry (heating of the earth, heat flow, and volcanology and hot springs); (c) hydrology (ground and surface water and sometimes including glaciology); (d) oceanography; (e) meteorology; (f) gravity and geodesy (the earth's gravitational field and the size and form of the earth); (g) atmospheric electricity and terrestrial magnetism (including ionosphere, Van Allen belts, telluric currents); (h) tectonophysics (geological processes in the earth); and (i) exploration and engineering geophysics. Geochronology (the dating of earth history) and geocosmogony (the origin of the earth). These are sometimes added to the foregoing list. Enthusiasts in particular branches are inclined to appropriate the word "geophysics" to their own branch exclusively, whether that branch be ionospheric studies or exploration for oil.
- Exploration geophysics is the use of seismic, gravity, magnetic, electrical, EM, etc., methods in the search for oil, gas, minerals, water, etc., for economic exploitation.

3.6 INDUCED POLARIZATION

- IP is an exploration method involving measurement of the slow decay of voltage in the ground following the cessation of an excitation current pulse (time-domain method) or low frequency (below 100 Hertz) variations of earth impedance (frequency-domain method). Also known as the overvoltage method. Refers particularly to electrode polarization (overvoltage) and membrane polarization of the earth. Also called induced potential, overvoltage, or interfacial polarization. Various electrode configurations are used.
- The production of a double layer of charge at mineral interfaces or of changes in such double layers as a result of applied electric or magnetic fluids.

3.7 LOW-VELOCITY LAYER

- Weathering; a near-surface belt of very low-velocity material.
- A layer of velocity lower than that of shallower refractors (i.e., blind zones).
- The B-layer in the upper mantle from 60 to 250 kilometers deep, where velocities are about 6 percent lower than in the outermost mantle.
- The region just inside the earth's core.

3.8 RESISTANCE

Resistance is the opposition to the flow of a direct current.

3.9 RESISTIVITY

Resistivity is the property of a material that resists the flow of electrical current. Also called specific resistance. The ratio of electric-field intensity to current density. The reciprocal of resistivity is conductivity. In nonisotropic material, the resistivity is a tensor.

3.10 RESISTIVITY LOGS

- Well logs that depend on electrical resistivity, normal, lateral, laterolog, and induction log. Most resistivity logs derive their readings from 10 to 100 cubic feet of material about the sonde. Microresistivity logs, however, derive their readings from a few cubic inches of material near the borehole wall.
- Records of surface resistivity methods.

3.11 RESISTIVITY METHOD

- Observation of electric fields caused by current introduced into the ground as a means for studying earth resistivity in geophysical exploration. The term is normally restricted to those methods in which a very low frequency or direct current is used to measure the apparent resistivity. Includes electrical profiling and electrical sounding. Various array types are used.
- Sometimes includes IP and EM survey methods also.

3.12 SEISMIC SURVEY

Seismic survey is a program for mapping geologic structure by creating seismic waves and observing the arrival time of the waves reflected from acoustic-impedance contrasts or refracted through high-velocity members. A reflection survey is usually implied unless refraction survey is specifically mentioned. The energy source for creating the waves is usually impulsive (i.e., energy is delivered to the earth for a very short period of time) although energy is introduced for considerable time with the Vibroseis method. The energy is detected by arrays of geophones or hydrophones connected to amplifiers, and the information is amplified and recorded for interpretation. The data often are processed to enhance the wanted information (signal) and displayed in record-section form. Signal is recognized as a coherent event, although noise often is coherent also. Events considered to be reflections from acoustic-impedance contrasts (reflectors) are used to locate the reflectors, it being assumed that their attitudes are that of the geologic structure. Events attributed to be head waves are used to locate the refractors of which they are characteristic, it being assumed that the attitudes of these refractors are those of the geologic structure. Velocity analysis is also done on reflection data where the offset varies.

3.13 SELF-POTENTIAL/SPONTANEOUS POTENTIAL

- The direct coupling or slowly varying natural ground voltage observed between nearby non-polarizing electrodes in field surveying. In many mineralized areas, this is caused by electrochemical reaction at an electrically conducting sulfide body.
- A well log of the difference between the potential of a movable electrode in the borehole and a fixed reference electrode at the surface. The SP results from electrochemical SP and electrokinetic potentials, which are present at the interface between permeable beds adjacent to shale. In impermeable shales, the SP is fairly constant at the shale base-line value. In permeable formations, the deflection depends on the contrast between the ion content of the formation water and the drilling fluid, the clay content, the bed thickness, invasion, and bed-boundary effects, etc. In thick, permeable, clean non-shale formations, the SP has the fairly constant sand line value, which will change if the salinity of the formation water changes. In sands containing disseminated clay (shale), the SP will not reach the sand line and a pseudostatic SP value will be recorded. The SP is positive with respect to the shale base line in sands filled with fluids fresher than the borehole fluid.

3.14 TELLURIC

Telluric means of the earth, and often refers specifically to telluric currents.

3.15 TELLURIC CURRENT

Telluric current is a natural electrical earth current of very low frequency that extends over large regions and may vary cyclically in that direction. Telluric currents are widespread, originating in variations of the earth's magnetic field.

4. Responsibilities

CTO Managers are responsible for determining whether surface geophysical methods should be used on a project and if so, which methods should be used. This information should be included in the project-specific WP. The objectives of the geophysical investigation shall be stated explicitly in the subcontract WP. Further, deliverables by the subcontractor shall be clearly identified in the WP so the prime contractor knows what to expect from the subcontractor. The CTO Manager is responsible for ensuring that all personnel involved in sampling and/or testing shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager (FM) is responsible for ensuring that the appropriate selected procedures are conducted according to the instructions in this manual and the project specific sampling plan. In many cases, subcontractors will conduct these procedures. In these situations, the FM is responsible for overseeing and directing the activities of the subcontractor. The need to establish site-specific quality control procedures is particularly important.

Field personnel are responsible for the implementation of this procedure.

5. Procedures

5.1 METHOD SUMMARY

A wide variety of surface-based geophysical methods exist that may apply to contamination delineation, geologic, hydrogeologic, or other site characterization/investigation requirements. In general, geophysical exploration methods provide for a non-invasive mapping of subsurface features through the measurement of the physical properties of a subsurface. Typically, an active signal (e.g., acoustic or electrical) propagates into the earth and the interaction of the signal with the subsurface materials is measured at the surface. Interpretation of the data provides a map or image of the subsurface. For example, electrical conductivity of soil governs the propagation of an electrical signal through the subsurface. The geologic/hydrologic/waste characteristics are then inferred from an interpretation of the data or correlated with borehole data.

For a geophysical survey to be successful, the method of choice must be capable of resolving a particular physical characteristic that relates to the goals of the investigation. For example, if a zone of contaminated groundwater is being investigated by an electrical method, the electrical conductivity of the contaminated portion of the aquifer should be sufficiently different from the uncontaminated portion to allow for identification of the 'plume'. If the target (i.e., the

high-conductivity plume in this example) does not contrast sufficiently with the uncontaminated portion, then the geophysical survey will not be successful. Often, preliminary calculations or a trial survey can be performed to evaluate a particular method.

For purposes of this procedure, the geophysical methods discussed herein are classified as follows:

- *Seismic Methods:* These include seismic refraction and reflection methods and are typically applied to investigate depths to water or geologic structures (stratigraphic horizons or depth to bedrock).
- *Electrical Methods:* A wide variety of these exist including Direct Current (DC) Resistivity, Low-Frequency EM Induction (i.e., loop-loop methods), Very Low Frequency EM, Ground Penetrating Radar (GPR), Complex Resistivity/IP, metal detection equipment, and SP profiling. These respond to variations in the electrical properties of a site, specifically the electrical conductivity and (for GPR) the dielectric/permittivity constant. Applications include general geologic/hydrologic mapping, identification of solute ‘plumes,’ and the detection of conductive metallic debris/objects.
- *Potential Field Methods:* Some methods do not require an active signal source and instead measure naturally occurring potential fields of the earth. These include measurements of the earth’s magnetic or gravitational fields. Magnetic methods are often used to detect the response of the earth’s magnetic field to metallic objects and can be very effective in locating buried metallic materials. Gravity methods respond to subtle density variations and are typically used to map the depth/thickness of alluvial basins or to detect cavities within consolidated sediments (e.g., Karst sinkholes).

While a number of geophysical methods may be applied at hazardous waste sites, the scope of this procedure is limited to the following commonly applied methods:

Seismic:	Refraction
Electrical:	DC Resistivity
	EM Induction (Loop-Loop)
	GPR
	Metal Detection
	IP
	SP Profiling
Potential Field:	Magnetics

Often, geophysical contractors specialize in a particular survey method. The following references may be useful to provide additional information:

Dobrin, M. B. and C. H. Savit. 1988. *Introduction to Geophysical Prospecting*. McGraw-Hill.

Journals: Geophysics (Society of Exploration Geophysics); Geophysical Exploration European Association of Exploration Geophysicists; occasionally - Groundwater, Groundwater Monitoring Review (National Water Well Association).

Sheriff, R. E. 1991. *Encyclopedic Dictionary of Exploration Geophysics*. Society of Exploration Geophysics.

Telford, W. M., L. P. Geldart, R. E. Sheriff, D.A. Keys. 1998. *Applied Geophysics*. Cambridge University Press.

5.2 METHOD LIMITATIONS/INTERFERENCES AND POTENTIAL PROBLEMS

Each of the geophysical methods discussed herein are typically designed and implemented on a site-specific basis. Exercise care to ensure that a particular method is applicable and that an identifiable target is likely to exist. A determination must be made that the exploration target can be resolved versus the background signal/site conditions and that cultural or other ‘noise’ problems will not interfere. ‘Cultural Noise’ is defined as near-surface or surficial features (e.g., power lines or traffic vibrations) that can potentially mask or overwhelm the signal produced by the subsurface target.

All of the survey methods require field instrumentation and electronics that might be impacted by extreme climactic variations. Check the equipment regularly (daily, at a minimum) to ensure internal calibration. Review the manufacturers’ guidelines and specifications prior to field application.

5.2.1 Seismic Method Limitations and Potential Problems

5.2.1.1 REFRACTION SURVEYS

Care should be exercised in avoiding the following potential problems:

- Poorly emplaced geophones (e.g., in loose soil)
- Poor couplings of induced signal (e.g. strike plate) with ground
- Intermittent electrical shorts in geophone cable (never drag geophone cables)
- Wet geophone connections
- Vibration due to wind and traffic-induced noise
- Improper gain/filter settings
- Insufficient signal strength
- Topographic irregularities (an accurate topographic survey is often required prior to field operations)

5.2.2 Electrical Method Limitations and Potential Problems

5.2.2.1 DC RESISTIVITY

Measurement of electrical resistivity represents a bulk average of subsurface material resistivity. In some instances, the resistivity of the target material may not contrast sufficiently with ‘background’ material to be observed with this method, especially as the target material gets thinner and/or deeper. If highly conductive soil/rock are present at shallow depths, electrical current may not penetrate to depths beyond this layer. An electrical current always follows the path of least resistance.

Care should be exercised in avoiding the following potential problems:

- Poorly coupled electrodes (insufficient grounding)
- Unshielded wires causing intermittent shorts
- Background electrical noise, such as natural currents (SP or telluric effects)
- EM coupling with power lines, causing the introduction of induced electrical currents into the receiver wire
- Grounded fence lines and power lines interfering with the survey
- Inadequate signal power (increase current levels to produce sufficient signal to noise ratios)
- Very low resistivity layer at the surface preventing the electrical field from penetrating deeper layers
- Very high resistivity layer at the surface (e.g. dry sandy gravel) preventing the electrical field from penetrating the surface layer

5.2.2.2 *EM METHOD*

A variety of EM methods may be applied; however, in practice, the Geonics EM31-MK2 and EM34-3 Loop-Loop instruments are usually used in hazardous waste surveys. The EM methods are similar to DC methods in application and are sensitive to conductive materials, except for the basic distinction that they are not electrically grounded. Complications may arise in the EM method in developed sites because aboveground, metallic objects or electrical fields may interfere. Power lines, automobiles, train tracks, water tanks, and other objects may completely dominate data results and render the method useless.

5.2.2.3 *GPR METHODS*

GPR methods are seldom useful where highly conductive conditions or clay is present at shallow depths. The high-frequency signal propagates as a function of both electrical conductivity and dielectric constant (permittivity). The selection of transmission frequency is important because high frequencies are rapidly attenuated and the signal may not penetrate. Often, a choice of frequencies is available and it is suggested to perform site-specific field tests over known, observable targets to determine whether GPR is appropriate for use.

Care should be exercised in avoiding the following potential problems:

- Improperly adjusted/configured equipment (e.g., antenna gain, filter slopes or gain thresholds)
- Insufficient signal and/or poor transmission qualities of the materials found at a site (e.g. clay, saline water conditions)
- The influence of reflected signals outside of the immediate zone of investigation upon the radar record (e.g., fences, power poles, buildings)

5.2.2.4 *METAL DETECTION*

Metal objects that are not survey targets, including those worn or carried by the operator, might interfere with measurements.

5.2.3 Potential Field Method Limitations and Problems

5.2.3.1 MAGNETICS

The signal measured by a magnetometer varies with time and is subject to variations induced by solar storms. Care should be exercised in avoiding the following potential problems:

- Metal objects that are not survey targets, such as those worn or carried by the operator and surficial metallic objects, interfering with measurements
- Lack of base station control to measure background field fluctuations
- Failure to maintain a constant sensor height with respect to ground elevation

5.3 SURVEY DESIGN/PRE-FIELD PREPARATION

5.3.1 Survey Design

Prior to performing a field investigation, it is often possible to estimate the effectiveness of a surface geophysical survey by using data interpretation software relevant to the survey or by other calculation methods. A sensitivity analysis is usually performed to determine if a geophysical target possesses sufficient contrast with background conditions to be detected using surface geophysics. In some instances, available site data or prior geophysical investigations may be available to obtain estimates of the geophysical characteristics of the site.

5.3.2 Field Preparation

- Verify that the required geophysical equipment is pre-calibrated and operational.
- Establish grid locations or set up traverses for location of sampling stations.
- Survey the station locations and record them on a scaled site plan.
- Test and calibrate geophysical equipment.

5.4 FIELD PROCEDURES

The following procedures apply to geophysical surveys conducted at a hazardous waste site. Procedures may vary since equipment capabilities and methodologies are rapidly evolving. In general, survey field locations, accurately record them, and ensure that the equipment is functional and calibrated. Typically, a control or base station location will be established to check the equipment response over the duration of the field investigation. In addition, ensure a high signal to noise ratio can be maintained to obtain a geophysical response representative of the target/zone of interest.

5.4.1 Seismic Refraction Methods

Use seismic refraction techniques to determine the structure of a site based upon the travel time or velocity of seismic waves within layers. Interpretation of the travel time variation along a traverse of geophones can yield information regarding the thickness and depth of buried strata. Seismic methods are often used to determine depths to specific horizons of contrasting seismic velocities, such as bedrock, clay layers, or other lithologic contrasts, and the water table (under unconfined conditions).

Procedures

- Check the seismic signal and noise conditions on the instrument to verify the proper functioning of geophones and cables and to check the instrument settings.
- When the seismic field equipment does not produce hard copies of seismic records, immediately plot the arrival time selected from the electronic display on a time/distance graph in the field. Produce a hard copy of the data, and keep it in the record file. Problems with improper picks are often discovered by early inspection of these plots.
- Background or offsite data may be required for correlation to site conditions. Correlation of the seismic data with electrical method results, if obtained, or with borehole or outcrop data, may be a useful means of assigning thickness or seismic velocities.
- If possible, analyze boring logs or other data to determine if low velocity (inverse layers) or thin beds may be present that might not be detected otherwise.
- Run the seismic system at a known standard base station for periodic checks of instrument operation.
- Properly store the data in digital form for subsequent processing and data evaluation.

5.4.2 Electrical Methods

5.4.2.1 DC RESISTIVITY

The resistivity method provides a measurement of the bulk electrical resistivity of subsurface materials. Application of the method requires that a known electrical current be induced into the ground through a pair of surface electrodes. Measure the resulting potential field (voltage) between a second pair of surface electrodes. Evaluate the subsurface electrical properties based on the current, voltage, and electrode position (array configuration).

Given the length of the wire cables, their connections to the electrodes, and the coupling of the electrodes with the ground, there are a number of potential problems for obtaining reliable data (e.g., poor electrical contact, short and open circuits). These conditions can be minimized by careful observation of instrument readings and trends.

Procedures

- Calculate and plot apparent resistivities during field acquisition as a means of quality control. If vertical electrical sounding is performed, the data plots (curves) should be smooth, and discontinuous jumps in the data should not occur. Profiling data should also show a general trend in the data from one station to the next; however, abrupt changes may occur in both sounding and profiling data due to “noise” from near-surface inhomogeneities or electrode contact problems.
- The resistivity instrument can be calibrated using standard resistors or by using the internal calibration circuits often contained within the equipment. Calibration is particularly important if the data are to be compared to resistivity measurements from other instruments or other parameters, such as specific conductance of water samples.

5.4.2.2 EM METHODS

EM methods provide a means of measuring the electrical conductivity of subsurface soil, rock, and groundwater. Electrical conductivity (the inverse of electrical resistivity) is a function of the type of soil, porosity, permeability, and the conductivity of fluids in the pore spaces. The EM method can be used to map natural subsurface conditions and conductive contaminant plumes. Additionally, trench boundaries, buried conductive wastes, such as steel drums, metallic utility lines, and steel underground storage tanks, might potentially be located using EM techniques.

Following factory calibration, the instruments will normally retain their accuracy for long periods; however, the user should establish a secondary standard area at the field site for periodic recalibration. This will provide a reference base station to check “drift” in the instrument’s performance and to permit correlation between instruments.

While precision can be easily checked by comparing subsequent measurements with the instrument at a standard site, accuracy is much more difficult to establish and maintain.

EM instruments are often used to obtain relative measurements. For these applications, it is not critical to maintain absolute accuracy; however, the precision of the instrument can be important. For example, in the initial mapping of the spatial extent of a contaminant plume, a moderate level of precision is necessary. If the same site is to be resurveyed annually to detect small changes in plume migration and movement, a very high level of precision is necessary.

If the objective of the survey is to obtain quantitative results from the EM data for correlation to other measurable parameters (e.g., specific conditions), proper steps should be taken to ensure good instrument calibration. This is particularly important when performing surveys in areas of low conductivity, where measurement errors can be significant.

The dynamic range of EM instruments varies from 1 to 1,000 millimhos/meter (mmho/m). At the lower conductivities, near 1 mmho/m and less, it is difficult to induce sufficient current in the ground to produce a detectable response; hence, readings may become unreliable. At conductivity values greater than about 100 mmho/m, the received signal is no longer linearly proportional to subsurface conductivities, and corrections must be applied to the data, if it is to be used for quantitative purposes.

Procedures

- Maintain or verify calibration records from the equipment supplier or manufacturer. Calibrate the EM system regularly.
- Prior to conducting a survey, select a temporary site on location for daily calibration checks. Conduct calibration checks twice daily, before and after conducting daily survey operations. Readings shall repeat to +/-5 percent. Originals of all calibration records shall remain on site during field activities, and copies shall be submitted to the records file. The original calibration records shall be transferred to the project files upon completion of the fieldwork.

Note: Conduct calibration checks outside the influence of power lines, buried utilities, buried metal objects, fences, etc. on a relatively flat surface.

- The field operating party shall check instrument stability when there is local or distant thunderstorm activity. EM radiation from thunderstorms can generate noise in the EM system. It may be necessary to postpone operations during rainstorms and resume them when they have passed.
- Exercise technical judgment such that conductivity readings recorded in the field are reasonable with respect to existing site conditions.
- Record instrument sensitivity settings in the field notebook as readings are taken. Submit the notebook to the records file.

5.4.2.3 GPR

GPR uses high frequency radio waves to acquire subsurface information. Energy is radiated downward into the subsurface through a small antenna, which is moved slowly across the surface of the ground. Energy is reflected back to the receiving antenna, where variations in the return signal are continuously recorded. This data produces a continuous cross sectional “picture” or profile of shallow subsurface conditions. These responses are caused by radar wave reflections from interfaces of materials having different electrical properties. Such reflections are often associated with natural hydrogeologic conditions, such as bedding, cementation, moisture content, clay content, voids, fractures, and intrusions, as well as manmade objects. The radar method has been used at numerous hazardous waste sites to evaluate natural soil and rock conditions, as well as to detect buried wastes and buried metallic objects.

The radar system measures two-way travel time from the transmitter antenna to a reflecting surface and back to the receiver antenna. Calibration of the radar system and data requires a two-step process:

- First, accurately determine the total time window (range) set by the operator.
- Second, determine the EM velocity (travel time) of the local soil-rock condition.

After completing these two steps, the radar data may then be calibrated for depths of particular features.

Calibrate the time window (range) that has been picked for the survey by using a pulse generator in the field. This generator is used to produce a series of time marks on the graphic display, measured in nanoseconds. These pulses are counted to determine the total time range of the radar. A calibration curve can be made up for each radar system.

In order to precisely relate travel time to actual depth units, determine the velocity (or two-way travel time per unit distance) for the particular soil or rock found at the site.

Various levels of accuracy in determining travel time can be used. These may range from first order estimates to precisely measured onsite values.

Using the depth of a known target (trenches, road cuts or buried pipes/road culverts can provide a radar target of known depth), a radar record taken over the known target, and a time scale provided by the pulse generator will provide basic calibration record. From these data, a two-way travel time can be accurately determined at the given target location. Because this approach may give accurate

calibration at the specific site, it must be assumed that conditions in other areas to be surveyed are the same as in the calibration areas. If they are not, errors will occur in determining depths.

If significant changes in soil type or moisture content occur with depth, travel time will not be the same throughout the vertical radar profile, and the vertical radar depth scale may be non-linear. Such a condition is common, and occurs whenever an unsaturated zone exists over a saturated zone.

Procedures

- Check the time scale of the GPR unit regularly for accuracy. This can be done either on or off the site by placing the GPR unit at a known distance from the ground, a wall, etc., and measuring the two-way travel time to that reflecting surface in the air. The velocity of electromagnetic waves in air is 1 foot per nanosecond (3×10^8 meters per second). The following equation shall be used:

$$t = 2d/c$$

Where:

- t = two-way travel time from antenna to the surface (nanoseconds)
- d = distance of antenna to the surface (feet)
- c = velocity of light in air, (1 foot/nanosecond)

- Prior to conducting a survey, conduct a GPR traverse over a buried object of known depth (if available). From the two-way travel time and the measured burial depth of the object, the average electromagnetic wave velocity in soil can be calculated from the following equation:

$$V = 2d/t$$

The average dielectric constant of the soil is then calculated using:

$$Er = c^2/v^2$$

Where:

- Er = average relative dielectric constant of soil (unitless)
- c = velocity of light in air (1 foot/nanosecond)
- v = average electromagnetic wave velocity of the soil (feet/nanosecond)

Note: The equation above assumes a soil with a relative magnetic permeability of 1. Exercise technical judgment such that soil velocity and relative dielectric constant values are reasonable with respect to existing site conditions.

- A short GPR traverse shall be repeated twice daily over a known feature prior to and after conducting daily operations. Exercise technical judgment to ensure that variations between repeat readings are due to changing soil conditions rather than the electronics.

5.4.2.4 METAL DETECTION - MAGNETOMETERS

Magnetometers are designed to provide measurements of the earth's magnetic field. In hazardous waste site investigations, magnetometers are invaluable for detecting buried drums and for delineating the boundaries of areas containing ferrous metallic debris.

Procedures

- Check the proposed date of the magnetic survey for solar flares to ensure that anticipated background conditions do not occlude data collection (Bureau of Standards, Boulder, CO, Goldendale, WA).
- Obtain a daily background reading in the immediate vicinity of the site to be surveyed. This reading should be outside the influence of all sources of cultural magnetic fields (e.g., power lines, pipeline). Exercise technical judgment such that the background reading is reasonable with regard to published data for the total magnetic field intensity at the site latitude and longitude. This daily background reading should repeat to within reasonable diurnal variations in the earth's magnetic field.
- Take sequential readings twice daily, before and after normal magnetic surveying operations. Take these readings (within 10 seconds of each other) at any location on site, distant from cultural magnetic fields, and record them in the field notebook. Two or three sequential readings should be sufficient. In the absence of magnetic storms (sudden and violent variations in the earth's magnetic field), the readings should compare within 0.1 to a few tenths of a gamma. Variations during magnetic storms may approach 1 gamma.
- Take base station readings so that the effects of diurnal variation in the earth's magnetic field may be removed from the data. Magnetic storms can be detected if the base station sampling frequency is high enough. It may be necessary to postpone operations during magnetic storms and resume them when they have passed. Identification of such periods of rapid synoptic variation may be documented at a permanent base stations set up on site where continuous readings are automatically recorded every 10 to 15 minutes. Alternatively, readings may be manually recorded at base stations during the survey every 45 to 60 minutes.
- Use of automatic recording magnetometers requires recording the magnetometer readings for the first and last station of each traverse in a field notebook. At the end of the day, compare the data recorded in the field notebook with data from the automatic recording device. Data recorded in the field notebook should be within 1 gamma of the values derived from the recording device. It is recommended to transfer the data onto hard copies from the recording device on a daily basis.

Total field measurements may be corrected for these time variations by employing a reference base station magnetometer; changes in the earth's field are removed by subtracting fixed base station readings from the moving survey data. Gradiometers do not require the use of a base station, as they inherently eliminate time variation in the data.

5.4.2.5 SP PROFILING

This method is different from other electrical techniques in that no artificial current source is used to inject a signal into the ground; only the naturally occurring voltage potentials are measured between

surface stakes. These natural voltages are produced by chemical oxidation reactions between groundwater and different soil and mineral types.

SP equipment consists of a digital, high-impedance volt meter; two porous pot electrodes; and cables. SP equipment should have a resolution of at least ± 2 millivolts (mv) and accuracy within ± 10 mv.

Procedures

- Calibrate equipment per the manufacturer's specifications. At a minimum, calibrate the equipment twice daily, once prior to beginning operations and once at the end of daily operations. Record calibration results in the field log.
- Each SP station shall be identified with a unique number and located on a site layout drawing. Record profiling results for each station using a field data form that includes the time of each measurement. Annotate the form to show any natural or cultural features near or between the SP stations.
- Establish a base station for the purpose of measuring instrument drift during the SP profiling activities. Take the instrument to the base station routinely during the day, and obtain readings from one location at the base station. Obtain base station readings at the beginning and end of each day and at interim intervals not exceeding 4 hours in duration.
- Reduce data by adjusting measurements obtained for instrument drift. Base station readings are plotted as a separate curve from profiling station measurements. The drift is interpolated (straight line) between base station readings as a function of time and the appropriate drift correction is subtracted from each profiling station measurement. Reduced data are used for interpretation.
- Interpret data by plotting reduced data (either for linear cross-sections of the study area or as surface contours over the study area surface). Anomalies are identified from these plots, and inferences regarding their sources are developed.

5.4.3 Post-Operations

Geophysical personnel working at a site should follow standard hazardous waste site protocols. In many cases, the geophysical survey may precede services that may result in personnel contact with hazardous waste/materials. Geophysical personnel at all sites should follow standard hazardous waste site decontamination procedures.

5.5 DATA REDUCTION/DATA INTERPRETATION

Geophysical surveys typically require significant data reduction and processing. The exact methodology depends upon the purpose, scope, and type of survey.

Data interpretation and presentation reports should include the following:

- Data reduction technique
- Data processing steps
- Technical basis for data processing

- Survey location data
- Site base map showing survey location or transects
- Dates and times of survey
- Interpretation results
- Theoretical assumptions for the interpretation
- Equipment used
- Data format (digital format, ASCII, SEG B.,)

5.6 QUALITY ASSURANCE/QUALITY CONTROL

The following QA procedures apply to all geophysical instrumentation and their use during data acquisition.

- Document all data transmittals on standard forms supplied by the geophysical subcontractor. Copies of these forms will be maintained with the field files on site.
- Operate geophysical instrumentation in accordance with operating instructions supplied by the manufacturer, unless otherwise specified in the work plan.
- Monitor battery voltage levels for all instruments each day throughout the survey. Charge or replace battery packs when voltage levels fall below the recommended level specified by geophysical equipment manufacturers.

6. Records

The FM is responsible for documenting all field activities in the field notebook. The FM should also oversee all subcontractor activities and ensure that their documentation is complete. The specific procedures used in the field shall be documented in the site characterization report or similar deliverable.

7. Health and Safety

Field Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Dobrin, M. B. and C. H. Savitt. 1988. *Introduction to Geophysical Prospecting*. McGraw-Hill.

Sheriff, R. E. 1991. *Encyclopedic Dictionary of Exploration Geophysics*. Tulsa, OK: Society of Exploration Geophysics.

Telford, W. M., L. P. Geldart, R. E. Sheriff, D. A. Keys. 1998. *Applied Geophysics*. Cambridge University Press.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

9. Attachments

None.

This page intentionally left blank

Surface Water Sampling

1. Purpose

The purpose of this standard operating procedure is to establish standard protocols for use in sampling surface water by all United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the most current version of the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e. Remedial Project Manager or QA manager) shall also concur with any deviations.

3. Definitions

None.

4. Responsibilities

The prime contractor CTO Manager is responsible for ensuring that all project field personnel follow these procedures when sampling surface water. The CTO Manager is responsible for ensuring that all personnel involved in sampling and/or testing shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager is responsible for ensuring that all project field staff follow these procedures.

Field sampling personnel are responsible for the implementation of this procedure.

5. Procedures

Surface water bodies that could be affected by a release from an investigation site may be selected for sampling. This procedure describes sample collection methods for a surface water sampling program.

5.1 SELECTION OF SAMPLING TECHNIQUES

Proper selection of sampling points and collection methodology are essential to meeting the objectives of a surface water sampling program. The data quality objectives and the conceptual site model should be used to determine all sampling methods and parameters. Sampling points should be selected for collection of surface water samples on the basis of characteristics of the surface water body to be monitored, the location of the body of surface water, and its hydrologic boundaries with respect to the site. Other considerations include the contaminants of concern, logistical considerations, such as access to the surface water body, the direction of flow, and determination of a background location.

Methods of collecting surface water samples vary from hand sampling procedures at a single point to sophisticated, multipoint sampling techniques. The number and type of samples to be collected depends on the characteristics of the body of water, the amount of suspended sediment that a moving body carries, the size of the discharge area at the site, and other factors. Multipoint sampling techniques apply to larger bodies of water; the samples are composited to provide a more representative sample.

Whenever possible, the sampling device, either disposable or constructed of a nonreactive material, should hold at least 500 milliliters to minimize the number of times the liquid must be disturbed, thus reducing agitation of any sediment layers. A 1-liter polypropylene or stainless steel beaker with a pour spout and handle works well. Any sampling device might contribute contaminants to a sample. The correct sampling device will not compromise the integrity of the sample and will give the desired analytical results.

5.1.1 Shallow Water Body Surface Water Sample Collection

A dip or grab sample is appropriate for a small body of water, or for collecting near-surface samples in a larger surface water body. The sampling method involves filling a sample container by submerging it either just below the surface, or by lowering the container to a desired depth by using a weighted holder. For shallow bodies of surface water, hold the sample container carefully just beneath the water surface to avoid disturbing the streambed and stirring the sediment. Position the container's mouth so that it faces upstream, while the sampling personnel are standing downstream. Any preservative added to the sample should be added after sample collection to avoid loss of preservative. Alternatively, a transfer device may be dipped into the water, and then the contents transferred to the appropriate container containing the preservative. For near-surface sample collection in a large surface water body, a pond sampler may be used if an extended reach is required to collect a representative sample. A pond sampler consists of a single use sample container attached to a telescoping, heavy-duty, aluminum pole via an adjustable clamp attached to the end. The collection technique for shallow surface water samples can be used for near-surface samples in a large surface water body.

5.1.2 Deep Surface Water Sample Collection

For deeper surface water bodies, either sample containers or transfer devices may be used to collect a sample. A weighted holder that allows either a sample transfer device or a sample container to be lowered, opened for filling, closed, and returned to the surface is suggested for sampling deeper surface water bodies. This is because concentrations of constituents near the surface of a deeper body of surface water might differ from the total concentration distributed throughout the water column cross section and thus a surface sample would not be representative of the water body. An open

container that is lowered and raised to the surface at a uniform rate so that the bottle is just filled on reaching the surface is appropriate for deeper stagnant water bodies, however this method does not collect a truly representative sample in deeper flowing surface water bodies.

Kemmerer Samplers. Collect samples near the shore unless sampling from a boat is feasible and permitted. If a boat is used, the body of water should be cross-sectioned, and samples should be collected at various depths across the water in accordance with the specified work plan. For this type of sampling, use a weighted-bottle sampler to collect samples at any predetermined depth. The sampler consists of a glass bottle, a weighted sinker, a bottle stopper, and a line that is used to open the bottle and to lower and raise the sampler during sampling. The sampler can be either fabricated or purchased. The general procedure for using the sampler is as follows:

1. Assemble the weighted bottle sampler.
2. Gently lower the sampler to the desired depth so as not to remove the stopper prematurely.
3. Pull out the stopper with a sharp jerk of the sampler line.
4. Allow the bottle to fill completely, as evidenced by the cessation of air bubbles.
5. Raise the sampler and cap the bottle.
6. Wipe the bottle clean. The bottle can also be used as the sample container.

Teflon Bailers: Teflon bailers have also been used to collect samples in deep bodies of water. When the use of Teflon bailers is deemed appropriate for sampling water from a specific depth, the bailers shall be equipped with a check valve that closes during sample retrieval.

Peristaltic Pump: Another method of extending the reach of sampling efforts is to use a small peristaltic pump. In this method, the sample is drawn through heavy-wall Teflon tubing and pumped directly into the sample container. This system allows the operator to reach into the liquid body, sample from depth, or sweep the width of narrow streams. However, use of the peristaltic pump is restricted to a maximum depth of 20 to 24 feet due to the physical constraints associated with vacuum pumps.

If medical-grade silicon tubing is used in the peristaltic pump, the system is suitable for sampling almost any analyte, including most organics. Some volatile stripping may occur; due to the relatively high flow rate of the pump. Therefore, avoid pumping methods for sampling volatile organics. Battery-operated peristaltic pumps are available and can be easily carried by hand or with a shoulder sling, as needed. It is necessary in most situations to change both the Teflon suction line and the silicon pump tubing between sampling locations to avoid cross contamination. This action requires maintaining a sufficiently large stock of material to avoid having to clean the tubing in the field.

Peristaltic pumps work especially well for sampling large bodies of water when a near-surface sample will not sufficiently characterize the body as a whole. It is capable of lifting water from depths in excess (but not much in excess) of 21 feet. This lift ability decreases somewhat with higher-density fluids and with increased wear on the silicone pump tubing. Similarly, increases in altitude will decrease the pump's ability to lift from depth. When sampling a liquid stream that exhibits a considerable flow rate, it may be necessary to weight the bottom of the suction line.

Use the following procedures for collecting samples using peristaltic pumps:

1. Install clean, medical-grade silicone tubing in the pump head, per the manufacturer's instructions. Allow sufficient tubing on the discharge side to facilitate convenient dispensation of liquid into sample bottles but only enough on the suction end for attachment to the intake line. This practice will minimize sample contact with the silicone pump tubing. (Some types of thinner Teflon tubing may be used.)
2. Select the length of suction intake tubing necessary to reach the required sample depth and attach it to the tubing on the intake side of the pump. If necessary, a small weight composed of relatively inert material, which will not react with anticipated chemicals, may be used to weight the intake tubing. Heavy-wall Teflon of a diameter equal to the required pump tubing will suit most applications. (A heavier wall will allow for a slightly greater lateral reach.)
3. If possible, allow several liters of sample to pass through the system before actual sample collection. Collect this purge volume, and then return it to the source (i.e., surface water) after the sample aliquot has been collected.
4. Fill necessary sample bottles by allowing pump discharge to flow gently down the side of bottle with minimal entry turbulence. Cap each bottle as it is filled.
5. Preserve the sample, if necessary, following guidelines in the work plan. In most cases, place preservatives in sample containers before sample collection to avoid overexposure of samples and overfilling of bottles during collection.
6. Check that a Teflon liner is present in the cap, if required. Secure the cap tightly. Tape the cap to the bottle, and then date and initial the tape. The tape will serve as a custody seal.
7. Label the sample bottle with an appropriate tag using a solvent-free marker. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Record the information in the field logbook, and complete the chain-of-custody documents.
8. Place the properly labeled sample bottle in an appropriate carrying container.
9. Allow the system to drain thoroughly, and then disassemble and decontaminate it.

5.2 TRANSFER DEVICES

Samples from various locations and depths can be composited if project quality objectives indicate that it is appropriate; otherwise, collect separate samples. Identify approximate sampling points on a sketch of the water body. Use the following procedures for collecting samples using transfer devices:

1. Submerge a stainless steel dipper or other suitable device, causing minimal disturbance to the surface of the water. Note the approximate depth and location of the sample source (e.g., 1 foot up from bottom or just below the surface).
2. Allow the device to fill slowly and continuously.
3. Retrieve the dipper or device from the surface water with minimal disturbance.
4. Remove the cap from the sample bottle and slightly tilt the mouth of the bottle below the dipper or device edge.
5. Empty the dipper or device slowly, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence.

6. Continue delivery of the sample until the bottle is almost filled. Check all procedures for recommended headspace for expansion.
7. If necessary, preserve the sample according to guidelines in the work plan. In most cases, place preservatives in sample containers before sample collection to avoid overexposure of samples and overfilling of bottles during collection.
8. Check that a Teflon liner is present in the cap, if required. Secure the cap tightly. Tape the cap to the bottle using solvent-free tape, and then date and initial the tape. The tape will serve as a custody seal.
9. Label the sample bottle with an appropriate sample tag using a solvent-free marker. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Record the information in the field logbook, and complete the chain-of-custody form.
7. Dismantle the sampler, wipe the parts with terry towels or rags, and store them in plastic bags for subsequent disposal. Follow all instructions for proper decontamination of equipment and personnel.

Use the following procedures for collecting samples using peristaltic pumps:

1. Install clean, medical-grade silicone tubing in the pump head, per the manufacturer's instructions. Allow sufficient tubing on the discharge side to facilitate convenient dispensation of liquid into sample bottles but only enough on the suction end for attachment to the intake line. This practice will minimize sample contact with the silicone pump tubing. (Some types of thinner Teflon tubing may be used.)
2. Select the length of suction intake tubing necessary to reach the required sample depth and attach it to the tubing on the intake side of the pump. If necessary, a small weight composed of relatively inert material, which will not react with anticipated chemicals, may be used to weight the intake tubing. Heavy-wall Teflon of a diameter equal to the required pump tubing will suit most applications. (A heavier wall will allow for a slightly greater lateral reach.)
3. If possible, allow several liters of sample to pass through the system before actual sample collection. Collect this purge volume, and then return it to the source (i.e., surface water) after the sample aliquot has been collected.
4. Fill necessary sample bottles by allowing pump discharge to flow gently down the side of bottle with minimal entry turbulence. Cap each bottle as it is filled.
5. Preserve the sample, if necessary, following guidelines in the work plan. In most cases, place preservatives in sample containers before sample collection to avoid overexposure of samples and overfilling of bottles during collection.
6. Check that a Teflon liner is present in the cap, if required. Secure the cap tightly. Tape the cap to the bottle, and then date and initial the tape. The tape will serve as a custody seal.
7. Label the sample bottle with an appropriate tag using a solvent-free marker. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Record the information in the field logbook, and complete the chain-of-custody documents.
8. Place the properly labeled sample bottle in an appropriate carrying container.
9. Allow the system to drain thoroughly, and then disassemble and decontaminate it.

Multipoint sampling techniques that represent both dissolved and suspended constituents and both vertical and horizontal distributions are applicable to larger bodies of water. Subsequent to sample collection, multipoint sampling techniques may require a compositing and sub-sampling process to homogenize all the individual samples into the number of subsamples required to perform the analyses of interest. Homogenizing samples is discouraged for samples collected for volatile organic analysis, because aeration causes a loss of volatile compounds. If collection of composite samples is required, then include the procedure for compositing in the project-specific work plan.

The sampling devices selected must not compromise sample integrity. Collect samples with either disposable devices, or devices constructed of a nonreactive material, such as glass, stainless steel, or Teflon. The device must have adequate capacity to minimize the number of times the liquid must be disturbed, reducing agitation of any sediment layers. Further, the device must be able to transfer the water sample into the sample container without loss of volatile compounds. A single- or double-check valve or stainless steel bailer made of Teflon equipped with a bottom discharging device may be used.

All equipment used for sample collection must be decontaminated before and after use in accordance with Procedure I-F, *Equipment Decontamination*.

5.3 TYPICAL FIELD SAMPLING SUPPLIES AND EQUIPMENT/APPARATUS

Sampling supplies

- Work Plan
- Maps/Plot plan
- Tape measure
- Survey stakes, flags, or buoys
- Camera
- Stainless steel, plastic, or other appropriate composition (e.g., Teflon) bucket
- Laboratory supplied sampling containers
- Ziploc plastic bags for samples, and sample jars
- Logbook
- Labels
- Chain of Custody forms
- Site description forms
- Cooler(s)
- Ice

Equipment/Apparatus

- Decontamination supplies/equipment
- Spade or shovel

- Spatula
- Scoop
- Trowel
- Task-specific surface water sampling equipment

6. Records

During the completion of sampling activities, fill out the sample logbook and transmit forms to the CTO Manager for storage in project files.

7. Health and Safety

Field Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-F, *Equipment Decontamination*.

9. Attachments

None.

This page intentionally left blank

Monitoring Well Installation and Abandonment

1. Purpose

This standard operating procedure describes the methods to be used by the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel during the installation of groundwater monitoring wells. It describes the components of monitoring well design and installation and sets forth the rationale for use of various well installation techniques in specific situations.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 FILTER PACK

Filter pack is sand or gravel that is smooth, uniform, clean, well-rounded, and siliceous. It is placed in the annulus of the well between the borehole wall and the well screen to prevent formation materials from entering the well and to stabilize the adjacent formation.

3.2 ANNULUS

The annulus is the downhole space between the borehole wall and the well casing and screen.

3.3 BRIDGE

An obstruction in the drill hole or annulus. A bridge is usually formed by caving of the wall of the well bore, by the intrusion of a large boulder, or by filter pack materials during well completion. Bridging can also occur in the formation during well development.

3.4 GROUT

Grout is a fluid mixture of cement and water that can be forced through a pipe and emplaced in the annular space between the borehole and casing to form an impermeable seal. Various additives, such as sand, bentonite, and polymers, may be included in the mixture to meet certain requirements.

3.5 SIEVE ANALYSIS

Sieve analysis is the evaluation of the particle-size distribution of a soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

4. Responsibilities

CTO Managers are responsible for issuing WPs that reflect the procedures and specifications presented in this procedure. Individual municipalities, county agencies, and, possibly, state regulatory agencies enforce regulations that may include well construction and installation requirements. The CTO Manager shall be familiar with current local and state regulations, and ensure that these regulations are followed. Regulations are subject to constant revision. Every effort should be made to stay informed of these changes through contact with the agencies that oversee work in specific project areas, prior to initiation of field activities. The CTO Manager or designee shall review all well construction logs on a minimum monthly basis. The CTO Manager is responsible for ensuring that all personnel involved in monitoring well installation and abandonment have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager (FM) is responsible for direct supervision of the installation of monitoring wells and ensuring that procedures and specifications are implemented in the field. The qualifications for the FM include a degree in geology, hydrogeology, civil/geotechnical/environmental engineering, or equivalent with at least 2 years of field experience in the installation of monitoring wells.

Field sampling personnel are responsible for the implementation of this procedure.

The onsite geologist/hydrogeologist/engineer is expected to obtain a description of the lithologic samples obtained during the excavation and construction of a monitoring well. These data are often required to provide guidance regarding the installation of specific components of the monitoring well. Guidance for lithologic sample collection and sample description is contained within Procedure I-B-1, *Soil Sampling*.

5. Procedures

5.1 CONSIDERATIONS FOR MUNITIONS AND EXPLOSIVES OF CONCERN

Potential Munitions and Explosives of Concern (MEC) hazards may be encountered in any area formerly or currently occupied or used by the Department of Defense (DoD). MEC hazards may occur on the ground surface, in the subsurface, and within bodies of water, and may not always be readily observable, or identifiable. As a result, whether or not munitions-related activities ever occurred on the specific work area or within waters in which Navy operations/activities will take place, special care should always be taken when conducting field operations, especially intrusive activities, in the event that MEC may be encountered.

If the site is currently recognized as belonging in the Military Munitions Response Program and has a current, Naval Ordnance Safety and Security-accepted, site-specific Explosives Safety Submission

(ESS) (per DON 2010), then field activities, especially intrusive activities, shall adhere to the safety procedures outlined within the ESS.

If suspected MEC is encountered on an active DoD installation, immediately notify your supervisor, DoD Point of Contact, and installation Point of Contact, who will contact and facilitate military Explosive Ordnance Disposal response.

5.2 BACKGROUND INFORMATION

The primary objectives of installing a monitoring well at a site are: to observe groundwater levels and flow conditions; to obtain samples for determining groundwater quality; and to evaluate the hydraulic properties of water-bearing strata. To achieve these objectives, it is necessary to satisfy the following criteria:

- Construct the well with minimum disturbance to the formation.
- Construct the well with materials that are compatible with the anticipated geochemical environment.
- Properly complete the well in the desired zone.
- Adequately seal the well with materials that will not interfere with the collection of representative water samples.
- Sufficiently develop the well to remove drilling fluids or other additives or conditions associated with drilling, and provide unobstructed flow to the well.

The proper design and construction of monitoring wells requires an understanding of site geology and hydrogeology, and knowledge of contaminant transport in subsurface materials.

A significant difference between monitoring wells and production or “water” wells is that the intake section of monitoring wells is often purposely completed in a zone of poor water quality and/or poor yield. The quality of water entering a monitoring well can vary from drinking water to a hazardous waste or leachate. In contrast, production wells are normally designed to efficiently obtain water from highly productive zones containing good quality water. The screen of a monitoring well often extends only a short length (typically 10 feet or less) to monitor hydraulic conditions within, and obtain water samples from, selected water-bearing intervals. In contrast, water wells are often designed to obtain economic quantities of water from multiple zones of water-bearing strata.

5.3 MONITORING WELL DESIGN CONSIDERATIONS

The following information was compiled from a number of technical references. For additional information related to monitoring well installation, consult the references listed in Section 8.

5.3.1 Well Placement

Select the location of a monitoring well according to the purpose of the monitoring program, which will vary among different sites and may include detection of contaminants in groundwater, verification of contaminant migration predictions, the monitoring of leachate at a landfill site, or remediation of a contaminated site. Each of these purposes will require a specialized array of monitoring locations and completion intervals, and a specific sampling program. Therefore, design the monitoring well network to satisfy the needs of the particular situation.

Determine the position of a monitoring well in a contaminant flow path for a monitoring effort based on the interpretation of preliminary data. These data shall be sufficient to facilitate identification of potential contaminant sources. Also consider site history, topography, climate, surface hydrology, and the location of nearby pumping wells.

Design the layout of the groundwater monitoring network following preliminary evaluation of the approximate direction of groundwater flow. A minimum of three wells is necessary to estimate local hydraulic gradients. Ideally, at least one well will be located hydraulically upgradient, and two or more wells strategically located hydraulically downgradient of each potential contaminant source. Determination of the horizontal and vertical extent of a contaminant plume is often an iterative process requiring the installation and sampling of wells in several phases.

Install monitoring wells hydraulically downgradient and as close as physically possible to the areas of suspected contamination in order to immediately detect releases from a hazardous waste site. Locate additional monitoring wells based on the interception of potential groundwater flow paths and direction of contaminant migration.

The placement of groundwater monitoring wells shall also consider the three-dimensional nature of groundwater flow. Significant vertical gradients and heterogeneous and/or anisotropic hydraulic conditions may exist at a site. Thus, the direction of groundwater flow may not necessarily coincide with the apparent horizontal gradient observed by the triangulation provided by three monitoring wells. Determine the completion intervals of existing wells prior to the calculation of groundwater gradient directions. Consider temporal/seasonal groundwater flow conditions if the monitoring well network is located near existing active well fields, near tidal zones, or near ephemeral surface water (e.g., canals, dry river beds).

5.3.2 Well Depth and Screened Interval

A detailed understanding of the site stratigraphy, including both horizontal and vertical extent of geologic formations, is necessary to identify zones of different permeabilities, and discontinuities, such as bedding planes, fractures, or solution channels. Groundwater flow and/or contaminant transport beneath the site preferentially occur in the more permeable zones. Equally important is the identification of relatively low permeability zones that may impede migration of contaminants. The occurrence and movement of groundwater in the subsurface is closely related to lithology. Thus, geologic conditions will influence the location, design, and methods used to locate and install monitoring wells.

The depth of a monitoring well is determined by the depth of one or more water-bearing zones that are to be monitored. For example, if preliminary soil borings indicate that multiple water-bearing zones are present at a site, and it is believed that zones other than the uppermost zone may be impacted by surface contamination, a well should be completed in each individual water-bearing zone encountered. Where two or more saturated zones occur beneath a site, and the intent of the monitoring program is to monitor water quality in the lower zone, the monitoring well will generally require surface casing to isolate the upper water-bearing zone from the deeper zone prior to drilling into the deeper zone.

In multiple aquifer systems, highly variable conditions may occur. For example, an overlying unconfined aquifer may be contaminated, whereas the underlying confined aquifer may not contain contaminants. Exercise extreme care to ensure that the installation/completion of monitoring wells

does not cause cross-contamination of the aquifers. In these cases, it may be preferable to install surface casing through the contaminated aquifer to minimize the possibility of cross-contamination to the lower aquifer system.

Characteristics of lithologic materials encountered at the site, such as the degree of consolidation and grain size, also influence the type of well completion. In unconsolidated alluvial deposits, screened well intakes are typically used. An emplaced filter pack, consisting of well-sorted, clean, inert silica sand with a grain size and well screen slot size appropriate for the formation, typically is used to filter out fine-grained materials present within formations encountered in the borehole. Where permeable, consolidated formations are present, casing may be extended through overlying unconsolidated deposits and the well may be completed with a section of open borehole in the consolidated water-bearing zone. Even in these cases, however, fine-grained materials may enter the well through fractures, and if severe enough, an artificial filter pack and screened intake may be required. Also, many regulatory agencies require a screened interval installed with filter pack for all well completions.

Placement of the screened interval depends primarily on two factors: the interval to be monitored and the type of contaminants. The desired interval to be monitored shall dictate the interval to be screened. Determine which stratigraphic horizons represent potential pathways for contaminant migration by the site characterization. Short screened sections provide more specific data on the vertical distribution of contaminants and hydraulic head, while long screen intervals can result in a cumulative dilution of contamination in one zone with uncontaminated groundwater in another zone, as well as less specific information on hydraulic head. In addition, a long screened interval could potentially create vertical conduits that might result in cross-contamination.

Consider the type of contaminants involved prior to well installation. Contaminants that have a density less than water migrate differently than contaminants with a density equal to or greater than water. For example, if the contaminant in an unconfined aquifer has a density lower than water, such as diesel or gasoline, it is important to ensure that the screened interval of the well extends above the maximum seasonal elevation of the water table. Doing so facilitates an accurate determination of apparent thickness of free product in a monitoring well. In general, the screen shall extend 3 to 5 feet above the highest anticipated level of the water table when monitoring the upper portions of an unconfined aquifer.

Conversely, if the contaminant of concern has a density higher than water, such as trichloroethene (TCE), the screened interval of one or more monitoring wells should be installed just above the lower confining bed of a potentially impacted aquifer. TCE may be transported at high concentrations as a dense, nonaqueous phase liquid (DNAPL) near the source area, and migrate along the top of a confining bed at the base of an impacted aquifer.

Give special attention to interpretation of site stratigraphy when assessing DNAPL, particularly with respect to dipping beds, as it is possible for DNAPLs to effectively move hydraulically upgradient if low permeability perching horizons dip in a direction opposite the hydraulic gradient. This type of situation is important to consider when selecting monitoring well locations.

If time and budget allow, correlate conventional borehole geophysical methods and continuous cores of soil samples to yield a more complete stratigraphic characterization. A continuous profile of borehole conditions is compared to field observations and is used to select screened intervals.

5.3.3 Well Permitting

All wells shall be permitted in accordance with the regulations of the jurisdiction where well installation is occurring, if this is Navy policy for the region of activity. Contact local authorities prior to establishing well construction requirements for the project.

The permit procedure may require permit fees, site inspections, and an application signed by a registered professional geologist or engineer. Permit requirements may impact field schedules and budgets. The driller may also be required by law to be licensed and bonded. Provide documentation that all legal requirements have been met to the appropriate agencies prior to the installation of a monitoring well.

5.4 SELECTION OF DRILLING METHOD

Monitoring well installation at hazardous waste sites may involve drilling through or near hazardous materials, in areas where the extent of contamination is unknown, or through more than one geologic material or aquifer. Use of any drilling method at a hazardous waste site involves an element of risk related to the potential spread of contamination or creation of a pathway through which contaminants can migrate. Selection of a method most appropriate for site-specific conditions is essential to minimize these risks. Table I-C-1-1 provides an interpretation of how geologic conditions may influence the selection of a particular drilling method.

Most drill rigs use gasoline or diesel fuel, as well as hydraulic fluid during operation. Because these fluids are all potential contaminants, it is important to protect the drill hole and immediate area from these substances. Whenever leaking fluid from the drill rig is detected, drilling operations shall cease as soon as practical following stabilization of the drill stem, and the rig shall be moved to a safe area to be repaired.

Table I-C-1-1: Relative Performance of Different Drilling Methods in Various Types of Geologic Formations; Commonly Utilized Drilling Methods

Type of Formation	Auger-Hollow Stem	Rotary Bucket Auger*	Rotary with Fluids (foam, mud)*	Air Rotary	Air Rotary with Casing Hammer	Down the Hole Air Hammer	Dual Tube/ Casing Hammer	Coring	Reverse Rotary with Fluids*	Reverse Rotary with Dual Tube	Direct Push **
Loose sand and gravel	G	P	P-G	NR	E	NR	E	NR	P-E	E	E
Loose boulders in alluvium	P	P-G	G	NR	E	NR	P	NR	P	G	NR
Clay, silt	E	G	E	NR	E	NR	E	P-G	E	E	G
Shale	P	NR	E	P	E	NR	NR	E	E	E	NR
Sandstone	P	NR	G	E	NR	NR	NR	E	G	E	P
Limestone with chert	NR	NR	G	E	NR	E	NR	E	G	G	NR
Limestone with and without fractures	NR	NR	G-E	E	NR	E	NR	E	P-E	E	P
Limestone, cavernous	NR	NR	P-G	P-G	NR	E	NR	E	NR	E	NR

Type of Formation	Auger-Hollow Stem	Rotary Bucket Auger*	Rotary with Fluids (foam, mud)*	Air Rotary	Air Rotary with Casing Hammer	Down the Hole Air Hammer	Dual Tube/Casing Hammer	Coring	Reverse Rotary with Fluids*	Reverse Rotary with Dual Tube	Direct Push **
Dolomite	NR	NR	E	E	NR	E	NR	E	E	E	NR
Basalts-thin layers in sedimentary rocks	P	NR	G	E	NR	NR	NR	E	G	E	P
Tuff	P	NR	G	E	NR	E	NR	E	G	G	NR
Basalts-thick layers	NR	NR	P	G	NR	E	NR	E	G	G	NR
Basalts-highly fractured	NR	NR	NR	P	NR	G	NR	E	NR	G	NR
Metamorphic rocks	NR	NR	NR-P	G	NR	E	NR	E	G	G	NR
Granite	NR	NR	NR-P	E	NR	E	NR	E	G	G	NR

E Excellent
G Good
NR Not Recommended
P Poor

* Cannot be used for analytical soil sampling

** Procedure I-H, *Direct-Push Sampling Techniques* discusses protocol associated with direct push applications.

The following sections discuss commonly used drilling methods and their applicability to installation of monitoring wells. Regardless of the drilling method selected, decontaminate all drilling equipment using Procedure I-F, *Equipment Decontamination*. Follow these procedures before use and between borehole locations to prevent cross-contamination. In addition to selecting the proper drilling technique, take other precautions to prevent distribution of any existing contaminants throughout the borehole.

5.4.1 Hollow-stem Continuous-flight Auger

Hollow-stem continuous-flight auger (HSA) is the most frequently employed method used in the environmental industry for the drilling and installation of shallow monitoring wells in unconsolidated materials. Drilling with HSA is possible in loose sand and gravel, loose boulders in alluvium, clay, silt, shale, and sandstone. HSA drilling is usually limited to unconsolidated materials and depths of approximately 150 to 200 feet. HSA drill rigs are mobile, relatively inexpensive to operate, generally cause minimal disturbance to the subsurface materials, and have the additional advantage of not introducing drilling fluids (e.g., air, mud, or foam) to the formation.

Another advantage of the HSA method is that undisturbed samples are obtained by driving a split-spoon sampler below the lead auger. Soil samples can usually be easily collected in this manner with a minimum of tripping sampling tools into and out of the hole.

Moreover, in the HSA drilling method, the well is constructed inside the HSAs as the augers are gradually removed from the ground. This method decreases the possibility of the borehole collapsing before the well is installed. HSAs shall have a nominal outside auger-flight diameter of 10 to 12 inches and a minimum inside diameter of 8 inches. Larger inside diameter auger flights are sometimes available. Well casing diameter is usually limited to 4 inches or less when using the HSA

method. The difference between the inner diameter (I.D.) of the auger and the outer diameter (O.D.) of the well casing shall be at least 4 inches (i.e., a minimum 2-inch annular space) to permit effective placement of filter pack, bentonite seal, and grout without bridging.

5.4.2 Rotary Bucket Auger

Rotary bucket auger drilling, or bucket auger drilling (BAD), utilizes a large-diameter bucket auger to excavate earth materials. Excavated material is collected in a cylindrical bucket that has auger-type cutting blades on the bottom of the bucket. The bucket is attached to the lower end of a kelly bar that passes through, and is rotated by, a large ring gear that serves as a rotary table.

The kelly bar is square in cross-section and consists of two or more lengths of square steel tubing, with each successive length of tubing telescoped inside the previous length. This design permits boring to a depth several times the collapsed length of the kelly bar before having to add a length of drill rod between the kelly and the bucket. In drilling with the telescoping kelly, the bucket is typically lifted and dumped without disconnecting, thereby speeding up the process when drilling deep holes. Depths of 75 to 100 feet are achievable with most telescoping kellys. It is possible to construct wells more than 250 feet deep by this method, although depths of 50 to 150 feet are more typical.

The BAD technique is most effective in semi-consolidated or clayey formations that stand open without caving. Drilling through unconsolidated materials within the saturated zone is difficult, but not impossible if the hole is kept full of water or mud (see direct rotary methods with foam or mud). Drilling mud may be necessary, particularly in loose formations consisting of unconsolidated fine- to medium-grained sands and silts. In the right conditions, a bucket auger bit will remove a cylinder of material 12 to 24 inches deep with each run. Therefore, samples obtained by the BAD method are representative of the formation being drilled, unless sloughing or caving of the borehole walls occurs.

Boreholes drilled with the BAD technique generally range from 18 to 48 inches in diameter. Because of the large diameter of the borehole drilled with this technique, and the common need to add either water or mud to maintain the borehole in unconsolidated, near-surface deposits, it is recommended to use this method only for the installation of surface casing through the first water-bearing unit at a hazardous waste site.

5.4.3 Direct Rotary with Foam or Mud

Direct rotary drilling (DRD) techniques involve the use of various types of drilling fluids, which typically include air, foam, and mud. In each of the DRD methods, drilling fluids are circulated down through the inside of the drilling pipe into the borehole, and then up through the annulus between the drilling pipe and the borehole wall to carry drill cuttings up to the surface. The drilling fluids may also be used for stabilizing the borehole wall, which may be especially useful in unconsolidated, caving formations. In this section, the DRD method and its use with either foam or mud are discussed.

A variety of bit types may be used with each of these drilling fluids, depending on the type of formational material encountered; however, typically, the tri-cone or roller bit is used. The drilling bit is attached directly to a heavy section of drill pipe called a drill collar, which is attached to help keep the borehole straight. The drill collar is in turn attached to the drill pipe and the kelly.

General types of drilling fluids available for use with the DRD method include water with clay additives, water with polymeric additives, water with clay and polymeric additives, and foams (comprised of air or water, surfactants, and occasionally clays or polymers). The drilling fluid density may be adjusted during drilling to improve or resume circulation within the borehole, or to attempt to stabilize the borehole wall. A major problem with the addition of these fluids is that it is almost impossible to estimate the amount introduced into the formation through the saturated and unsaturated zones. Additionally, it is also very difficult to estimate the magnitude and duration of the impact to groundwater quality by the use of these fluids.

The drilling fluids and associated cuttings shall not be allowed to flow over the site unrestricted. A downhole circulation system, or fluid diversion system shall be used to keep the fluids and cuttings contained in a reasonable manner, yet still allow the collection of grab samples for lithologic identification.

While in some geologic situations DRD may be the most efficient method of drilling a borehole, potential problems associated with the drilling fluids usually make DRD a last-resort drilling technique for environmental purposes; one that should be avoided whenever possible.

Potential Problems of DRD with Foam or Mud

- The chemistry of the drilling fluid could adversely affect the chemistry of groundwater samples, soil samples, or the efficiency of the well (when using mud).
- Bentonite mud reduces the effective porosity of the formation around the well, thereby compromising the estimates of well recovery. Bentonite may also affect groundwater pH. Additives to adjust viscosity and density may introduce contaminants to the system or force irrecoverable quantities of mud into the formation.
- Some organic polymers and compounds provide an environment for bacterial growth, which in turn, reduces the reliability of sampling results.
- Uncontained drilling foam and/or mud may create unsafe working conditions at the surface around the rig.

Solutions

- DRD should only be utilized as a last resort.
- The hydrogeologist should ensure that the fluids used will not affect the chemistry of the soil samples and groundwater samples. One possibility is to collect samples of the drilling fluid for laboratory analysis.
- The hydrogeologist shall keep track of the amount of water and fluids introduced to the borehole in order to purge this quantity during well development.
- Provisions to contain drilling mud and foam shall be discussed in the drilling contractor scope of work.

5.4.4 Air Rotary and Air Rotary with Casing Hammer

Air rotary drilling (ARD) and air rotary with casing hammer (ARCH) force air down the drill pipe and back up the borehole and remove drill cuttings in the same manner as DRD with foam or mud. Without a casing hammer, the use of ARD techniques is best suited to hard-rock formations where

the borehole will stand open on its own and circulation loss is not a major concern. ARCH is most useful in unconsolidated sediments of all types due to the use of a hardened steel casing that is driven behind the bit with a pneumatic casing hammer to keep the hole open. A combination of these two drilling techniques is very useful where unconsolidated overburden overlies consolidated rock. In this case, the casing hammer attachment would be used to set the surface casing at the top of the consolidated formation while continuing with ARD. As a well is being installed or the hole is being abandoned, the casing can be retrieved for use on another hole, or left in place to serve as surface casing.

Air from the compressor shall be filtered to ensure that oil or hydraulic fluid is not introduced into the soils and/or groundwater system to be monitored. In addition, foam or hydrocarbon-based lubricating joint compounds for the drill rods shall not be used with any rotary drilling method due to the potential for introduction of contaminants into the native materials and/or groundwater. Teflon-based joint lubricating compounds that are typically mixed with vegetable oil are available for this purpose.

Potential Problems of ARD and ARCH

- In the case of sampling with a split-spoon sampler to collect soil samples for laboratory analysis, the high-pressure air from inside the drill pipe can cause volatilization of contaminants from the soils beneath the bit in unconsolidated sediments. If installing deep wells or boreholes, this problem may not be avoidable.
- Fine-grained saturated materials that may cause surging and heaving problems are common in many coastal areas. Heaving sediments may cause problems during sampling and well installation when drilling with ARD.
- Rocks and other drill cuttings may be ejected from the borehole at high velocities, creating a secondary hazard around the rig.

Solutions

- ARD and ARCH should not be used for soil sampling in shallow, unconsolidated situations where a HSA rig could be used as effectively.
- One method to compensate for heaving and surging aquifer materials is to over drill the borehole by 5 or 10 feet to provide space for heaving sediments to fill in while well completion is being performed.
- Another method to control heaving sands is to add clean water to a level above the water table to create a downward pressure on the heaving materials. This additional volume of water should also be extracted during well development.
- Drill rigs shall be equipped with cyclones or equivalent devices designed to contain formation projectiles.

5.4.5 Dual Tube Casing Hammer with Reverse Air Circulation

Dual tube casing hammer with reverse air circulation (DTCH) is useful in unconsolidated sediments, but is most effective as a method for drilling through thick sequences of materials, such as coarse-grained sands and gravels. The DTCH system operates by simultaneously driving a pair of heavy gauge steel pipes into the ground while using high pressure reverse air circulation to blow air down

the annulus of the two pipes and bring air and unconsolidated lithologic materials out through the inside of the inner pipe. The method does not employ a typical bit in that the formational materials are not ground up, sliced, nor cut into pieces. Instead, the bit consists of a special shoe that is used to funnel materials either into, or away from, the inner pipe, depending on whether the formational material is fine- or coarse-grained, respectively.

Typically, the method can drill through 200 feet of gravel in a day with relative ease. The inside diameter of the inner pipe is about 6 inches, with the borehole diameter being about 10 inches. Cobbles with long axes of up to 6 inches come up through the inner pipe easily. Larger conglomerate clasts must be either pushed aside or broken up using the pneumatic hammer to drive the heavy shoe down onto the clast.

Conversely, the method works poorly in clay-rich materials. The shoe acts as a large cookie cutter, forcing a plug of clay into the inner pipe, which then must be forced to the surface and physically removed from the diverter/shoe assembly with the hammer. This method should probably be avoided where large thicknesses of clay are expected to be encountered in the subsurface.

Typically, the DTCH method can drill to approximately 200 feet with standard equipment. Deeper holes will likely require a larger air volume for circulation via an additional compressor hooked up to the drilling rig. Additionally, a variation of the DTCH called “triple tube” can be used to install larger-diameter wells to depths of about 200 feet depending upon the site. This method can also be used to supply a temporary surface casing to avoid cross-contamination of deeper zones while extending the boring to greater depths.

Potential Problems of DTCH

- In the case of soil sampling with a split-spoon sampler to collect samples for laboratory analysis, the high-pressure air from inside the drill pipe can cause volatilization of contaminants from the soils beneath the bit in unconsolidated sediments. If installing deep wells or boreholes, this problem may not be avoidable.

Solutions

- DTCH should not be used for sampling soil in shallow, unconsolidated situations where a HSA rig could be used as effectively.

5.5 MONITORING WELL DESIGN PROCEDURES

The designs of typical groundwater monitoring wells are depicted in Figure I-C-1-1 and Figure I-C-1-2. A discussion of the design of the individual components of a typical monitoring well is given in the following subsections.

5.5.1 Pre-installation Design Drawing

Develop a pre-installation design drawing after the borehole for the well has been completed and well-specific lithologic and hydrologic information are available. The pre-design drawing shall identify the anticipated depth of the well, the locations of the top and bottom of the screened interval, the anticipated top of the filter pack, the anticipated top of the bentonite seal, and the locations of centralizers (if applicable). In addition, calculate the volumes of sand, bentonite, and grout

anticipated to be placed in the annular space of the well. Maintain the drawing as documentation of the well design.

5.5.2 Casing Selection

The cased section of a monitoring well is a pipe without slots or openings, which is installed to prevent the well from directly accessing formations above the screened interval. The casing isolates the screened interval.

The selection of appropriate casing materials must take into account several site-specific factors, such as: (1) geology, (2) geochemistry, (3) well depth, (4) size and type of equipment to be used in the well, and (5) the types and concentrations of suspected contaminants. In addition, consider several other logistical factors, including drilling method, cost, and availability.

Typical casing materials comprise polyvinyl chloride (PVC), chlorinated PVC, fiberglass reinforced plastic, Teflon, galvanized steel, carbon steel, Type 304 stainless steel, and Type 316 stainless steel. Casing materials must be compatible with the environment into which they will be placed. Metallic casings are most subject to corrosion, while thermoplastic casings are most subject to chemical degradation. Some thermoplastic materials are susceptible to sorption and desorption of chemicals. The extent to which these processes occur is related to water quality, the concentration of contaminants, and the type of casing materials. Choose casing material with knowledge of the existing or anticipated groundwater chemistry. If non-aqueous phase liquids (light non-aqueous-phase liquid or DNAPL) are potentially present at a site, careful consideration of the concentrations and types of chemicals that may come into contact with the casing must be made to insure the casing will not degrade over time. Table I-C-1-2 presents the relative compatibilities of some typical casing materials.

Table I-C-1-2: Relative Chemical Compatibility of Rigid Well-Casing Material

	PVC ^a 1	Galvanized Steel	Carbon Steel	Low-Carbon Steel	Stainless ^b Steel 304	Stainless ^b Steel 316	Teflon ^c
Buffered weak acid	100	56	51	59	97	100	100
Weak acid	98	59	43	47	96	100	100
Mineral acid/high solids	100	48	57	60	80	82	100
Aqueous/organic mixtures	64	69	73	73	98	100	100
Percent overall rating ^d	91	58	56	59	93	96	100

^a PVC casing shall not be installed in a groundwater environment containing chlorinated solvent or other destructive contaminants where the concentration of organics is greater than 1 part per million, and where the desired detection limit is less than 25 part per billion.

^b Type 316 stainless steel screen and/or casing shall be used rather than type 304 when conditions are unknown and the lifespan of the monitoring well is to be greater than 5 years, or where the pH (indicates the hydrogen ion concentration – acidity or basicity) is less than 4.5, or where chloride concentration is greater than 1,000 part per million.

^c Trademark of E.I. DuPont de Nemours

^d Overall rating based on scale of 0 to 100 with 0 being the least compatible and 100 being the most compatible.

Besides chemical compatibility, a second consideration for specification of casing materials is the depth of the monitoring well. Well installations greater than 150 feet deep require casing materials of greater structural strength. In the case of PVC casing, Schedule 80 PVC rather than Schedule 40 may be required to prevent over-stressing of the casing couplings. The build-up of heat during grout setup might adversely affect some thermo-plastic materials.

Regardless of the type of casing materials, use only flush-threaded couplings. Flush-threaded couplings ensure that no screws, mechanical adapters, glues, or solvents are necessary to join individual sections. Steel conductor casing shall be welded at the joints, and the joint shall be at least as thick as the thickness of the casing wall. The weld shall be fully penetrating and shall meet the standards of the American Welding Society. Outside steel collars may be used to increase the strength of the welded joint. Do not use Teflon tape on PVC or stainless steel casing joints because it reduces the tensile strength of the joints.

The selection of an appropriate casing diameter is also important. The I.D. shall be 4 inches or greater to allow better access to the well and more rigorous well development than is commonly possible with smaller-diameter wells. Wells with casing smaller than 4-inch I.D. shall only be installed with the approval of the QA Manager or Technical Director. Wells greater than 150 feet in depth may require diameters larger than 4 inches to ensure that development and sampling equipment can be moved easily through the well. In addition, wells designed for groundwater extraction shall have a casing diameter large enough to accommodate a pump capable of achieving the appropriate pumping rate. The borehole in which the well is to be installed shall be a minimum of 4 inches larger in diameter than the O.D. of the well casing.

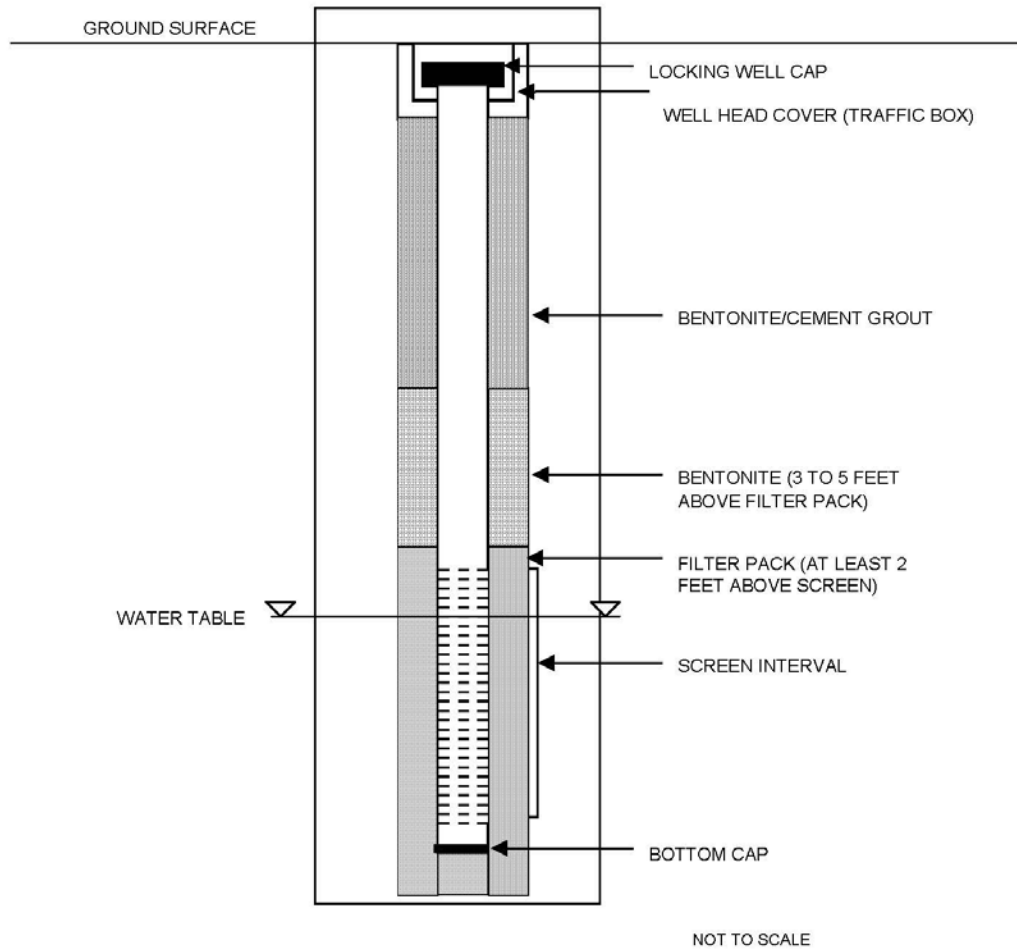


Figure I-C-1-1: General Cross Section of Monitoring Well, Unconfined Water Bearing Zone

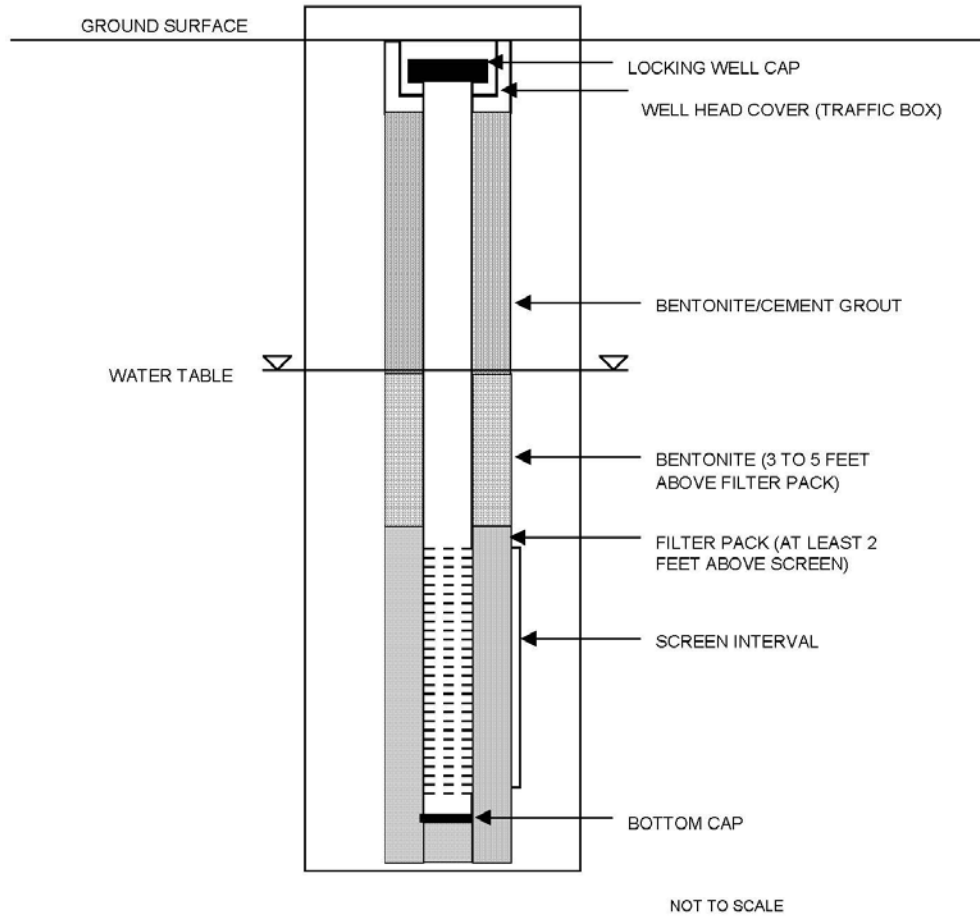


Figure I-C-1-2: General Cross Section of Monitoring Well, Confined Water Bearing Zone

5.5.3 Well Screen Selection

The screened section of the monitoring well allows groundwater to flow freely into the well, while retarding movement of fine-grained lithologic materials into the well. When designing a well screen, consider important factors, such as type of well screen material, length of the screened section, location of the screened section, the intake opening (slot) size, the type of intake opening, and size of filter pack to be utilized.

Five factors directly affect the performance of the monitoring well and are evaluated in the selection of an appropriate screen: (1) chemical resistance/interference, (2) screen length, (3) screen placement, (4) intended use of well (e.g., long-term groundwater extracted); and (5) intake opening size.

Selection of a screen material that provides chemical resistance and minimizes interference follows the same basic procedures as the selection of an appropriate casing material (see Table I-C-1-2). Some typical screen materials consist of PVC, Teflon, Type 304 stainless steel, and Type 316 stainless steel. Again, use only flush-threaded couplings. Screen sections constructed of different metals in the same well may cause electrochemical reactions that could rapidly degrade the casing or screen; therefore, do not use this type of composite well construction. In addition, construct wells intended for long-term groundwater extraction with well screen rather than slotted casing for facilitating redevelopment.

Selection of the screen length depends on its primary use(s). Most monitoring wells function as both groundwater sampling points and piezometers. Shorter-screened sections provide more specific data on vertically distributed contaminants, hydraulic head, and flow, and are generally preferred to longer-screened lengths. Saturated sections in groundwater monitoring wells shall be limited to between 5 and 10 feet in length; however, longer intervals may be justified in certain circumstances with approval of the QA Manager or Technical Director.

Placement of the screened interval within a groundwater monitoring well depends primarily upon two factors: the discrete interval and the type of contaminants to be monitored. The location of the discrete interval to be monitored will dictate the location of the screened interval within a monitoring well; however, also consider the characteristics of the contaminants to be monitored (i.e., light, non-aqueous phase liquid; dense, non-aqueous phase liquid) when choosing placement of the screened interval.

An additional consideration in the design of the screened section of the well is the hydraulic characteristics of the water-bearing zone that is to be monitored (i.e., confined or unconfined). If an unconfined zone is being monitored for contaminants that are less dense than water (e.g., gasoline, diesel, waste oil), place 3 to 5 feet of screened interval above the highest level of the water table to allow for evaluation of fluctuations in water level and to ensure that contaminant phases less dense than water can be observed. Conversely, if an unconfined zone is being monitored for contaminants that are denser than water (e.g., chlorinated solvents), place approximately 5 feet of screened interval (maximum) just above the confining unit at the base of the water-bearing zone to facilitate detection of the dense-phase contaminants. In the case of a confined water-bearing zone, use a maximum-screened interval of approximately 5 feet.

Selection of an appropriate intake opening size is critical to the performance of the monitoring well and to the integrity of groundwater samples obtained from the well. The size of the intake openings

can only be determined following the selection of an appropriate filter pack, which itself is selected based upon the grain-size of the formation. An intake size is generally designed to hold back between 85 to 100 percent of the filter pack material. Figure I-C-1-3 can be used to select appropriate intake opening sizes. The screen slots shall be factory-made (or formed).

5.5.4 Filter Pack Design

Filter pack material shall be clean and chemically stable within the monitoring well environment to minimize addition to, or sorption from, the groundwater. Filter pack shall meet the following minimum specifications:

- Filter pack material shall be at least 95 percent silica, consisting of hard, durable grains that have been washed until free of dust and contamination, and graded.
- Filter pack material shall not be angular and non-uniform such that it will bridge in the annular space, leaving a void or poorly packed materials that can consolidate or settle after construction.
- Select filter pack to meet the grading specification determined from sieve analysis of the geologic formation to be screened, if available.
- Filter pack material shall be commercially packaged in bags that prevent the entrance of contaminants, and allow proper handling, delivery, and storage at the monitoring well site. Do not use material delivered in broken bags for monitoring well construction.

In investigations where there are limited data on site conditions prior to monitoring well installation, select the filter pack size prior to field activities based on available lithologic data. Use finer filter pack sizes if fine-grained formations are anticipated to be present, and use coarser-grained filter packs in coarser lithologies and consolidated formations.

In investigations where sieve analysis data exist for a site prior to field activities, base selection of a proper filter pack upon the grain size of the formation materials to be monitored. Use the sieve data for the finest lithology identified in the interval to be monitored for establishing filter pack size. The U.S. Environmental Protection Agency recommends that filter pack grain size be selected by multiplying the 70 percent retained grain size of the formation materials by a factor between 4 and 6. Use a factor of 4 if the formation materials are fine-grained and uniform, and use a factor of 6 if the formation materials are coarse-grained and non-uniform. In any case, the actual filter pack used should fall within the area defined by these two curves. An example of this technique is presented in Figure I-C-1-4.

5.5.5 Annular Seal

The annular seal is placed directly above the filter pack in the annulus between the borehole and the well casing. The annular space must be sealed to prevent the migration of water and contaminants through the annulus. The annular seal is also intended to hydraulically and chemically isolate discrete water-bearing zones.

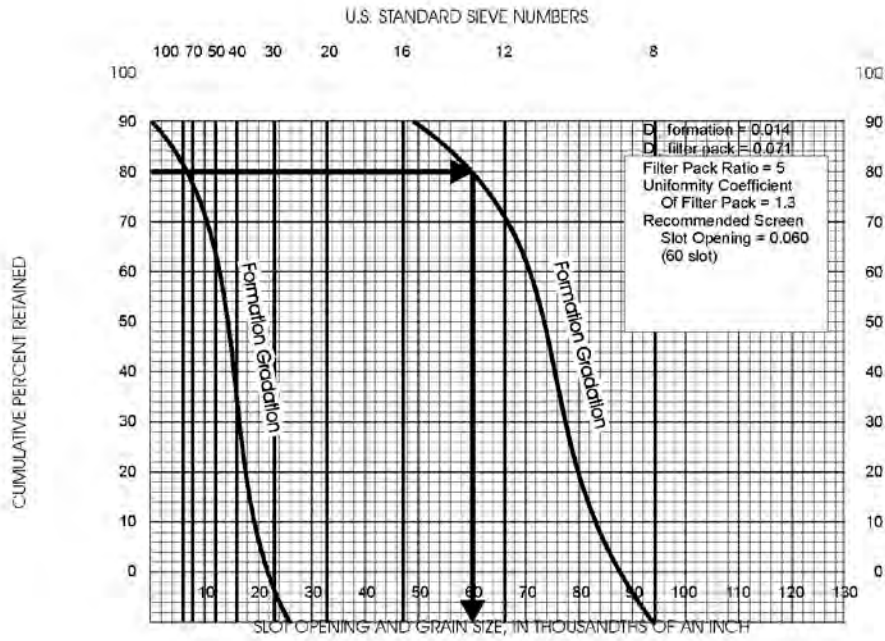


Figure I-C-1-3: Selecting Well Intake Slot Size Based on Filter Pack Grain Size

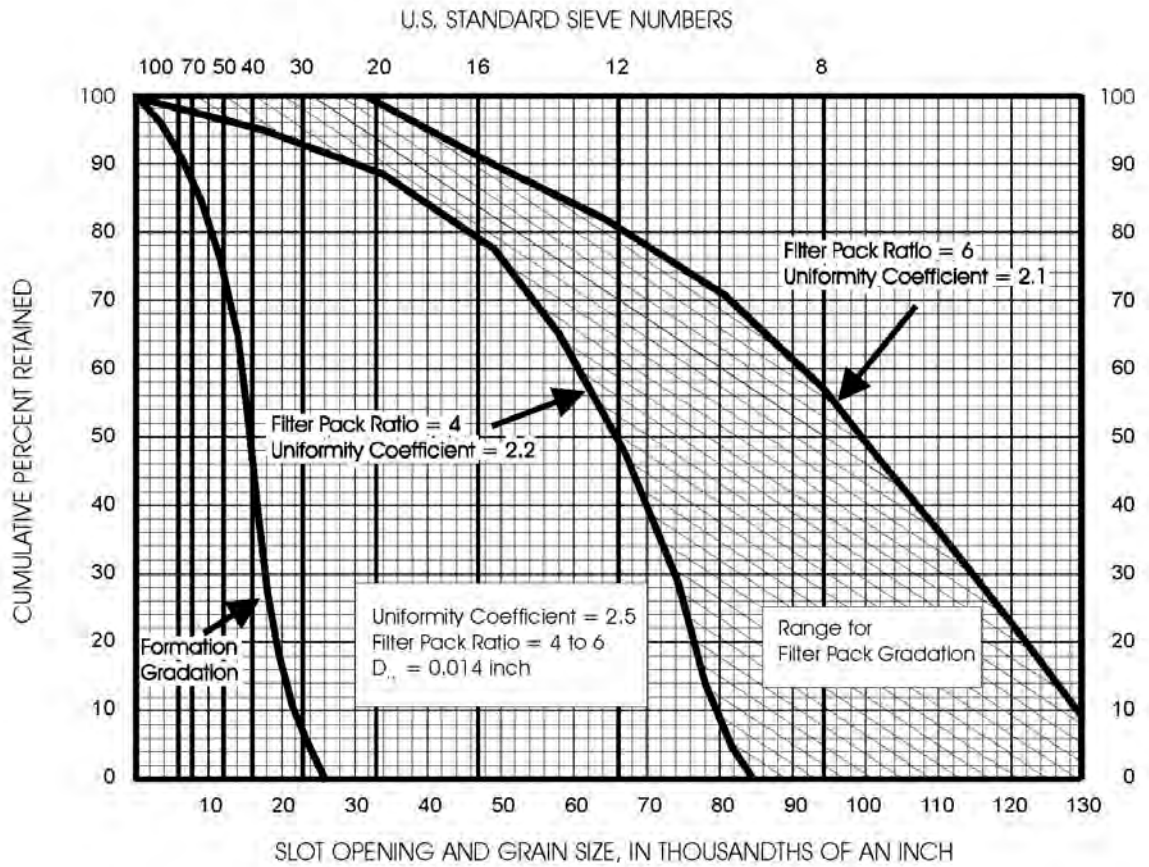


Figure I-C-1-4: Filter Pack Design Criteria

Typically, annular seals consist of two discrete sections. The first section, known as the bentonite seal, consists of a pure sodium bentonite seal. To be effective, the bentonite seal should be emplaced directly over the top of the filter pack and extend approximately 3 to 5 feet (no less than 3 feet thick). Typical materials for the seal consist of granular sodium bentonite, or sodium bentonite pellets or chips.

The second section of the annular seal typically contains grout slurry, which completely fills the remaining annular space from the bentonite seal to just below the ground surface. Grout consists of either sodium bentonite and Portland cement slurry or neat cement slurry. Give special consideration to the selection of annular seal material for wells installed in coastal areas where groundwater may contain elevated concentrations of sulfates. In this situation, use a sulfate resistant grout to prolong the usefulness of the well.

5.5.6 Surface Completion

The surface of the well shall be completed using either an above-grade (monument) style, or a flush-to-grade (traffic box) style. In either case, the protection of the wellhead at land surface is accomplished by means of a surface seal of concrete and a metal completion box surrounding the well casing. The surface seal serves to prevent infiltration of surface water and unauthorized entry, and where necessary, to provide protection from vehicular traffic.

5.6 MONITORING WELL INSTALLATION TECHNIQUES

The following general procedures describe the installation of groundwater monitoring wells.

5.6.1 General Casing and Screen Installation Techniques

Following completion of the borehole, the FM or designate will first measure the total depth of the hole to ensure that the desired depth has been attained. The lengths of casing and screen shall also be measured. These measurements shall be made with an accuracy of 0.01 feet using either a fiberglass or steel tape measure.

Installation of the casing and screen is normally accomplished by emplacing them into the well as an integral unit. Prior to installation, decontaminate individual lengths of the well casing and screen according to Procedure I-F, *Equipment Decontamination*, unless the casing and screen were certified by the manufacturer to have been properly pre-cleaned at the factory and sealed in plastic. Following decontamination, inspect each length to ensure that damaged or otherwise unsuitable sections are not used.

To ensure even distribution of filter pack, bentonite seal, and grout materials around the well within the borehole, suspend the casing and screen with a threaded hoisting plug and do not allow them to rest on the bottom of the boring unless the installation is less than 30 feet deep.

5.6.2 Centralizers

Install centralizers at the top and bottom of screened sections when using the air or mud rotary techniques for well installation. Also place centralizers at 20- to 40-foot intervals on blank casing; the FM will determine the spacing according to the depth of the well. Align the centralizers from top to bottom of the casing so that they do not interfere with the insertion and removal of the tremie pipe. All devices used to affix centralizers to the casing shall not puncture the casing or contaminate the groundwater with which they come in contact. Centralizers shall be constructed of stainless steel.

5.6.3 Filter Pack Installation

Prior to the addition of any filter pack material, cover the top of the well casing to prevent filter pack material from entering it.

The filter pack is usually installed through HSAs, conductor casing, or a tremie pipe depending on the drilling technique used; however, if the depth to the bottom of the screened interval is less than 10 feet, and lithologic materials are sufficiently consolidated to preclude the possibility of hole collapse, the filter pack may be poured into the annular space of the well from the ground surface. This procedure applies to any drilling method.

During installation, measure the level of the top of the filter pack periodically to ensure that no bridging has occurred, and to determine the depth to the top of the filter pack. Be sure that the filter pack encloses the entire length of the screened section. For wells less than 100 feet in total depth, the filter pack shall generally extend to 2 feet above the top of the screened section of the well. For wells greater than 100 feet in total depth, an additional 1 foot of filter pack may be emplaced above the screen for each 100 feet of well depth.

An alternative to conventional monitoring well construction and installation is through the use of small diameter pre-fabricated monitoring wells, commonly referred to as “pre-pack” wells. Pre-pack wells typically consist of a well screen (slotted PVC) surrounded by sand (filter-pack) held in place by a stainless steel or polyethylene mesh. The pre-pack well assembly is commonly used in conjunction with direct-push drilling methodologies, which allows a relatively quick installation of these small diameter wells. Having the filter pack around the slotted PVC before the well screen is installed ensures that the filter pack is located directly around the well screen and minimizes the effort required for the filter pack installation.

The filter pack is normally an inert (e.g., siliceous) granular material that has a grain-size distribution chosen to retain formation materials. A sleeved screen consists of a slotted pipe base over which a sleeve of stainless steel mesh filled with selected filter media is installed. Pre-packed or sleeved screens may be used for any formation conditions, but they are most often used where heaving, running or blowing sands make placement of conventional well screens and filter packs difficult, or where predominantly fine-grained formation materials are encountered (ASTM 2010). During installation, the boring is advanced using hollow drive rods with an expendable drive point. Upon reaching the desired monitoring well installation depth, the entire well assembly (i.e., pre-pack well) is lowered to the desired depth within the hollow drive rods. At the desired depth, the hollow drive rods are retracted to a point above the screen. At this step a barrier is placed directly above the screen to prevent grout or material from entering the screened interval as the hollow drive rods are extracted from the boring. This barrier can be created either by natural formation collapse (occurring during the initial rod retraction), by gravity installation of fine-grade sand through the rod annulus, or as part of the pre-pack monitoring well components (e.g. expanding foam bridge). With the barrier in place, granular bentonite or bentonite slurry is then installed in the annulus to form a well seal. When installing pre-pack screens additional sand must be used to fill in the annular space between the pre-pack and the edge of the borehole. Furthermore, filter sand should be installed to at least 2 feet above the top of the pre-packed well screen.

Vendors offer pre-pack monitoring well components with varying outer diameters, which is typically based on the inner diameter of the hollow drill rods. These types of wells may be sampled by several

methods including peristaltic pump, mini-bailer, or bladder pump to yield data of similar quality to that of conventional monitoring wells.

Following the installation of the filter pack, a surge block or large bailer shall be placed into and removed from the casing for approximately 10 minutes to set and compact the filter pack and to begin well development. Then, check the level of the filter pack again. Add more filter pack material according to the procedures described above if any settling of the filter pack has occurred. After emplacement, note the volume of filter pack material placed in the well, record it in the well completion record (Figure I-C-1-5), and compare it to the calculated volume of filter pack that was expected to have been used.

5.6.4 Annular Seal Installation

The sodium bentonite seal shall have a minimum thickness of 3 feet. Generally, to be effective the bentonite seal should extend above the filter pack approximately 3 to 5 feet. It may be constructed of powdered, granular, or pelletized bentonite, and may be emplaced as a dry solid, powder, or slurry. Use only sodium bentonite manufactured specifically for use in the drilling and construction of water wells. Typically, granular or pelletized bentonite is emplaced dry. Powdered bentonite is usually mixed with potable water to produce a slurry. Depending on the type of installation method, the bentonite may be emplaced through the HSAs, conductor casing, or tremie pipe.

In dry form, place the bentonite directly on the top of the filter pack. After emplacing each 1-foot-thick layer of dry bentonite in the well, add approximately 5 gallons of water of known chemical quality to hydrate the bentonite. Allow a minimum of 15 minutes for hydration of the bentonite seal once it is completely installed.

When emplacing the bentonite in slurry form, take care to ensure that the bentonite is thoroughly mixed, with no visible lumps to ensure the proper consistency. Then place a 1-foot layer of fine-grained silica sand over the top of the filter pack. This fine-grained sand layer will prevent infiltration of the filter pack by the bentonite slurry.

Emplace the remaining annular seal following the installation of the bentonite seal. The annular seal shall be a slurry consisting of 7 to 9 gallons of water per 94-pound bag of Portland cement Type I or II and a minimum of 3 to 5 percent bentonite (1/4 to 1/2 bags of bentonite powder per five bags of Portland cement). The slurry may be emplaced through a HSA, conductor casing, or tremie pipe, depending on the method of installation. Thoroughly mix the grout to ensure the proper consistency with no visible lumps of dehydrated powder. The rates at which the augers or pipe are withdrawn and the slurry added will be such that the level of the grout within the well annulus is just below the lowermost auger or pipe.

If a tremie pipe is used, emplace the annular grout seal by pumping through a pipe with a minimum 1-inch I.D., in one continuous pour, from the top of the transition seal to the ground surface. Place the bottom of the tremie pipe about 5 to 10 feet above the transition seal, depending on the stability of the hole and impact velocity of the grout.

A tremie pipe is not required for annular seals less than 10 feet from the ground surface to the top of the transition seal or for grouting within dual wall drill strings or HSAs. Measure the volume of grout seal material placed in the well, record it in the well construction log, and compare it with the

calculated volume. The slurry shall extend from the top of the bentonite seal to a depth of approximately 2 feet below ground surface (bgs).

5.6.5 Annular Seal “Set Time” and Setting

Let the annular grout seal set at least 12 hours before disturbing the casing or well so that separations or breaks do not occur between the seal and the casing, or between the seal and the borehole. Development of the well is prohibited until the grout seal has set. Likewise, the concrete slab, traffic box, and/or casing riser of the surface completion shall not be poured and constructed until the grout seal has set. Top off any settlement of the grout seal as soon as possible after it sets. Record all pertinent data on the well construction log.

5.6.6 Surface Completion

The surface of a groundwater monitoring well shall be either an above-ground completion or as a flush-to-ground completion. Regardless of the method, each monitoring well shall have, at a minimum, a casing cap, concrete slab and annular seal, and a locking protective casing or locking vault. Although wellheads vary in size, effort should be made to use a consistent size wellhead or similar completion per site.

In an above-ground completion, the protective casing or monument is installed around the top of the well casing within a cement surface seal. A 2-foot-long by 2-foot-wide cement pad with a minimum thickness of 3 inches is constructed around the protective casing. Type 1 Portland cement, which meets the requirements of CLASS A standards, is used for the surface seal. Inspect the monument prior to installation to ensure that no oils, coatings, or chemicals are present. Once installed, maintain the monument in a plumb position with 2 to 3 inches of clearance between the top of the well casing and the lid of the monument. The monument shall extend at least 18 inches above grade and at least 12 inches below grade. Construct a minimum of three concrete-filled posts around the well to protect it from vehicular damage.

Inside the monument, cut or scribe two permanent survey marks, approximately 0.25 inches apart, into the top of the well casing, and also permanently mark the well with its identification number. Permanent marks may include painting, marking, or engraving on the protective casing or surface completion. An alternate option may be to attach a non-corroding, imprinted metal tag to part of the well. Cover the top of the well casing with a slip cap or locking cap to prevent debris from entering the well. Fit the monument with a casehardened lock to prevent unauthorized entry.

In a flush-to-ground completion, the protective casing or traffic box is installed around the top of the well casing, which has been cut off slightly below grade. The traffic box has a lid that is held firmly in place by bolts and has a flexible O-ring or rubber gasket to prevent water from entering the box. Whenever possible, wells with flush completions should not be placed in low spots where surface water can accumulate. If this is unavoidable, consider an aboveground completion. The traffic box is set within a cement surface seal slightly above grade to deflect surface water flow away from the well. The surface seal must form an apron at ground surface that is at least 2 feet wide and 4 inches thick. The concrete apron must slope away from the well (a minimum of 1 percent) to prevent surface water leakage into the well head (DOH 2009). An effort should be made to standardize the appearance of the well completions at a particular site. Type 1 Portland cement, which meets the requirements of CLASS A standard, is used for the surface seal. Where monitoring well protection must be installed flush with the ground, an internal cap should be fitted on top of the riser within the

manhole or vault. This cap should be leak-proof so that if the vault or manhole fills with water, the water will not enter the well casing. The cap should also be able to lock to prevent unwanted access or tampering with the well. Ideally, the manhole cover cap should also be leak-proof (ASTM 2010). Inspect the traffic box prior to installation to ensure that no oils, coatings, or chemicals are present. Once installed, maintain the traffic box in a level position that leaves 2 to 3 inches of clearance between the top of the well casing and the lid of the traffic box. Regular maintenance may be necessary to maintain the integrity of the seals and pads protecting the wells.

Cut two permanent survey marks into the top of the well casing, approximately 0.25 inches apart, and also permanently mark the well with its identification number. Cover the top of the well casing with a lockable cap to prevent debris from entering the well. Also fit the lockable cap with a casehardened lock to prevent unauthorized entry.

In areas where there is a high probability of damaging the well (high traffic, heavy equipment, poor visibility), it may be necessary to enhance the normal protection of the monitoring well through the use of posts, markers, signs, or other means. The level of protection should meet the damage threat posed by the location of the well (ASTM 2010).

5.6.7 Installation of Surface Casing

The use of surface casing may be required to minimize the potential for cross-contamination of different hydrogeologic zones within the subsurface of a site. The depth of placement of the surface casing shall be based on site-specific geologic knowledge obtained from lithologic samples collected in situ during the drilling of the well boring.

If a surface casing is to be installed permanently along with the well, grout it in place. The borehole shall be of sufficient diameter that a tremie or grout pipe can be easily placed between the borehole wall and the outside of the surface casing. After the desired placement depth is reached and the drilling tools are removed from the borehole, lower the casing into the borehole and center it. The bottom of the surface casing may be plugged or driven into the sediment at the base of the borehole to keep grout from entering the casing, if necessary.

Install grout through the tremie pipe and pump it from the bottom of the casing to ground surface. As the grout is being placed, raise the tremie pipe slowly to avoid excessive backpressure and potential clogging of the tremie pipe. After the grout has been allowed to set for at least 24 hours, drilling and subsequent well installation can continue. The required time for grout to set before drilling can continue depends on the volume of grout emplaced; the more grout used, the longer the delay time.

JOB NO.: _____ WELL NO. _____ HYDROGEOLOGIST: _____
 CLIENT: _____ DRILLER: _____
 WELL LOCATION: _____ DATE/TIME: _____

DETAILS OF CONSTRUCTION

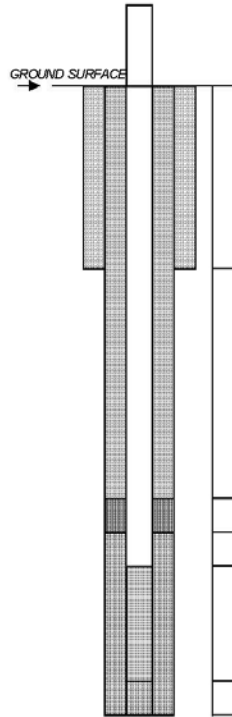
Date Completed _____
 Borehole Diameter (in.) _____
 Type and Size of Casing (in.) _____
 Type and Size of Screen (in.) _____
 Screen Perforation Diameter (in.) _____
 Screen Length (ft.) _____
 Centralizer Depths (ft.) _____
 Completion Technique
 1. Type of Filter Pack and Placement Method

 2. Type of Bentonite and Placement Method

 3. Type of Grout Mixture and Placement Method

 Description of Potential Problems With Well:

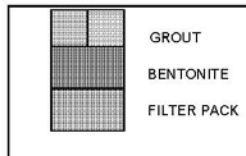
 Development Technique



Well Head Elevation _____
 Ground Surface Elev. _____
 Well Head Completion Method _____
 Drilling Method/Rig Type _____
 Surface Casing: Type _____
 Diameter _____
 Length _____

MATERIALS
 Cement (sks.) _____
 Filter Pack Material (ft.³) _____
 Casing Material (ft.) _____
 Bentonite (ft.³) _____

Top of Bentonite Seal _____ ft.
 Top of Filter Pack _____ ft.
 Top of Screen _____ ft.
 Bottom of Screen _____ ft.
 Bottom of Hole _____ ft.



NOTE: ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

Figure I-C-1-5: Well Completion Record

5.6.8 Shallow Well Completion

Due to the occurrence of shallow groundwater in some areas, there are instances when the top of the screened interval must be placed at a depth so shallow that it is impossible to install the well using the typical design for annular materials (i.e., 2 feet above the screen for filter pack followed by a 3-foot thickness of bentonite seal). In cases where the top of the screen must be placed between 4 and 6 feet bgs, use the following design alteration:

- Place the filter pack 1 foot above the top of the screened interval.
- Place a minimum of 3 feet of bentonite seal above the filter pack.
- Fill the remainder of annular space with a 3 percent to 5 percent bentonite-cement grout.

In no case shall the top of the screen be brought higher than 4 feet bgs because it is difficult to install a reliable annular seal at these shallow depths.

5.6.9 Method-specific Well Installation Techniques

The following sections describe well installation techniques for groundwater monitoring at hazardous waste sites. Sections on troubleshooting common problems encountered when using each technique and potential solutions to the problems are included.

5.6.9.1 HSA

General methods of well installation using the HSA technique are listed below:

- Complete a pre-installation design drawing in accordance with Section 5.4.1.
- Prior to well installation, properly decontaminate and measure the well screen, cap, and casing to ensure accurate placement of well casing and screen. Mark the well casing near the ground surface to signal to the drillers where the casing should be placed.
- Remember that wells are constructed within the augers as the augers are removed from the ground.
- The diameter of the well casing constructed within an HSA is limited to 4 inches. *Note:* The difference between the I.D. of the HSA and O.D. of the well casing must be at least 4 inches to permit effective placement of filter pack, bentonite seal, and grout.
- Remove the inner rod and hammer quickly, measure the depth of the borehole, and place the well screen and casing quickly into the auger to the desired depth. *Note:* the well screen and casing shall be suspended in hole by the use of a hoisting bail in order to ensure proper depth and plumb construction. This may not be necessary for wells less than 30 feet in depth.
- Prior to adding filter pack, cover the top of the well casing to prevent filter pack material from entering it.
- The HSA acts as tremie pipe for placement of filter pack, bentonite, and grout.
- Slowly pour filter pack between the inside of the auger and the outside of the well casing.
- While the filter pack material is being poured, incrementally withdraw the auger. The rate of auger withdrawal and filter pack placement shall allow for the top of the filter pack level to be just below the lead auger. In general, the augers should be withdrawn in increments of

2 to 3 feet. *Note:* The level of the top of the filter pack shall be constantly tagged with a measuring tape during emplacement of the filter pack.

- Surge the well to consolidate the filter pack; add more if settlement occurs.
- Emplace bentonite pellets or chips through the HSA. Tag the level of the bentonite periodically to ensure accurate placement. For each foot of bentonite seal installed in an unsaturated completion, pour 5 gallons of water of known chemical quality into the well to hydrate the bentonite. If the bentonite seal is less than 10 feet bgs and the borehole is stable, the bentonite may be emplaced directly from the top of the borehole rather than through the HSA.
- After allowing 15 minutes for the bentonite seal to hydrate, emplace a grout seal through the HSA from the top of the bentonite seal to within 2 feet of ground surface. The grout shall be emplaced from bottom to top in one continuous pour. If the top of the bentonite seal is less than 10 feet bgs and the borehole is not subject to collapse, the grout may be emplaced directly from the top of the borehole. If the top of the bentonite seal is greater than 10 feet bgs, a tremie tube shall be used to emplace the grout. The composition of the grout is detailed in Section 5.4.5.
- Construct an above- or below-ground wellhead.

Potential Problems and Solutions

Bridging Filter Pack or Bentonite Seal

Bridging filter pack or bentonite can create unwanted void spaces or lock the well casing within the HSA.

Avoidance of Locked Well Casing

- Carefully tag the filter pack level and keep it just below the lead auger while the auger is inched up and sand is slowly added.
- Use an auger with a larger I.D.
- Use filter pack materials with a larger grain size.
- Add water of known chemical quality while pouring the sand filter pack. Try this only in cases where the filter pack is very fine.

Solutions for Unlocking Well Casing from Augers

- Gently hold the casing in place while lifting and twisting the auger (do not force).
- Insert the surge block into the casing and gently surge the water column if bridge is below water table.
- Add water between the well and auger if the sand bridge is above the water table.
- Attach an air compressor to a tremie pipe, and then gently blow the bridge away.
- Completely remove the casing and screen, and reinstall the well.
- Never drive the casing out of the auger with a hammer because this will break the casing.

Heaving, Surging Materials

Fine-grained saturated materials that might cause surging problems are common in coastal areas. Heaving sediments might cause problems when drilling with HSA.

Solutions for Heaving Sediments

- Over-drill the borehole by 5 or 10 feet to provide space for heaving sediments to fill in while well installation begins. Begin placement of filter pack as soon possible. Add it quickly until over-drilled space is filled.
- Add clean water to a level above the water table to create a downward pressure on the heaving materials. The volume of water added shall be recorded on the well installation log and extracted during well development.
- Drill an initial pilot borehole and sample with a 6-inch-diameter auger. The 6-inch auger may be fitted with plastic or metal core catcher on the lead auger, which will allow for soil sampling and prevent sediments from entering augers. After the total sampling depth is reached, the 6-inch auger is removed and 10-inch-diameter augers are substituted to ream out the borehole. Fit the lead auger with a tapered stainless steel plug. At a depth below the desired total depth of the well, use the sampling hammer and center rod to knock out the stainless steel plug. Then complete well installation.

5.6.9.2 DIRECT ROTARY WITH FOAM OR MUD

General well installation techniques using direct rotary with foam or mud are listed below:

- Complete a pre-installation design drawing in accordance with Section 5.4.1.
- Prior to well installation, measure the well screen, cap, and casing to ensure accurate placement of well casing and screen. Place mark on the portion of the well casing near ground surface to identify to the drillers where the casing should be placed. Place centralizers on the well casing and screen as discussed in Section 5.5.2.
- With DRD techniques, wells are constructed in the borehole after the bit and drill pipe are removed from the hole. For mud rotary drilling, first thin the mud sufficiently prior to removing the bit and drill pipe from the hole. Thinning the mud allows faster and more accurate placement of the annular materials within the borehole, which balances the density of the borehole fluids so they more closely match the density of the fluids used to install the filter pack and bentonite seal. It also reduces the potential for annular materials to be washed out of the borehole through the tremie.
- After the bit and drill pipe are retrieved from the hole as smoothly and quickly as possible, measure the total depth of the hole to verify its depth and to check its stability.
- Suspend the well screen and casing in the hole by the use of hoisting bail in order to ensure proper depth and a plumb construction. This may be unnecessary for wells less than 30 feet in depth. Place the casing and screen in the hole as fast as is safely possible to minimize the time that the borehole stays open.
- Prior to the addition of filter pack, cover the top of the well casing to prevent filter pack material from entering the well casing.

- Use a tremie pipe for placement of filter pack, bentonite, and grout. Also emplace the filter pack and bentonite seal as soon as possible to avoid potential collapse of the hole.
- Slowly pour the filter pack into the tremie pipe to avoid bridging within the tremie pipe at the water table. The level of the top of the filter pack shall be constantly tagged with measuring tape as the filter pack is being emplaced.
- Make the bentonite seal at least 3 feet thick. It should consist of bentonite pellets or chips emplaced through the tremie pipe. Tag the level of the bentonite periodically to ensure accurate placement. If the bentonite seal is less than 10 feet bgs and the borehole is stable, the bentonite may be placed directly from the top of the borehole rather than through the tremie pipe.
- After allowing 15 minutes for the bentonite seal to hydrate, emplace a grout seal through the tremie pipe from the top of the bentonite seal to within 2 feet of ground surface. The grout shall be placed from bottom to top in one continuous pour. If the top of the bentonite seal is less than 10 feet bgs, and the borehole is not subject to collapse and is not filled with drilling fluid, the grout may be placed directly from the top of the borehole. The composition of the grout is detailed in Section 5.4.5.
- Construct an above- or below-ground wellhead.

Potential Problems and Solutions

Bridging Filter Pack or Bentonite Seal

Bridging filter pack or bentonite can create unwanted void spaces that might collapse in the future.

Solution

Controlled pouring of the annular materials is the best solution for bridging. In the case of mud rotary, however, it may be necessary to perform emplacement of the filter pack and bentonite chips or pellets through the borehole without the aid of a tremie pipe. For wells greater than 10 feet deep, obtain the approval of the QA Manager or Technical Director.

5.6.9.3 AIR ROTARY AND AIR ROTARY WITH CASING HAMMER

General well installation techniques using ARD or ARCH are listed below:

- Prepare a pre-installation design drawing in accordance with Section 5.4.1.
- Prior to well installation, properly decontaminate and measure the well screen, cap, and casing to ensure the accurate placement of well casing and screen.
- Remember that with ARD techniques, wells are constructed in the borehole after the bit and drill pipe are removed from the hole. With ARCH, the driven casing remains in the ground and is slowly withdrawn as well installation proceeds.
- After the bit and drill pipe are retrieved from the hole as smoothly and quickly as possible, measure the total depth of the hole to verify its depth and to check its borehole stability.
- To ensure proper depth and a plumb construction, suspend the well screen and casing in the hole using a hoisting bail. Place the casing and screen in the borehole as fast as is safely possible to minimize the time that the hole stays open, particularly for ARD.

- Before adding filter pack, cover the top of the well casing to prevent filter pack material from entering it.
- For ARD, use a tremie pipe for placement of filter pack, bentonite, and grout. Emplace the filter pack and bentonite seal as soon as possible to avoid potential collapse of the hole. For ARCH, the annular materials can in most cases be placed directly between the driven casing and the well casing. A tremie pipe is advisable if exacting placement is required.
- For ARD, place the tremie pipe within 2 feet of the interval where the filter pack is to be placed. Slowly pour the filter pack into the tremie pipe to avoid bridging within the tremie pipe at the water table. The tremie pipe shall be slowly withdrawn during placement.
- Periodically tag the level of the top of the filter pack with measuring tape while the filter pack is being emplaced. Install bentonite in a similar manner.
- For ARCH, pour the filter pack slowly between the well casing and driven casing. The driven casing shall be withdrawn periodically while the filter pack is being emplaced. Withdraw the driven casing in increments no greater than 2 to 3 feet.
- For ARD, emplace bentonite pellets or chips through the tremie pipe to a minimum thickness of 3 feet. Tag the level of the bentonite periodically to ensure accurate placement. For each foot of bentonite seal installed in an unsaturated completion, add 5 gallons of water of known chemical quality into the well to hydrate the bentonite. If the bentonite seal is less than 10 feet bgs and the borehole is stable, the bentonite may be emplaced directly from the top of the borehole rather than through the tremie pipe. For ARCH, emplace the bentonite between the well casing and the driven casing while the driven casing is being withdrawn.
- Emplace a grout seal through the tremie pipe for the ARD method or through the driven casing for the ARCH method. Emplace the grout from the top of the bentonite seal to within 2 feet of ground surface. The driven casing or tremie pipe shall be withdrawn as the grout is placed. Emplace the grout from bottom to top in one continuous pour following placement of the bentonite seal. If the top of the bentonite seal is less than 10 feet bgs and the borehole is not subject to collapse, emplace the grout directly from the top of the borehole. The composition of the grout is detailed in Section 5.4.5.
- Construct an above- or below-ground wellhead.

Potential Drilling Problems

Bridging Filter Pack or Bentonite Seal

Bridging filter pack or bentonite can create unwanted void spaces that might collapse in the future.

Solutions

Controlled pouring of the annular materials is the best solution against bridging.

Heaving Sediment

Fine-grained saturated materials that might cause heaving problems are common in coastal areas. Difficulties caused by heaving sediments might create problems when drilling with ARCH. Heaving sediments cannot be drilled using ARD techniques.

Solutions for Heaving Sediments

- Over-drill the borehole by 5 or 10 feet to provide space for heaving sediments to fill in while well completion is begun.
- Add clean water to a level above the water table to create a downward pressure on the heaving materials. The volume of water added should be extracted during well development.
- Heaving sands may also be controlled by first removing the drill pipe from the hole, and then constructing an airlift line made from the tremie pipe. If there is sufficient water above the heaving sands, an air line connected approximately 10 feet from the bottom of the tremie pipe can be used to air lift out the fine-grained sediments at the base of the casing.
- Begin placement of filter pack as soon as possible and add it quickly until the over-drilled space is filled.

5.6.9.4 DTCH

General well installation techniques using DTCH are listed below:

- Prepare a pre-installation design drawing in accordance with Section 5.4.1.
- Prior to well installation, measure the well screen, cap, and casing to ensure accurate depth placement of well casing and screen. Place a mark near the top of the casing to identify to the drillers the proper position to place the casing and screen.
- Like HSA drilling techniques, wells are constructed within the dual tube pipe as the pipe is removed from the ground.
- Prior to setting the casing and screen in the hole, verify total depth of the hole by measuring it and check for surging materials. Suspend the well screen and casing in the hole using a hoisting bail in order to ensure proper depth and plumb construction.
- Prior to addition of filter pack, cover the top of the well casing to prevent filter pack material from entering the well casing.
- The inner pipe of the dual tube assembly shall act as tremie pipe for placement of filter pack, bentonite, and grout.
- Slowly pour the filter pack between the inside of the augers and the outside of the well casing to avoid potential bridging of the annular materials. While the filter pack material is being poured, the dual tube pipe shall be incrementally withdrawn. The rate of pipe withdrawal and filter pack emplacement shall allow for the top of the filter pack level to be just below the shoe of the dual tube assembly. The level of the top of the filter pack shall be constantly tagged with measuring tape.
- Use bentonite pellets or chips to construct the well seal, which shall be a minimum of 3-feet thick, and shall also be emplaced through the dual tube assembly. For each foot of bentonite seal installed in an unsaturated completion, 5 gallons of water of known chemical quality shall be poured into the well to hydrate the bentonite. Tag the level of the bentonite periodically to ensure accurate emplacement. If the bentonite seal is less than 10 feet bgs and the borehole is stable, the bentonite may be emplaced directly from the top of the borehole rather than through the tremie pipe.

- Emplace a grout seal through the dual tube assembly from the top of the bentonite seal to within 2 feet of ground surface. Emplace the grout from bottom to top in one continuous pour immediately following emplacement of the bentonite seal. If the top of the bentonite seal is less than 10 feet bgs, the grout may be emplaced directly from the top of the borehole. The composition of the grout is detailed in Section 5.4.5.
- Construct an above- or below-ground wellhead.

Potential Problems and Solutions

Bridging Filter Pack or Bentonite Seal

Bridging filter pack or bentonite can create unwanted void spaces or lock the well casing and dual tube pipe together.

Avoidance of Locked Well Casing

- Tag carefully and always keep the filter pack just below the shoe while inching the dual tube assembly up and slowly adding sand.
- Use a smaller-diameter well casing.
- Use a filter pack with a larger grain size.
- Add water while pouring the sand filter pack. Avoid this unless absolutely necessary.

Solutions for Unlocking Well Casing from Dual Tube Pipe

- Insert a surge block into casing and gently surge the water column if the bridge is below water table.
- Add water between the well and piping if the sand bridge is above the water table.
- Attach an air compressor to a tremie pipe, and gently blow the bridge away.

Heaving, Surging Materials

Fine-grained saturated materials that might cause surging problems are common in coastal areas. Heaving sediments might cause problems when drilling with DTCH.

Solutions for Heaving Sediments

- Over-drill the borehole by 5 or 10 feet to provide space for heaving sediments to fill in while well completion begins.
- Add clean water to a level above the water table to create a downward pressure on the heaving materials. The volume of water added should be extracted during well development.
- Remove the drill pipe from the hole, and then construct an airlift line made from the tremie pipe. If there is sufficient water above the heaving sands, an air line connected approximately 10 feet from the bottom of the tremie pipe can be used to air lift out the fine-grained sediments at the base of the casing.
- Begin emplacement of the filter pack as soon as possible, and add it quickly until the over-drilled space is filled.

5.6.10 Well Construction Record Keeping Procedures

A written well completion record (Figure I-C-1-5) detailing the timing, amount of materials, and methods of installation/construction for each step of monitoring well construction shall be prepared during construction of each monitoring well by the FM or designate. Construction records shall be kept in a hard-bound field notebook dedicated to the CTO. An “as-built” drawing illustrating the placement location and amounts of all materials used in construction of each monitoring well shall be prepared in the field at the time of construction. The well construction record shall be filled out with indelible ink. Construction records shall include the date/time and quantities of materials used at each of the following stages of monitoring well construction, including:

- Drilling
 - Drill rig type
 - Drilling method/coring method
 - Drill bit/core barrel diameter (hole diameter)
 - Drill company, driller, helper(s)
 - Field geologist, supervising geologist
 - Dates/times start and finish drilling hole, interval drilling rates
 - Total depth of hole
 - Drilling location, surveyed ground elevation
 - Inclination of hole from horizontal
- Borehole abandonment – type, volume, and surface seal
- Casing material – type
- Casing decontamination – document process and equipment used
- Casing diameter – nominal I.D. of casing
- Screen material
 - Type
 - Top and bottom of section as actually installed
 - Length
 - Slot type, size, shape
 - Type of bottom plug and/or cap used
- Filter pack material
 - Composition and size gradation
 - Manufacturer
 - Actual volume and depth of top and bottom of filter pack
 - Calculated volume versus actual volume used and explanation of discrepancies
- Transition seal

- Composition and depth of top and bottom of seal
- Size (or gradation) or material used (e.g., pellets, granulated, or powdered)
- Time allowed for hydration prior to emplacement of annular grout slurry seal
- Annular slurry seal
 - Date and time of beginning and completion of annular seal
 - Type and actual volume of seal
 - Calculated volume versus actual volume and explanation of discrepancies
 - Set time allowed prior to commencement of additional work
- Surface completion
 - Type of construction
 - Nature of materials used for surface completion
 - Date/time of completion

5.6.11 Well Location

A registered land surveyor shall survey each monitoring well location for exact horizontal location to the nearest 0.5 foot, and exact vertical location to the nearest 0.01 foot, referenced to mean sea level or mean low low water. The vertical elevation shall be surveyed between the two notches cut in the top of the well casing, which is the point from which all water level measurements shall be made. The elevation of the ground or top of the concrete slab adjacent to the monitoring well shall also be surveyed, to the nearest 0.01 foot.

5.7 WELL ABANDONMENT/DESTRUCTION

Once a monitoring well is no longer needed as part of an investigation, or has been damaged to the extent that it cannot be repaired, it is essential that it be properly abandoned. The proper abandonment of a monitoring well ensures that the underlying groundwater supply is protected and preserved. In addition, proper well abandonment eliminates a potential physical hazard and liability. An additional permit and/or inspection may be required for abandonment, depending on state or local regulations.

The standard procedures for the abandonment of a groundwater monitoring well apply to the HSA drilling method. This type of installation was chosen because it is the primary method of abandoning groundwater monitoring wells. For wells abandoned on Guam, the current Guam Environmental Protection Agency Well Abandonment Procedures shall be followed (Attachment I-C-1-1).

The first step in abandoning a groundwater monitoring well is to remove the surface completion from around the top of the well casing. This is normally accomplished using a jackhammer to break the surface cement seal, and then removing the monument or traffic box. When the surface seal and the wellhead cover have been removed, over-drill the well to its total depth using HSAs. Once the total depth of the well has been reached, remove the casing and screen from the borehole. Then completely backfill the borehole with a grout seal. Typically, the grout seal is emplaced as slurry of Portland cement grout, which contains a minimum of 3 to 5 percent bentonite as described in

Section 5.4.5. When mixing the slurry, take care that the bentonite is mixed according to the manufacturer's specifications to ensure the proper consistency.

Emplace the slurry through the HSAs. The rates at which the augers are withdrawn and the slurry is added shall be such that the level of the slurry within the borehole is just below the lead auger. The borehole seal shall extend from the total depth of the borehole to a depth of approximately 1 foot bgs. Then repair the surface to prior conditions and grade.

If the monitoring well casing cannot be pulled or drilled out, perforate the well casing adjacent to the saturated zones so that the annular space and any nearby voids can be filled with sealing material. Fill the perforated well or borehole from the bottom up with an appropriate sealing material, such as neat cement. Inject the neat cement under pressure to force it into the annular space, nearby voids, and filter pack. Apply pressure for a sufficient time to allow the cementing mixture to set. After the cement has hardened, excavate a hole around the well (use a backhoe if necessary) to the depth specified in the Monitoring Well Abandonment Work Plan (WP) and ensure the excavation depth is in accordance with local regulatory agency guidelines (Attachment 1 for *Guam Monitoring Well Abandonment Procedure*) (GEPA 2006). Remove the uppermost portion of the casing, (if still in place), and pour a cement cap on top of the abandoned well, and backfill the remaining portion of the excavation with sealing material. Note, if personnel are required to enter the excavation to remove the upper portion of the casing, then proper sloping and shoring are required as per Section 25, *Excavations* of The Safety and Health Requirements Manual EM 385-1-1 (USACE 2008).

The State of Hawaii Department of Health Hazard Evaluation and Emergency Response must be notified at least 1 week prior to any well abandonment activities conducted in Hawaii (DOH 2009, Section 6.2.5.1). Additionally, an Abandonment of Monitoring Well Summary Report should be prepared using the form presented in Attachment 1-C-1-2. The record should include the following information:

- Well construction information:
 - Date of installation
 - Drilling company
 - Total depth
 - Casing material/length
 - Screen material/length
 - Annular material
- General abandonment information:
 - Drilling firm (contact, mailing address, and phone number).
 - Consulting firm (contact, mailing address, and phone number).
- Well abandonment information
 - Date of abandonment
 - Reason for abandonment

- Details of how the casing/screen was removed drilled out or perforated.
- Sealing material (weight/volume/bags/mix ratio)

5.8 VAPOR EXTRACTION/MONITORING WELLS

Vapor extraction/monitoring wells have most of the same design and installation considerations and procedures as groundwater-monitoring wells, with the exception that they are screened in the unsaturated zone. Vapor extraction/monitoring wells generally shall not be screened over an interval greater than 20 feet and shall not be screened over two or more lithologies that have air permeabilities that differ by more than one order of magnitude. Vapor extraction/monitoring wells shall be installed using drilling techniques that do not require drilling fluids other than filtered air. Vapor monitoring wells may have casing I.D.s of 2 inches or less while extraction wells shall generally have casing I.D.s of at least 4 inches. The design of vapor extraction/monitoring wells is dependent upon many site-specific factors, such as the depth of contamination, soil conditions, geology, and depth to groundwater. As a result, specifics related to the design of these wells shall be included in the CTO WP, field sampling plan, or plans and specifications.

5.9 DRIVE POINTS

An alternative to conventional monitoring well construction is, under limited conditions, the use of drive points. These consist of slotted steel pipe that is pushed, hammered, or hydraulically jetted into the ground. A filter pack is not constructed around the screen, so the width of the screen openings must be sufficiently small to prevent the passage of significant quantities of sediment into the well during the withdrawal of water for sampling. In some instances, the drive points are used only as piezometers.

Drive points are commonly used in hazardous waste investigations to sample ambient soil gases in the vadose zone. It is often possible to extend the drive point below the water table to collect water samples. In some instances, permits may be required because the drive points are considered in some jurisdictions to be equivalent to a temporary monitoring well.

5.10 DISCRETE DEPTH GROUNDWATER SAMPLING

Another alternative to conventional monitoring well construction is the use of a discrete groundwater sampling device such as a Hydropunch. The Hydropunch tool can be used in conjunction with a standard drill rig, a cone penetrometer rig, or possibly a vehicle capable of driving vapor probes to sample groundwater and non-aqueous phase liquid in unconsolidated formations. The Hydropunch tool is constructed of a stainless steel drive point, a perforated section of Teflon pipe for a sample intake, and a stainless steel sample chamber. The tool is 55.5 inches long, 2 inches in O.D., and weighs approximately 24 pounds.

Ideally, a standard HSA drilling rig is used to drill a pilot hole to a depth just above the desired sampling depth. The Hydropunch tool is then hydraulically pushed or driven 4 to 5 feet through the saturated zone at each sampling location. As the tool is advanced, the sample intake screen remains pristine within the watertight stainless steel chamber. When the desired sampling interval is reached, the steel sampling chamber is unscrewed and withdrawn 1 foot to several feet, depending on how long a sampling interval is needed. This exposes the intake screen to the groundwater. Under hydrostatic pressure, groundwater flows through the intake screen and fills the sample chamber,

without aeration or agitation occurring. The drive cone, which is attached to the base of the screen, will remain in place by soil friction.

The pointed shape of the sampler and its smooth exterior surface prevent downward transport of surrounding soil and groundwater as the tool is advanced. Once in place, the intake screen will be sealed from groundwater above and below the interval being sampled, because the exterior of the Hydropunch tool is flush against the surrounding soil wall. Additionally, as the tool is advanced, the sample intake screen is retained within the steel watertight sample chamber.

A stainless steel or Teflon bailer with a bottom check valve is lowered into the sample chamber to collect the groundwater sample. Groundwater is then decanted at ground surface from the bailer into the appropriate sample containers.

6. Records

Monitoring well location, design, and construction shall be recorded in the field notebook for the CTO and on a well completion record form (Figure I-C-1-5). The field operations manager should provide a copy of this form to the CTO Manager for the project files.

7. Health and Safety

Field personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

ASTM International (ASTM) 2010. *Standard Practice for Design and Installation of Ground Water Monitoring Wells*. D5092-04^{e1} (Reapproved 2010). West Conshohocken, PA.

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of Health, State of Hawaii (DOH). 2009. *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*. Interim Final. Honolulu: Office of Hazard Evaluation and Emergency Response. 21 June.

Department of the Navy (DON). 2010. *Ammunition and Explosives Safety Ashore*. NAVSEA OP 5 Volume 1, 7th Revision, Change 11. 0640-LP-108-5790. Commander, Naval Sea Systems Command. July 1.

———. 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Guam Environmental Protection Agency (GEPA). 2006. *Well Abandonment Procedure*. Water Resources Management Program.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-A-5, Utility Clearance.

Procedure I-B-1, Soil Sampling.

Procedure I-B-5, Surface Water Sampling.

Procedure I-F, Equipment Decontamination.

9. Attachments

Attachment I-C-1-1, Guam Monitoring Well Abandonment Procedure

Attachment I-C-1-2, DOH Abandonment of Monitoring Well Summary Report Form

**Attachment I-C-1-1
Guam Well Abandonment Procedure**

This page intentionally left blank



I. Abandonment procedure for cased wells that will not have its casing removed

1. Remove the well pedestal and concrete pad if applicable.
2. Excavate down to six (6) feet and cut the casing.
3. If the well extends into the water table, measure the depth to the water table(DWT) and fill the well with 3/8 to 3/4 inch clean washed aggregate to three (3) feet above the water table. If the well is completely within the vadose zone, proceed to item "I.4."
4. Provide a two-foot (2) a bentonite plug by placing 3/4 inch bentonite chip in six (6) inch lifts and hydrating with potable water.
5. Fill the casing with clean cement up to six (6) below the ground surface which will form a mushroom cap.
6. Fill the final six (6) feet with native soil.

- Note:
- a. For wells with a depth to the water table greater than eleven (11) feet, the total depth of fill for item "I.5" will be equal to DWT less eleven feet.
 - b. For shallow wells with a depth to the water table greater than nine (9) feet, but less than eleven (11) feet above the water table, item "I.5" will not be included.
 - c. For shallow wells with a depth to the water table greater than three (3) feet, but less than nine (9) feet, items "I.4" and "I.5" will not be included.

II. Abandonment procedure for wells that will have its casing removed and open boreholes.

1. Remove the old pedestal and concrete pad if applicable.
2. Remove the casing if not an open borehole.
3. If the well extends into the water table, measure the depth to the water table(DWT) and fill the well with 3/8 to 3/4 inch clean washed aggregate to three (3) feet above the measured water table. If the well is completely within the vadose zone, proceed to item "II.4."
4. Provide a two-foot (2) bentonite plug by placing 3/4 inch bentonite chips in six (6) inch lifts and hydrating with potable water.
5. Fill the remaining portion with bentonite/cement slurry (30% of bentonite by volume) in 10-foot lifts up to twenty-six (26) feet below the ground surface.
 - a. After each 10-foot lift, the hole shall be sounded to determine if ten (10) feet of the hole is actually filled with the bentonite/cement slurry by at least eight (8) feet. If the depth of the fill is greater than eight (8) feet, continue with the next ten-foot (10) lift of bentonite/cement slurry. If the depth of the fill is less than eight (8) feet (an indication that there is a cavity), go to "II.5.b." Otherwise, continue with item "II.5.a." When the bentonite/cement fill reaches a height of twenty-six (26) feet below the ground surface, go to item "II.6."
 - b. Fill the next ten (10) feet with 3/8 to 3/4 inch clean washed aggregate. Sound the hole to ensure that at least nine (9) feet has been filled with clean aggregate. If less than nine (9) feet is filled, repeat another ten-foot (10) lift of 3/8 to 3/4 inch clean washed aggregate until the sounding of the well/borehole reveals a rise of nine (9) feet or greater. Go to item "II.5.c."

- c. Provide a two-foot (2) bentonite plug above the clean aggregate by placing 3/4 inch bentonite chips in six (6) inch lifts and hydrating with potable water. Continue with item "II.5.a."
6. Fill the next twenty (20) feet above the bentonite/cement fill with neat cement.
7. The remaining six (6) feet shall be filled with native soil.

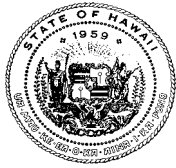
- Note:
- a. For wells with a depth to the water table greater than thirty-one (31) feet, the total depth of fill for item "II.5" will be equal to DWT less thirty-one (31) feet.
 - b. For shallow wells with a depth to the water table greater than eleven (11) feet, but less than thirty-one (31) feet above the water table, item "II.5" will not be included.
 - c. For shallow wells with a depth to the water table greater than nine (9) feet, but less than eleven (11) feet above the water table, items "II.5" and "II.6" will not be included.
 - d. For shallow wells with a depth to the water table greater than three (3) feet, but less than nine (9) feet, items "II.4", "II.5" and "II.6" will not be included.

General Notes:

- a. The driller shall submit a well abandonment plan following the above procedure to Guam EPA for review/approval.
- b. The driller shall notify Guam EPA administrator 48 hours prior to starting date of the the approved abandonment plan.
- c. All above-ground materials shall be removed from the well site and disposed in a manner that conforms to the Guam EPA's solid waste regulations.
- d. If a well is in an area that is covered with asphalt or concrete that is not to be removed (such as a parking lot or a driveway/street), the native soil fill may be excluded and the well may be filled to the top with neat cement and then covered with new asphalt or concrete.

Attachment I-C-1-2
DOH Abandonment of Monitoring Well Summary Report Form

This page intentionally left blank



Abandonment of Monitoring Well Summary Report

_____ (Monitoring Well ID)

Submit form within 30 days of well abandonment or within 90 days if included in a site closure, monitoring, or investigation report. In addition, submit copies of the original boring log and well construction diagram for the monitoring well, a site map showing the location of the abandoned monitoring well, and the disposal documentation for wastes generated during the abandonment process. Submit all documentation to: Hawaii Department of Health, Hazard Evaluation and Emergency Response Office, Attention: SDAR, 919 Ala Moana Blvd, Rm. 206, Honolulu Hawaii 96814.

Location Information		Owner Information	
Facility Name:		Well Owner:	
Facility Address:		Contact Person:	
		Mailing Address:	
Latitude:			
Longitude:		Phone Number:	Fax Number:
TMK:		Land Owner:	
Location Description:		Contact Person:	
		Mailing Address:	
Monitoring Well Location Map Attached: Y N		Phone Number:	Fax Number:
Well Construction Information			
Date of Installation:		Casing Material:	Casing Diameter:
Drilling Company:		Casing Length:	Casing Depth:
Total Depth:		Screen Material:	Slot Size:
Depth to Water:		Screen Length:	Screen Depth:
Was the Well Set in an Aquifer that is a Current or Potential		Annular Material:	Depth:
Drinking Water Source: Y N		Annular Material:	Depth:
Boring Log/Well Construction Diagram Attached: Y N		Annular Material:	Depth:
General Abandonment Information			
Drilling Firm:		Consulting Firm:	
Contact Person:		Contact Person:	
Mailing Address:		Mailing Address:	
Phone Number:	Fax Number:	Phone Number:	Fax Number:
Well Abandonment Information			
Date of Abandonment:		Sealing Material:	Depth:
Reason for Abandonment:		Volume/Weight/Bags	Mixing Ratio:
Casing/Screen Removed: Y N		Sealing Material:	Depth:
If Yes, was annular material removed?: Y N		Volume/Weight/Bags	Mixing Ratio:
If No, was casing cut off below the surface?: Y N		Method of Sealing Material Placement:	
Comments:			
Driller's Signature:		Date:	
Consultant's Signature:		Date:	

This page intentionally left blank

Monitoring Well Development

1. Purpose

This section describes the standard operating procedures for monitoring well development to be used by United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

None.

4. Responsibilities

The prime contractor CTO Manager is responsible for ensuring that these monitoring well development procedures are followed during projects conducted under the NAVFAC Pacific ER Program. The CTO Manager is responsible for ensuring that all personnel involved in monitoring well development shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager is responsible for ensuring that all project field staff follow these procedures.

Field personnel are responsible for the implementation of this procedure.

5. Procedure

5.1 INTRODUCTION

Well development procedures are crucial in preparing a well for sampling. They enhance the flow of groundwater from the formation into the well and remove the clay, silt, and other fines from the formation so that produced water will not be turbid or contain suspended matter that can interfere with chemical analyses. A monitoring well should be a “transparent” window into the aquifer from

which samples can be collected that are truly representative of the quality of water that is moving through the formation.

The goal of well development is to restore the area adjacent to a well to its natural condition by correcting damage to the formation during the drilling process. Well development shall accomplish the following tasks:

- Remove a filter cake or any drilling fluid within the borehole that invades the formation.
- Remove fine-grained material from the filter pack.
- Increase the porosity and permeability of the native formation immediately adjacent to the filter pack.

Well development shall not occur until 24 hours after the completion of well installation to allow the annular seal to fully set up.

5.2 FACTORS AFFECTING MONITORING WELL DEVELOPMENT

5.2.1 Type of Geologic Materials

Different types of geologic materials are developed more effectively by using certain development methods. Where permeability is greater, water moves more easily into and out of the formation and development is accomplished more quickly. Highly stratified deposits are effectively developed by methods that concentrate on distinct portions of the formation. If development is performed unevenly, a groundwater sample will likely be more representative of the permeable zones. In uniform deposits, development methods that apply powerful surging forces over the entire screened interval will produce satisfactory results.

5.2.2 Design and Completion of the Well

Because the filter pack reduces the amount of energy reaching the borehole wall, it must be as thin as possible if the development procedures are to be effective in removing fine particulate material from the interface between the filter pack and natural formation. Conversely, the filter pack must be thick enough to ensure a good distribution of the filter pack material during emplacement. The general rule is that filter pack material must be at least 2 inches thick.

The screen slot size must be appropriate for the geologic material and filter pack material in order for development to be effective. If slot size is too large, the removal of too much sediment may cause settlement of overlying materials and sediment accumulation in the casing. When screen openings are too small, full development may not be possible and well yield will be below the potential of the formation. Additionally, incomplete development coupled with a narrow slot size can lead to blockage of the screen openings.

5.2.3 Drilling Method

The drilling method influences development procedure. Typical problems associated with specific drilling methods include the following:

- If a mud rotary method is used, mud cake builds up on the borehole wall and must be removed during the development process.

- If drilling fluid additives have been used, the development process must include an attempt to remove all fluids that have infiltrated into the native formation.
- If driven casing or hollow-stem auger methods have been used, the interface between the casing or auger flights and the natural formation may have been smeared with fine particulate matter that must be removed during the development process.
- If an air rotary method has been used in rock formations, fine particulate matter is likely to build up on the borehole walls and may plug pore spaces, bedding planes, and other permeable zones. These openings must be restored during the development process.

5.3 PREPARATION

In preparing for monitoring well development, development logs for any other monitoring wells in the vicinity should be reviewed to determine the general permeability of the water-bearing formation and the appropriate development method.

Depth to groundwater and information from the well construction log should be used in calculating the required quantity of water to be removed. The distance between the equilibrated water level and the bottom of the screen is the saturated section. The saturated section (feet) multiplied by the unit well volume per foot (gallons/linear foot) equals the gallons required to remove one total well volume of water. The unit well volume is the sum of the casing volume and the filter pack pore volume, both of which depend upon casing and borehole diameter and the porosity of the filter pack material. Well volume can be calculated using Table I-C-2-1, Table I-C-2-2, or Table 1-C-2-3.

Table I-C-2-1: Casing Volume*

Casing Diameter (inches)	Volume (gallon/linear foot)
2	0.16
4	0.65
6	1.47

Table I-C-2-2: Filter Pack Pore Volume

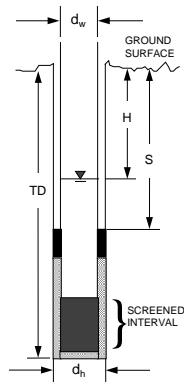
Casing Diameter (inches)	Borehole Diameter (inches)	Volume ^a (gallon/linear foot)
2	6	0.52
2	8	0.98
4	10	1.37
4	12	2.09
6	12	1.76

* The above two volumes must be added together to obtain one unit well volume.

^a Assumes a porosity of 40% for filter pack.

Table I-C-2-3: Well Volume Calculation

HOLE DIAMETER	d_h	=	_____
WELL CASING INSIDE DIAMETER	d_wID	=	_____
OUTSIDE DIAMETER	d_wOD	=	_____
DEPTH TO: WATER LEVEL	H	=	_____
BASE OF SEAL	S	=	_____
BASE OF WELL	TD	=	_____
EST. FILTER PACK POROSITY	P	=	_____



WELL VOLUME CALCULATION :

$$\text{CASING VOLUME} = V_c = \pi \left(\frac{d_wID}{2} \right)^2 (TD - H) = 3.14 \left(\frac{\quad}{2} \right)^2 (\quad - \quad) = \quad$$

$$\text{FILTER PACK PORE VOLUME} = V_f = \pi \left[\left(\frac{d_h}{2} \right)^2 - \left(\frac{d_wOD}{2} \right)^2 \right] (TD - (S \text{ or } H * (P))) = \quad$$

(* if $S > H$, use S ; if $S < H$, use H)

$$= 3.14 \left[\left(\frac{\quad}{2} \right)^2 - \left(\frac{\quad}{2} \right)^2 \right] (\quad - \quad)(\quad) = \quad$$

$$\text{TOTAL WELL VOLUME} = V_T = V_c + V_f = \quad + \quad = \quad \text{ft.}^3 \times 7.48 = \quad \text{gal.}$$

5.4 DECONTAMINATION

The purpose of decontamination of development equipment is to prevent cross-contamination between monitoring wells. Use disposable equipment where appropriate. Use a steam-cleaner, if available, to decontaminate development equipment. Clean the equipment away from the monitoring well in such a fashion that decontamination effluent can be intercepted and drummed.

A triple rinse decontamination procedure is acceptable for equipment, such as bailers, or if access to a steam cleaner is not possible (Procedure I-F, *Equipment Decontamination*).

During well development, place visqueen around the well to prevent contamination at ground surface. Properly dispose of this sheeting after each use.

5.5 WELL DEVELOPMENT MONITORING

Throughout the well development process, maintain a development record using the form presented in Attachment I-C-2-1. The record should include the following information:

- General:
 - Project name and number
 - Well name/number and location
 - Date, time, and weather conditions
 - Names of personnel involved
- Development volume:
 - Initial and final water level
 - Casing total depth and diameter
 - Borehole diameter
 - Casing volume, filter pack pore volume, total well volume
 - Volume of water to be evacuated
 - Method and rate of removal
 - Appearance of water before and after development
- Monitoring data for each sample point:
 - Date, time, elapsed time
 - Cumulative gallons removed, removal method, removal rate
 - Temperature, pH (indicates the hydrogen ion concentration – acidity or basicity), specific conductivity, turbidity, dissolved oxygen, redox potential, and salinity

Part of the well development procedure shall consist of acquisition and analysis of water samples at appropriate intervals considering the total quantity of water to be removed. Measure conductivity, pH, temperature, dissolved oxygen, redox potential, turbidity, and salinity in each sample using a multi-parameter meter and flow-through cell. Collect readings on a periodic basis (approximately every 3 to 5 minutes) during development and obtain at least one reading after removal of each well

volume. At the time each sample is analyzed, record the cumulative water removed, the time, the time elapsed during development, and calculated flow rate. Continue development until at least 3 borehole volumes have been removed, turbidity stabilizes at or below 5 nephelometric turbidity units, and three successive readings of the parameters have stabilized (values within 10 percent of each other). If stabilization has not been attained, if turbidity remains high, or if the well does not readily yield water, allow the water level in the well to recover, conduct an additional 15 minutes of mechanical surging and/or bailing, then continue development until stabilization can be achieved or for a reasonable time.

Section 5.7 describes well development in special situations, such as low yield formations and 2-inch wells.

5.6 METHODS OF MONITORING WELL DEVELOPMENT

The methods available for the development of monitoring wells have been inherited from production well practices. Methods include: (1) mechanical surging with a surge block or swab, and (2) surge pumping. Development methods using air or jetting of water into the well are generally inappropriate for development of monitoring wells due to the potential for affecting water quality.

Containerize and appropriately label all development water (unless it is permissible to discharge it on site). All development efforts must utilize mechanical surging or surge pumping, followed by bailing or groundwater removal with a pump. More detailed descriptions of appropriate development methods are presented below.

5.6.1 Mechanical Surging and Bailing

For mechanical surging and bailing, a surge block or swab is operated either manually or by a drill rig. The surge block or swab should be vented and be of sufficient weight to free-fall through the water in the well and create a vigorous outward surge. The equipment lifting the tool must be strong enough to extract it rapidly. A bailer is then used to remove fine-grained sediment and groundwater from the well.

Procedures:

1. Properly decontaminate all equipment entering the well.
2. Record the static water level and the total well depth.
3. Lower the surge block or swab to the top of the screened interval.
4. Operate in a pumping action with a typical stroke of approximately 3 feet.
5. Gradually work the surging downward through the screened interval during each cycle.
6. Surge for approximately 10 to 15 minutes per cycle.
7. Remove the surge block and attach the bailer in its place.
8. Bail to remove fines loosened by surging until the water appears clear.

9. Repeat the cycle of surging and bailing at least three times or until turbidity is reduced and stabilization of water quality parameters occurs.
10. The surging shall initially be gentle and the energy of the action should gradually increase during the development process.

The advantages (+) and disadvantages (–) of this method are listed below:

- + Reversing the direction of flow reduces bridging between large particles, and the inflow then moves the fine material into the well for withdrawal.
- + It affects the entire screened interval.
- + It effectively removes fines from the formation and the filter pack.
- It might cause upward movement of water in the filter pack that could disrupt the seal.
- Potential exists for damaging a screen with a tight-fitting surge block or with long surge strokes.

5.6.2 Surge Pumping

Procedures:

1. Properly decontaminate all equipment entering the well.
2. Record the static water level and the total well depth.
3. Lower a submersible pump or airlift pump without a check valve to a depth within 1 to 2 feet of the bottom of the screened section.
4. Start pumping and increase discharge rate to maximum capacity (overpumping), causing rapid drawdown of water in the well.
5. Periodically stop and start the pump, allowing the water in the drop pipe to fall back into the well and surge the formation (backwashing), thus loosening particulates.
6. The pump intake shall be moved up the screened interval in increments appropriate to the total screen length.
7. At each pump position, the well shall be pumped, overpumped, and backwashed alternately until satisfactory development has been attained as demonstrated by reduction in turbidity and stabilization of water quality parameters.

The advantages (+) and disadvantages (–) of this method are listed below:

- + Reversing the direction of flow reduces bridging between large particles, and the inflow then moves the fine material into the well for withdrawal.
- + It effectively removes fines from the formation and filter pack.
- The pump position or suction line must be changed to cover the entire screen length.

- Submersible pumps suitable to perform these operations may not be available for small diameter (1 inch or less) monitoring wells.
- It is not possible to remove sediment from the well unless particle size is small enough to move through the pump.

For additional information on well development, consult the references included in Section 8 of this procedure.

5.7 SPECIAL SITUATIONS

5.7.1 Development of Low Yield Wells

Development procedures for monitoring wells in low-yield (<0.25 gallons per minute), water-bearing zones are somewhat limited. Due to the low hydraulic conductivity of the materials, surging of water in and out of the well casing is difficult. Also, the entry rate of water is inadequate to remove fines from the well bore and the gravel pack when the well is pumped. Additionally, the process may be lengthy because the well can be easily pumped dry and the water level is very slow to recover.

Follow the procedures for mechanical surging and bailing for low yield wells. During surging and bailing, wells in low yield formations should be drawn down to total depth twice, if possible. Development can be terminated, however, if the well does not exhibit 80 percent recovery after 3 hours.

5.7.2 Development of 2-inch Wells

It is easier to develop monitoring wells that are large in diameter than small diameter wells. Mechanical surging or bailing techniques that are effective in large diameter wells are much less effective when used in wells 2 inches or less in diameter. Mechanical surge blocks and bailers have a high potential for damaging a small diameter well. As a result, the CTO Manager shall obtain approval from the QA Manager or Technical Director prior to installing groundwater monitoring wells with inside diameters of 2 inches or less.

Develop two-inch or smaller diameter wells by surging with a specially designed, hand-operated surge block or by pumping with a bladder or airlift pump. Information related to development of wells 2 inches or less in diameter shall be included in the CTO work plan.

6. Records

Well development information should be documented in indelible ink on well development monitoring forms (Attachment I-C-2-1). Copies of this information shall be sent to the CTO Manager and to the project files. The CTO Manager shall review all well development logs on a minimum monthly basis.

7. Health and Safety

Field personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-F, *Equipment Decontamination*.

9. Attachments

Attachment I-C-2-1: Well Development Record

This page intentionally left blank

**Attachment I-C-2-1
Well Development Record**

This page intentionally left blank

This page intentionally left blank

Drum Sampling

1. Purpose

This standard operating procedure describes the methods by which United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel will sample drum(s) at hazardous waste and non-hazardous waste sites. Prior to disturbing and handling drums of unknown origin and/or with unknown contents, approval from the Navy will be required.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program. As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations

3. Definitions

None.

4. Responsibilities

The prime contractor CTO Manager is responsible for ensuring that drums of concern are handled and sampled according to this procedure. The CTO Manager is responsible for ensuring that all personnel involved in drum sampling have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager is responsible for ensuring that these procedures and the work plan (WP) are followed when drums are sampled.

Field sampling personnel are responsible for the implementation of this procedure.

5. Procedures

5.1 METHOD SUMMARY

Prior to sampling, drums should be inventoried, staged, and opened. Inventorying entails recording the visible qualities of each drum and any characteristics pertinent to classification of the contents. Staging involves the organization, and sometimes consolidation, of drums containing similar wastes

or that share characteristics. Closed drums may be opened manually or remotely. In the interest of worker safety, it is required to open drums remotely unless the drum contents are known not to present any potential physical or chemical threat to workers. Analytical results from associated field samples may be used to evaluate potential threats. The most widely used method of sampling a drum containing liquids involves the use of a glass thief. This method is quick, simple, relatively inexpensive, and does not require decontamination. Additional information related to drum sampling is available in Section 8, References.

5.2 INTERFERENCE AND POTENTIAL PROBLEMS

The practice of tapping drums to determine their contents is neither safe nor effective and should not be used. Any necessary air monitoring should be conducted when working near over-pressurized drums.

Do not move drums that are over-pressurized to the extent that the head is swollen several inches above the level of the chime (the protruding rings at the top and bottom of the drum). A number of devices have been developed for venting critically swollen drums. One method that has proven to be effective is a tube and spear device. A light aluminum tube (3 meters long) is positioned at the vapor space of the drum. A rigid, hooking device attached to the tube goes over the chime and holds the tube securely in place. The spear is inserted in the tube and positioned against the drum wall. A sharp blow on the end of the spear drives the sharpened tip through the drum, and the gas vents along the grooves. The venting should be done remotely (e.g., using a backhoe bucket) from behind a wall or barricade. Once the pressure has been relieved, the bung can be removed and the drum sampled. It is necessary that personnel experienced in sampling of over-pressurized or unknown drum contents, or known hazardous waste contents, perform this task. If project team personnel are not experienced in this type of sampling, it is recommended that a subcontractor experienced in this type of sampling implement this portion of the sampling.

5.3 EQUIPMENT/APPARATUS

The following are standard materials and equipment required for sampling:

- An approved site-specific sampling plan and health and safety plan (HSP)
- Personal protection equipment
- Sample containers appropriate for the matrix being sampled
- Uniquely numbered sample identification labels
- One-gallon covered cans half-filled with absorbent packing material, to be used as necessary to hold waste
- Chain-of-custody sheets
- Decontamination equipment (Procedure I-F, *Equipment Decontamination*.)
- Glass thieving tubes, composite liquid waste sampler (COLIWASA), or equivalent
- Drum-opening devices
- Monitoring equipment for the detection of toxic and explosive environments, whenever the contents are not known

5.3.1 Drum-Opening Devices

5.3.1.1 BUNG WRENCH

A common method for opening drums manually is using a universal bung wrench. The fittings on a bung wrench are made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium, non-sparking alloy. The use of a non-sparking wrench does not eliminate the possibility of producing a spark.

5.3.1.2 DRUM DEHEADER

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to partially or completely cut off the lid of a drum by means of scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums. Drums with removable heads or over-pressurized drums should be opened by other means.

5.3.1.3 BACKHOE SPIKE

The most common means of opening drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

5.3.1.4 HYDRAULIC DRUM OPENER

Hydraulic drum openers use hydraulic pressure to pierce the drum. It consists of a manually operated pump that pressurizes oil through a length of hydraulic line attached to a metal point that pierces the side or head of the drum.

5.3.1.5 PNEUMATIC DEVICES

A pneumatic bung remover consists of a compressed air supply that is controlled by a heavy-duty, two-stage regulator. A high-pressure air line of desired length delivers compressed air to a pneumatic drill, which is adapted to turn a bung fitting selected to fit the bung to be removed. An adjustable bracketing system positions and aligns the pneumatic drill over the bung. The bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. The pneumatic bung opener does not permit the slow venting of the container, and therefore, appropriate precautions must be taken. The pneumatic bung opener also requires the container to be upright and relatively level. This device cannot remove bungs that are rusted shut.

5.4 SAMPLING PROCEDURE

5.4.1 Drum Staging

Prior to sampling, stage the drums (if not already staged) for easy access. Ideally, the staging area should be located just far enough from the drum opening area to prevent a chain reaction if one drum with unknown contents or visibly over-pressurized should explode or catch fire when opened.

During staging, physically separate the drums into the following categories: those containing liquids; those containing solids; lab packs; gas cylinders; and those that are empty. The strategy for sampling and handling drum/containers in each of these categories will be different. Categories are determined by:

- Visual inspection of the drum and its labels, codes, etc. Solids and sludges are typically disposed of in open top drums. Closed head drums with a bung opening generally contain liquid.
- Visual inspection of the contents of the drum during sampling, followed by restaging, if needed.

For discovered drums that require excavation, eliminate immediate hazards by over packing or transferring the drum's contents to another suitable container, affixing with a numbered tag, and transferring to a staging area. Use color-coded tags, labels, or bands to mark similar waste types. Record a description of each drum, its condition, any unusual markings, and the location where it was buried or stored on a drum data sheet (see Attachment I-D-1-1.) This data sheet becomes the principal record-keeping tool for tracking the drum on site.

Where space allows, physically separate the unknown or suspected hazardous waste-containing or over-pressurized drum opening area from the drum removal and drum staging operations. Move drums from the staging area to the drum opening area one at a time using forklift trucks equipped with drum grabbers or a barrel grappler. In a large-scale drum handling operation, drums may be conveyed to the drum opening area using a roller conveyor.

5.4.2 Drum Opening

There are three techniques for opening drums at suspected or known hazardous waste sites:

- Manual opening with non-sparking bung wrenches
- Drum deheading
- Remote drum puncturing and bung removal

The choice of drum opening technique and accessories depends on the number of drums to be opened, their waste contents, and their physical condition. Remote drum opening equipment should always be considered to protect worker safety. Under Occupational Safety and Health Administration 1910.120 (OSHA 1998), manual drum opening with bung wrenches or deheaders should be performed only on structurally sound drums whose waste contents are known not to be shock sensitive, reactive, explosive, or flammable.

5.4.2.1 MANUAL DRUM OPENING

Bung Wrench

Do not perform manual drum opening with bung wrenches unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be non-explosive. If opening the drum with bung wrenches is deemed reasonably cost-effective and safe, then certain procedures should be implemented to minimize the hazard:

- Field personnel should be fully outfitted with protective gear.
- Continually monitor atmospheres for toxicity, explosivity, and if applicable, radioactivity.

- Position drums upright with the bung up, or, for drums with bungs on the side, laid on their sides with the bung plugs up.
- The wrenching motion should be a slow, steady pull across the drum. If the length of the bung wrench handle provides inadequate leverage for unscrewing the plug, attach a “cheater bar” to the handle to improve leverage.

5.4.2.2 DRUM DEHEADING

Do not perform drum deheading unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be non-explosive. Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off, if desired. If the top chime of a drum has been damaged or badly dented, it may not be possible to cut the entire top off. Because there is always the possibility that a drum may be under pressure, make the initial cut very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote method prior to using the deheader.

Self-propelled drum openers, which are either electrically or pneumatically driven, are available and can be used for quicker and more efficient deheading.

5.4.2.3 REMOTE OPENING

Remotely operated drum opening tools are the safest available means of opening a drum. Remote drum opening is slow, but provides a high degree of safety compared to manual methods of opening.

Backhoe Spike

“Stage” or place drums in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, punching a hole in the drumhead or lid with the spike can quickly open the drums.

Decontaminate the spike after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, mounting a large shatter-resistant shield in front of the operator’s cage can protect the operator of the backhoe. When combined with the normal personal protection gear, this practice should protect the operator. Providing the operator with an on-board air line system affords additional respiratory protection.

Hydraulic Devices

Hydraulic devices consist of a piercing device with a metal point that is attached to the end of a hydraulic line and is pushed into the drum by hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head of the drum. Some of the metal piercing devices are hollow or tube-like so that they can be left in place, if desired, to serve as a permanent tap or sampling port. The piercing device is designed to establish a tight seal after penetrating the container.

Pneumatic Devices

Pneumatically operated devices using compressed air have been designed to remove drum bungs remotely.

5.4.3 Drum Sampling

Immediately after the drum has been opened, sample the headspace gases within the drum using an explosimeter, organic vapor analyzer, and/or a photoionization detector, and record the data on the Drum Data Sheet (see Attachment I-D-1-1) as necessary. The CTO WP shall reference procedures listed in the site HSP.

In most cases, it is impossible to observe the contents of these sealed or partially sealed drums. Because some layering or stratification is likely in any solution left undisturbed over time, take a sample that represents the entire depth of the vessel. In addition, a sample of solid material collected from a drum should include the entire depth to be most representative of the drum contents.

When sampling a previously sealed drum, check for the presence of bottom sludge. This is easily accomplished by measuring the depth to apparent bottom, and then comparing it to the known interior depth.

5.4.3.1 GLASS THIEF SAMPLER

The most widely used implement for sampling liquids in a drum is a glass tube (glass thief, 6 millimeters inner diameter × 30.47 centimeters [cm] [48 inches] length). This tool is simple, cost effective, quick, and collects a sample without having to decontaminate.

Specific Sampling Procedure Using a Glass Thief

1. Remove the cover from the sample container.
2. Slowly insert the glass tubing almost to the bottom of the drum or until a solid layer is encountered. About 1 foot of tubing should extend above the drum.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with the stopper.
5. Carefully remove the capped tube from the drum, and insert the uncapped end into the sample container. Do not spill liquid on the outside of the sample container.
6. Release the stopper, and allow the glass thief to drain completely into the sample container. Fill the container to about 2/3 of capacity.
7. Remove the tube from the sample container, carefully break it into pieces, and place the pieces in the drum.
8. Cap the sample container tightly, and place the pre-labeled sample container in a carrier.
9. Replace the bung or place plastic over the drum.
10. Transport the sample to the decontamination zone to be prepared for transport to the analytical laboratory.

In many instances, a drum containing waste material will have a sludge layer on the bottom. Slow insertion of the sampling tube down into this layer and then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

In some instances, disposal of the tube by breaking it into the drum might interfere with eventual plans for the removal of its contents. Clear this technique with NAVFAC Pacific personnel or evaluate other disposal techniques.

5.4.3.2 COLIWASA SAMPLER

The COLIWASA is a much-cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. It collects a sample from the full depth of a drum and maintains it in the transfer tube until delivery to the sample bottle. One configuration consists of a 152 cm by 4 cm-inner diameter section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper.

The major drawbacks associated with using a COLIWASA include decontamination and cost. The sampler is difficult (if not impossible) to decontaminate in the field, and its high cost relative to alternative procedures (glass tubes) make it an impractical throwaway item. However, disposable, high-density, inert polyethylene COLIWASAs are available at a nominal cost. Although the applications of a disposable COLIWASA are limited, it is especially effective in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Open the sampler by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.
2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.
3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.
4. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.
5. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.
6. Cap the sample container with a Teflon-lined cap, attach a label and seal, and record it on the sample data sheet.
7. Unscrew the T-handle of the sampler, and disengage the locking block.
8. Clean the sampler.

5.5 DRUM CLOSING

Upon completion of sampling activities, close the drums, and then store them in a secure area as described in Procedure I-A-6, *Investigation-Derived Waste Management*. If the bung opening and the bung are still intact, then close the drum by replacing the bung. In addition, open top drums that

are still in good condition can be closed by replacing the top and securing the drum ring with the attached bolt.

If a drum cannot be closed in the manner discussed above, then secure it by placing it in an approved 85-gallon overpack drum (type UN 1A2/Y43/S). Fill the void spaces between the outer portion of the inner drum and the inside of the overpack drum with vermiculite to secure the drum contents to the extent possible.

5.6 EQUIPMENT DECONTAMINATION

Decontamination of sampling equipment should follow Procedure I-F, *Equipment Decontamination*.

5.7 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

1. Do not add preservatives to the sample unless specifically required by the analytical method or WP.
2. Place the labeled sample container in two re-sealable plastic bags.
3. If the contents of the investigation-derived waste drum are unknown, or known to contain hazardous waste, place each bagged sample container in a 1-gallon covered can containing absorbent packing material. Place the lid on the can.
4. Mark the sample identification number on the outside of the can.
5. Place the samples in a cooler, and fill the remaining space with absorbent packing material.
6. Fill out the chain-of-custody record for each cooler, place it in a re-sealable plastic bag, and affix it to the inside lid of the cooler.
7. Secure the lid of the cooler, and affix the custody seal.
9. Arrange for the appropriate transport mode consistent with the type of waste involved (hazardous or non-hazardous).

6. Records

Keep records of all sampling activities in the field notebook and on the Drum Data Sheets. Document sample custody on the chain-of-custody form. The CTO Manager shall review these documents at the completion of field activities, and, at least on a monthly basis for long-term projects.

7. Health and Safety

Field Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Occupational Safety and Health Administration (OSHA). 1998. *Occupational Safety and Health Standards* (29 CFR 1910); with special attention to Section 1910.120, *Hazardous Waste Operations and Emergency Response (HAZWOPER)*. Washington, DC: United States Department of Labor.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-A-6, *Investigation-Derived Waste Management*.

Procedure I-F, *Equipment Decontamination*.

9. Attachments

Attachment I-D-1-1: Drum Data Sheet

This page intentionally left blank

**Attachment I-D-1-1
Drum Data Sheet**

This page intentionally left blank

DRUM DATA SHEET

CTO/DO #: _____ Date Sampled: _____
Drum I.D.#: _____ Time: _____
Estimated Liquid Quantity: _____
Original Drum Location: _____
Staging Location: _____
Sampler's Name: _____
Drum Condition: _____
Physical Appearance of the Drum/Bulk Contents: _____
Headspace Gas Concentration: _____
Odor: _____ Color: _____
pH: _____ % Liquid: _____

Laboratory _____ Date of Analysis: _____
Analytical Data: _____

Compatibility: _____
Hazard: _____
Waste I.D.: _____
Treatment Disposal Recommendations: _____

This page intentionally left blank

Soil and Rock Classification

1. Purpose

This section sets forth standard operating procedures for soil and rock classification for use by United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

None.

4. Responsibilities

The prime contractor CTO Manager is responsible for ensuring that these standard soil and rock classification procedures are followed during projects conducted under the ER Program and that a qualified individual conducts or supervises the projects. A qualified individual is defined as a person with a degree in geology, hydrogeology, soil science, or geotechnical/civil engineering with at least 1 year of experience classifying soil. Supervision is defined as onsite and continuous monitoring of the individual conducting soil classification. The CTO Manager is responsible for ensuring that all personnel involved in soil and rock classification have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The CTO Manager is responsible for reviewing copies of the field boring log forms on a monthly basis at a minimum. However, it is recommended that initially boring logs are reviewed daily to ensure accuracy.

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager is responsible for field oversight to ensure that all project field staff follow these procedures.

Field personnel are responsible for the implementation of this procedure.

5. Procedures

5.1 SOIL CLASSIFICATION

The basic purpose of the classification of soil is to thoroughly describe the physical characteristics of the sample and to classify it according to an appropriate soil classification system for the NAVFAC Pacific ER Program. The Unified Soil Classification System (USCS) was developed so that soils could be described on a common basis by different investigators and serve as a "shorthand" description of soil. A classification of a soil in accordance with the USCS includes not only a group symbol and name, but also a complete word description.

Describing soil on a common basis is essential so that soil described by different site qualified personnel is comparable. Site individuals describing soil as part of site activities *must* use the classification system described herein to provide the most useful geologic database for all present and future subsurface investigations and remedial activities at NAVFAC Pacific ER Program sites.

The site geologist or other qualified individual shall describe the soil and record the description in a boring log or logbook. The essential items in any written soil description are as follows:

- Classification group name (e.g., silty sand)
- Color, moisture, and odor
- Range of particle sizes
- Approximate percentage of boulders, cobbles, gravel, sand, and fines
- Plasticity characteristics of the fines
- In-place conditions, such as density/consistency, compaction, amount of induration/cementation or weathering, retention of the parent rock fabric, and structure
- USCS classification symbol

The USCS serves as "shorthand" for classifying soil into 15 basic groups:

- GW¹ Well graded (poorly sorted) gravel (>50 percent gravel, <5percent fines)
- GP¹ Poorly graded (well sorted) gravel (>50percent gravel, <5percent fines)
- GM¹ Silty gravel (>50 percent gravel, >15 percent silt)
- GC¹ Clayey gravel (>50 percent gravel, >15 percent clay)
- SW¹ Well graded (poorly sorted) sand (>50 percent sand, <5 percent fines)
- SP¹ Poorly graded (well sorted) sand (>50 percent sand, <5 percent fines)
- SM¹ Silty sand (>50 percent sand, >15 percent silt)
- SC¹ Clayey sand (>50 percent sand, >15 percent clay)

¹ If percentage of fine is 5 percent to 15 percent, a dual identification shall be given (e.g., a soil with more than 50 percent poorly sorted gravel and 10 percent clay is designated GW-GC.

ML ²	Inorganic, low plasticity silt (slow to rapid dilatancy, low toughness, and plasticity)
CL ²	Inorganic, low plasticity (lean) clay (no or slow dilatancy, medium toughness and plasticity)
MH ²	Inorganic elastic silt (no to slow dilatancy, low to medium toughness and plasticity)
CH ²	Inorganic, high plasticity (fat) clay (no dilatancy, high toughness, and plasticity)
OL	Organic low plasticity silt or organic silty clay
OH	Organic high plasticity clay or silt
PT	Peat and other highly organic soil

Figure I-E-1 defines the terminology of the USCS. Flow charts presented in Figure I-E-2 and Figure I-E-3 indicate the process for describing soil. The particle size distribution and the plasticity of the fines are the two properties of soil used for classification. In some cases, it may be appropriate to use a borderline classification (e.g., SC/CL) if the soil has been identified as having properties that do not distinctly place the soil into one group.

5.1.1 Estimation of Particle Size Distribution

One of the most important factors in classifying a soil is the estimated percentage of soil constituents in each particle size range. Being proficient in estimating this factor requires extensive practice and frequent checking. The steps involved in determining particle size distribution are listed below:

1. Select a representative sample (approximately 1/2 of a 6-inch long by 2.5-inch diameter sample liner).
2. Remove all particles larger than 3 inches from the sample. Estimate and record the percent by volume of these particles. Only the fraction of the sample smaller than 3 inches is classified.
3. Estimate and record the percentage of dry mass of gravel (less than 3 inches and greater than 1/4 inch).
4. Considering the rest of the sample, estimate, and record the percentage of dry mass of sand particles (about the smallest particle visible to the unaided eye).
5. Estimate and record the percentage of dry mass of fines in the sample (do not attempt to separate silts from clays).
6. Estimate percentages to the nearest 5 percent. If one of the components is present in a quantity considered less than 5 percent, indicate its presence by the term "trace."
7. The percentages of gravel, sand, and fines must add up to 100 percent. "Trace" is not included in the 100 percent total.

² If the soil is estimated to have 15 percent to 25 percent sand or gravel, or both, the words "with sand" or "with gravel" (whichever predominates) shall be added to the group name (e.g., clay with sand, CL; or silt with gravel, ML). If the soil is estimated to have 30 percent or more sand or gravel, or both, the words "sandy" or "gravely" (whichever predominates) shall be added to the group name (e.g., sandy clay, CL). If the percentage of sand is equal to the percent gravel, use "sandy."

5.1.2 Soil Dilatancy, Toughness, and Plasticity

5.1.2.1 DILATANCY

To evaluate dilatancy, follow these procedures:

1. From the specimen, select enough material to mold into a ball about 1/2 inch (12 millimeters [mm]) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.
2. Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table I-E-1. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

Table I-E-1: Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

5.1.2.2 TOUGHNESS

Following the completion of the dilatancy test, shape the test specimen into an elongated pat and roll it by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. (If the sample is too wet to roll easily, spread it into a thin layer and allow it to lose some water by evaporation.) Fold the sample threads and re-roll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble at a diameter of 1/8 inch when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, lump the pieces together and knead it until the lump crumbles. Note the toughness of the material during kneading. Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table I-E-2.

Table I-E-2: Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread near the plastic limit. The thread and the lump have very high stiffness.

DEFINITION OF TERMS							
MAJOR DIVISIONS		SYMBOLS		TYPICAL DESCRIPTIONS			
COARSE GRAINED SOILS More Than Half of Material is Larger Than No. 200 Sieve Size	GRAVELS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN GRAVELS (Less than 6% Fines)		GW	Well graded gravels, gravel-sand mixtures, little or no fines		
					GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	
		GRAVELS With Fines			GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines	
					GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines	
	SANDS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN SANDS (Less than 6% Fines)		SW	Well graded sands, gravelly sands, little or no fines		
				SP	Poorly graded sands, gravelly sands, little or no fines		
		SANDS With Fines			SM	Silty sands, sand-silt mixtures, non-plastic fines	
					SC	Clayey sands, sand-clay mixtures, plastic fines	
FINE GRAINED SOILS More Than Half of Material is Smaller Than No. 200 Sieve Size	SILTS AND CLAYS Liquid Limit is Less Than 50%			ML	Inorganic silts, rock flour, fine sandy silts or clays, and clayey silts with non- or slightly-plastic fines		
				CL	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, sandy clays, lean clays		
				OL	Organic silts and organic silty clays of low plasticity		
	SILTS AND CLAYS Liquid Limit is Greater Than 50%			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts, clayey silt		
				CH	inorganic clays of high plasticity, fat clays		
				OH	Organic clays of medium to high plasticity, organic silts		
HIGHLY ORGANIC SOILS				PT	Peat and other highly organic soils		

GRAIN SIZES							
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	200	40	10	4	3/4"	3"	12"
	U.S. STANDARD SERIES SIEVE				CLEAR SQUARE SIEVE OPENINGS		

Figure I-E-1: Unclassified Soil Classification System (USCS)

This page intentionally left blank

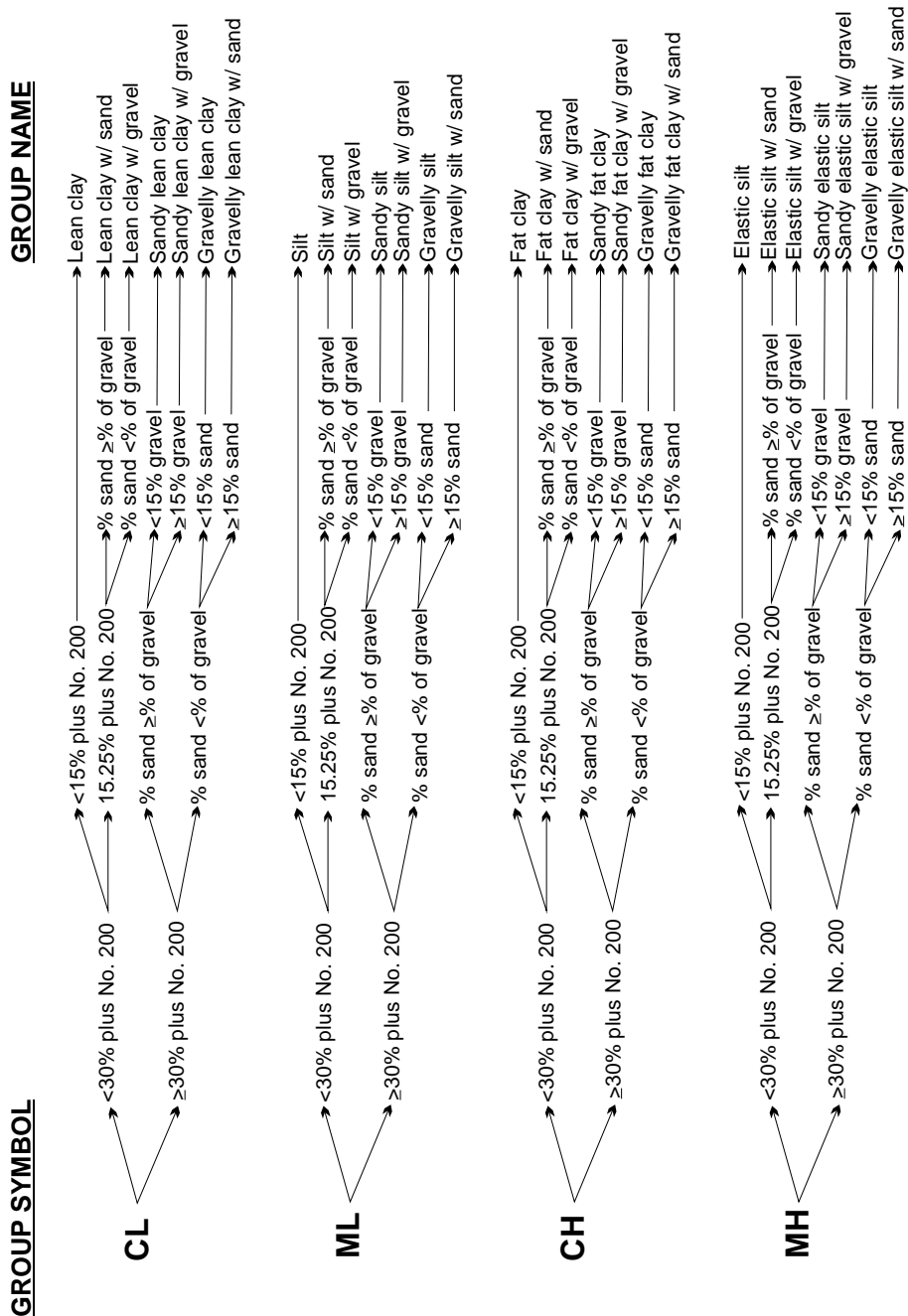


Figure I-E-2: Flow Chart for Fine Grain Soil Classification

This page intentionally left blank

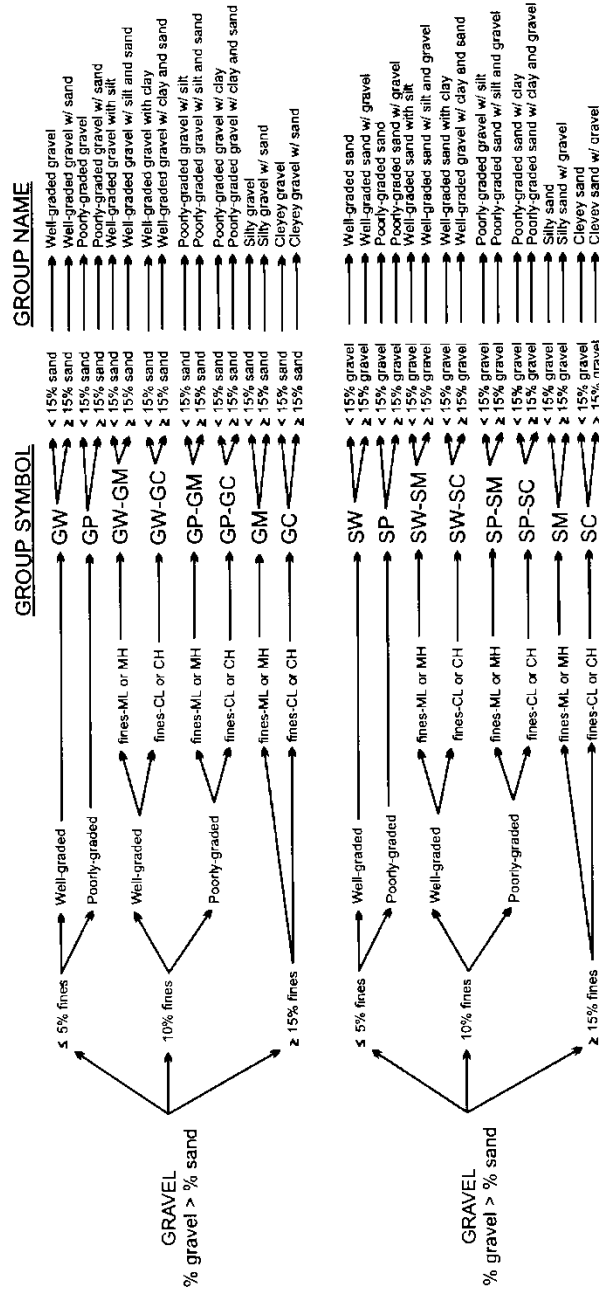


Figure I-E-3: Flow Chart for Soil with Gravel

This page intentionally left blank

5.1.2.3 PLASTICITY

The plasticity of a soil is defined by the ability of the soil to deform without cracking, the range of moisture content over which the soil remains in a plastic state, and the degree of cohesiveness at the plastic limit. The plasticity characteristic of clays and other cohesive materials is defined by the liquid limit and plastic limit. The liquid limit is defined as the soil moisture content at which soil passes from the liquid to the plastic state as moisture is removed. The test for the liquid limit is a laboratory, not a field, analysis.

The plastic limit is the soil moisture content at which a soil passes from the plastic to the semi-solid state as moisture is removed. The plastic limit test can be performed in the field and is indicated by the ability to roll a 1/8-inch (0.125-inch) diameter thread of fines, the time required to roll the thread, and the number of times the thread can be re-rolled when approaching the plastic limit.

The plasticity tests are not based on natural soil moisture content, but on soil that has been thoroughly mixed with water. If a soil sample is too dry in the field, add water prior to performing classification. If a soil sample is too sticky, spread the sample thin and allow it to lose some soil moisture.

Table I-E-3 presents the criteria for describing plasticity in the field using the rolled thread method.

Table I-E-3: Criteria for Describing Plasticity

Description	Criteria
Non-Plastic	A 1/8-inch thread cannot be rolled.
Low Plasticity	The thread can barely be rolled.
Medium Plasticity	The thread is easy to roll and not much time is required to reach the plastic limit.
High Plasticity	It takes considerable time rolling the thread to reach the plastic limit.

5.1.3 Angularity

The following criteria describe the angularity of the coarse sand and gravel particles:

- *Rounded* particles have smoothly-curved sides and no edges.
- *Subrounded* particles have nearly plane sides, but have well-rounded corners and edges.
- *Subangular* particles are similar to angular, but have somewhat rounded or smooth edges.
- *Angular* particles have sharp edges and relatively plane sides with unpolished surfaces. Freshly broken or crushed rock would be described as angular.

5.1.4 Color, Moisture, and Odor

The natural moisture content of soil is very important. Table I-E-4 shows the terms for describing the moisture condition and the criteria for each.

Table I-E-4: Soil Moisture Content Qualifiers

Qualifier	Criteria
Dry	Absence of moisture, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil is below water table

Color is described by hue and chroma using the Munsell Soil Color Chart (Munsell 2000). For uniformity, all site geologists shall use this chart for soil classification. Doing so will facilitate correlation of geologic units between boreholes logged by different geologists. The Munsell Color Chart is a small booklet of numbered color chips with names like “5YR 5/6, yellowish-red.” Note mottling or banding of colors. It is particularly important to note and describe staining because it may indicate contamination.

In general, wear a respirator if strong organic odors are present. If odors are noted, describe them if they are unusual or suspected to result from contamination. An organic odor may have the distinctive smell of decaying vegetation. Unusual odors may be related to hydrocarbons, solvents, or other chemicals in the subsurface. An organic vapor analyzer may be used to detect the presence of volatile organic contaminants.

5.1.5 In-Place Conditions

Describe the conditions of undisturbed soil samples in terms of their density/consistency (i.e., compactness), cementation, and structure utilizing the following guidelines:

5.1.5.1 DENSITY/CONSISTENCY

Density and consistency describe a physical property that reflects the relative resistance of a soil to penetration. The term “density” is commonly applied to coarse to medium-grained sediments (i.e., gravels, sands), whereas the term “consistency” is normally applied to fine-grained sediments (i.e., silts, clays). There are separate standards of measure for both density and consistency that are used to describe the properties of a soil.

The density or consistency of a soil is determined by observing the number of blows required to drive a 1 3/8-inch (35 mm) diameter split barrel sampler 18 inches using a drive hammer weighing 140 pounds (63.5 kilograms) dropped over a distance of 30 inches (0.76 meters). Record the number of blows required to penetrate each 6 inches of soil in the field boring log during sampling. The first 6 inches of penetration is considered to be a seating drive; therefore, the blow count associated with this seating drive is recorded, but not used in determining the soil density/consistency. The sum of the number of blows required for the second and third 6 inches of penetration is termed the “standard penetration resistance,” or the “N-value.” The observed number of blow counts must be corrected by an appropriate factor if a different type of sampling device (e.g., Modified California Sampler with liners) is used. For a 2 3/8-inch inner diameter Modified California Sampler equipped with brass or stainless steel liners and penetrating a cohesionless soil (sand/gravel), the N-value from the Modified California Sampler must be divided by 1.43 to provide data that can be compared to the 1 3/8-inch diameter sampler data.

For a cohesive soil (silt/clay), the N-value for the Modified California Sampler should be divided by a factor of 1.13 for comparison with 1 3/8-inch diameter sampler data.

Drive the sampler and record blow counts for each 6-inch increment of penetration until one of the following occurs:

- A total of 50 blows have been applied during any one of the three 6-inch increments; a 50-blow count occurrence shall be termed “refusal” and noted as such on the boring log.
- A total of 150 blows have been applied.
- The sampler is advanced the complete 18 inches without the limiting blow counts occurring, as described above.

If the sampler is driven less than 18 inches, record the number of blows per partial increment on the boring log. If refusal occurs during the first 6 inches of penetration, the number of blows will represent the N-value for this sampling interval. Table I-E-5 and Table I-E-6 present representative descriptions of soil density/consistency vs. N-values.

Table I-E-5: Measuring Soil Density with a California Sample – Relative Density (Sands, Gravels)

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.43 factor
Very Loose	0–4	0–6
Loose	4–10	6–14
Medium Dense	10–30	14–43
Dense	30–50	43–71
Very Dense	>50	>71

Table I-E-6: Measuring Soil Density with a California Sampler – Fine Grained Cohesive Soil

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.13 factor
Very Soft	0–2	0–2
Soft	2–4	2–4
Medium Stiff	4–8	4–9
Stiff	8–16	9–18
Very Stiff	16–32	18–36
Hard	>32	>36

For undisturbed fine-grained soil samples, it is also possible to measure consistency with a hand-held penetrometer. The measurement is made by placing the tip of the penetrometer against the surface of the soil contained within the sampling liner or Shelby tube, pushing the penetrometer into the soil a distance specified by the penetrometer manufacturer, and recording the pressure resistance reading in pounds per square foot. The values are as follows (Table I-E-7):

Table I-E-7: Measuring Soil Consistency with a Hand-Held Penetrometer

Description	Pocket Penetrometer Reading (psf)
Very Soft	0–250
Soft	250–500
Medium Stiff	500–1,000
Stiff	1,000–2,000
Very Stiff	2,000–4,000
Hard	>4,000

Consistency can also be estimated using thumb pressure using Table I-E-8.

Table I-E-8: Measuring Soil Consistency Using Thumb Pressure

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)
Soft	Thumb will penetrate soil about 1 inch (25 mm)
Firm	Thumb will penetrate soil about 1/4 inch (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

5.1.5.2 CEMENTATION

Cementation is used to describe the friability of a soil. Cements are chemical precipitates that provide important information as to conditions that prevailed at the time of deposition, or conversely, diagenetic effects that occurred following deposition. Seven types of chemical cements are recognized by Folk (1980). They are as follows:

1. Quartz – siliceous
2. Chert – chert-cemented or chalcedonic
3. Opal – opaline
4. Carbonate – calcitic, dolomitic, sideritic (if in doubt, calcareous should be used)
5. Iron oxides – hematitic, limonitic (if in doubt, ferruginous should be used)
6. Clay minerals – if the clay minerals are detrital or have formed by recrystallization of a previous clay matrix, they are not considered to be a cement. Only if they are chemical precipitates, filling previous pore space (usually in the form of accordion-like stacks or fringing radial crusts) should they be included as “kaolin-cemented,” “chlorite-cemented,” etc.
7. Miscellaneous minerals – pyritic, collophane-cemented, glauconite-cemented, gypsiferous, anhydrite-cemented, baritic, feldspar-cemented, etc.

The degree of cementation of a soil is determined qualitatively by utilizing finger pressure on the soil in one of the sample liners to disrupt the gross soil fabric. The three cementation descriptors are as follows:

1. Weak – friable; crumbles or breaks with handling or slight finger pressure
2. Moderate – friable; crumbles or breaks with considerable finger pressure
3. Strong – not friable; will not crumble or break with finger pressure

5.1.5.3 STRUCTURE

This variable is used to qualitatively describe physical characteristics of soil that are important to incorporate into hydrogeological and/or geotechnical descriptions of soil at a site. Appropriate soil structure descriptors are as follows:

- *Granular*: Spherically shaped aggregates with faces that do not accommodate adjoining faces
- *Stratified*: Alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness
- *Laminated*: Alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness
- *Blocky*: Cohesive soil that can be broken down into small angular or subangular lumps that resist further breakdown
- *Lensed*: Inclusion of a small pocket of different soil, such as small lenses of sand, should be described as homogeneous if it is not stratified, laminated, fissured, or blocky. If lenses of different soil are present, the soil being described can be termed homogeneous if the description of the lenses is included
- *Prismatic or Columnar*: Particles arranged about a vertical line, ped is bounded by planar, vertical faces that accommodate adjoining faces; prismatic has a flat top; columnar has a rounded top
- *Platy*: Particles are arranged about a horizontal plane

5.1.5.4 OTHER FEATURES

- *Mottled*: Soil that appears to consist of material of two or more colors in blotchy distribution
- *Fissured*: Breaks along definite planes of fracture with little resistance to fracturing (determined by applying moderate pressure to sample using thumb and index finger)
- *Slickensided*: Fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)

5.1.6 Development of Soil Description

Develop standard soil descriptions according to the following examples. There are three principal categories under which all soil can be classified. They are described below.

5.1.6.1 COARSE-GRAINED SOIL

Coarse-grained soil is divided into sands and gravels. A soil is classified as a sand if over 50 percent of the coarse fraction is “sand-sized.” It is classified as a gravel if over 50 percent of the coarse fraction is composed of “gravel-sized” particles.

The written description of a coarse-grained soil shall contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); grain size of coarse fraction; Munsell color and color number; moisture content; relative density; sorting; angularity; other features, such as stratification (sedimentary structures) and cementation, possible formational name, primary USCS classification, secondary USCS classification (when necessary), and approximate percentages of minor constituents (i.e., sand, gravel, shell fragments, rip-up clasts) in parentheses.

Example: POORLY SORTED SAND WITH SILT, medium- to coarse-grained, light olive gray, 5Y 6/2, saturated, loose, poorly sorted, subrounded clasts, SW/SM (minor silt with approximately 20 percent coarse-grained sand-sized shell fragments, and 80 percent medium-grained quartz sand, and 5 percent to 15 percent ML).

5.1.6.2 *FINE-GRAINED SOIL*

Fine-grained soil is further subdivided into clays and silts according to its plasticity. Clays are rather plastic, while silts have little or no plasticity.

The written description of a fine-grained soil should contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); Munsell color; moisture content; consistency; plasticity; other features, such as stratification, possible formation name, primary USCS classification, secondary USCS classification (when necessary), and the percentage of minor constituents in parentheses.

Example: SANDY LEAN CLAY, dusky red, 2.5 YR 3/2, moist, firm, moderately plastic, thinly laminated, CL (70 percent fines, 30 percent sand, with minor amounts of disarticulated bivalves [about 5 percent]).

5.1.6.3 *ORGANIC SOIL*

For highly organic soil, describe the types of organic materials present as well as the type of soil constituents present using the methods described above. Identify the soil as an organic soil, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soil usually has a dark brown to black color and may have an organic odor. Often, organic soils will change color, (e.g., from black to brown) when exposed to air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

Example: ORGANIC CLAY, black, 2.5Y, 2.5/1, wet, soft, low plasticity, organic odor, OL (100 percent fines), weak reaction to HCl.

5.2 **ROCK CLASSIFICATION**

The purpose of rock classification is to thoroughly describe the physical and mineralogical characteristics of a specimen and to classify it according to an established system. The generalized rock classification system described below was developed for the NAVFAC Pacific ER Program because, unlike the USCS for soils, there is no universally accepted rock classification system. In some instances, a more detailed and thorough rock classification system may be appropriate. Any modifications to this classification system, or the use of an alternate classification system should be considered during preparation of the site work plan. Both the CTO Manager and the QA Manager or

Technical Director must approve any modifications to this classification system, or the use of another classification system.

Describing rock specimens on a common basis is essential so that rocks described by different site geologists are comparable. Site geologists describing rock specimens as a part of investigative activities must use the classification system described herein, or if necessary, another more detailed classification system. Use of a common classification system provides the most useful geologic database for all present and future subsurface investigations and remedial activities at NAVFAC Pacific ER Program sites.

A rock classification template has been designated as shown in Figure I-E-4 to provide a more consistent rock classification between geologists. The template includes the classification of rocks by origin and mineralogical composition. When classifying rocks, all site geologists shall use this template.

The site geologist shall describe the rock specimen and record the description in a borehole log or logbook. The items essential for classification include:

- Classification Name (i.e., schist)
- Color
- Mineralogical composition and percent
- Texture/Grain size (i.e., fine-grained, pegmatitic, aphanitic, glassy)
- Structure (i.e., foliated, fractured, lenticular)
- Rock Quality Designation (sum of all core pieces greater than two times the diameter of the core divided by the total length of the core run, expressed as a percentage)
- Classification symbol (i.e., MF)

Example: Metamorphic foliated schist: Olive gray, 5Y, 3/2, Garnet 25 percent, Quartz 45 percent, Chlorite 15 percent, Tourmaline 15 percent, Fine-grained with Pegmatite garnet, highly foliated, slightly wavy, MF.

6. Records

Document soil classification information collected during soil sampling onto the field boring logs, field trench logs, and into the field notebook. Procedure I-B-1, *Soil Sampling* presents copies of the field boring log form. Copies of this information shall be placed in the project files.

7. Health and Safety

Field Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Folk, Robert L. 1980. *Petrology of Sedimentary Rocks*. Austin, TX: Hemphill Publishing Company.

Munsell Color Company (Munsell). 2009. *Munsell Soil Color Chart*, (Revised). Baltimore.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-B-1, *Soil Sampling*.

9. Attachments

None.


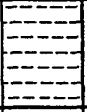
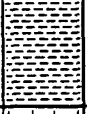
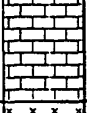




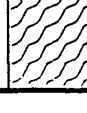
DEFINITION OF TERMS				
PRIMARY DIVISIONS			SYMBOLS	SECONDARY DIVISIONS
SEDIMENTARY ROCKS	Clastic Sediments	CONGLOMERATE		CG Coarse-grained Clastic Sedimentary Rock types including: Conglomerates and Breccias
		SANDSTONE		SS Clastic Sedimentary Rock types including: Sandstone, Arkose and Greywacke
		SHALE		SH Fine-grained Clastic Sedimentary Rock types including: Shale, Siltstone, Mudstone and Claystone
	Chemical Precipitates	CARBONATES		LS Chemical Precipitates including: Limestone, Crystalline Limestone, Fossiliferous Limestone Micrite and Dolomite
		EVAPORITES		EV Evaporites including: Anhydrite, Gypsum, Halite, Travertine and Caliche
IGNEOUS ROCKS	EXTRUSIVE (Volcanic)		IE Volcanic Rock types including: Basalt, Andesite, Rhyolite, Volcanic Tuff, and Volcanic Breccia	
	INTRUSIVE (Plutonic)		II Plutonic Rock types including: Granite, Diorite and Gabbro	
METAMORPHIC ROCKS	FOLIATED		MF Foliated Rock types including: Slate, Phyllite, Schist and Gneiss	
	NON-FOLIATED		MN Non-foliated Rock types including: Metaconglomerate, Quartzite and Marble	

Figure I-E-4: Rock Classification System

This page intentionally left blank

Equipment Decontamination

1. Purpose

This standard operating procedure describes methods of equipment decontamination for use during site activities by United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

None.

4. Responsibilities

The prime contractor CTO Manager is responsible for identifying instances of non-compliance with this procedure and ensuring that decontamination activities comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in equipment decontamination have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager is responsible for field oversight to ensure that all project field staff follow these procedures.

Field personnel are responsible for the implementation of this procedure.

5. Procedures

Decontamination of equipment used in sampling of various media, groundwater monitoring, and well drilling and development is necessary to prevent cross-contamination and to maintain the highest integrity possible in collected samples. Planning a decontamination program requires consideration of the following factors:

- The location where the decontamination procedures will be conducted
- The types of equipment requiring decontamination
- The frequency of equipment decontamination
- The cleaning technique and types of cleaning solutions appropriate for the contaminants of concern
- The method for containing the residual contaminants and wash water from the decontamination process
- The use of a quality control measure to determine the effectiveness of the decontamination procedure

The following subsection describes standards for decontamination, including the frequency of decontamination, cleaning solutions and techniques, containment of residual contaminants and cleaning solutions, and effectiveness.

5.1 DECONTAMINATION AREA

Select an appropriate location for the decontamination area at a site based on the ability to control access to the area, the ability to control residual material removed from equipment, the need to store clean equipment, and the ability to restrict access to the area being investigated. Locate the decontamination area an adequate distance away and upwind from potential contaminant sources to avoid contamination of clean equipment.

It is the responsibility of the site safety and health officer (SSHO) to set up the site zones (i.e., exclusion, transition, and clean) and decontamination areas. Generally, the decontamination area is located within the transition zone, upwind of intrusive activities, and serves as the washing area for both personnel and equipment to minimize the spread of contamination into the clean zone. For equipment, a series of buckets are set up on a visqueen-lined bermed area. Separate spray bottles containing laboratory-grade isopropyl alcohol (or alternative cleaning solvent as described in the CTO work plan [WP]) and distilled water are used for final rinsing of equipment. Depending on the nature of the hazards and the site location, decontamination of heavy equipment, such as augers, pump drop pipe, and vehicles, may be accomplished using a variety of techniques.

5.2 TYPES OF EQUIPMENT

Drilling equipment that must be decontaminated includes drill bits, auger sections, drill-string tools, drill rods, split barrel samplers, tremie pipes, clamps, hand tools, and steel cable. Decontamination of monitoring well development and groundwater sampling equipment includes submersible pumps, bailers, interface probes, water level meters, bladder pumps, airlift pumps, peristaltic pumps, and lysimeters. Other sampling equipment that requires decontamination includes, but is not limited to, hand trowels, hand augers, slide hammer samplers, shovels, stainless-steel spoons and bowls, soil sample liners and caps, wipe sampling templates, composite liquid waste samplers, and dippers. However, equipment that is shipped pre-packaged from the vendor should not have to be decontaminated prior to first use. Equipment with a porous surface, such as rope, cloth hoses, and wooden blocks, cannot be thoroughly decontaminated and shall be properly disposed of after one use.

5.3 FREQUENCY OF EQUIPMENT DECONTAMINATION

Decontaminate down-hole drilling equipment and equipment used in monitoring well development and purging prior to initial use and between each borehole or well. Down-hole drilling equipment, however, may require more frequent cleaning to prevent cross-contamination between vertical zones within a single borehole. When drilling through a shallow contaminated zone and installing a surface casing to seal off the contaminated zone, decontaminate the drilling tools prior to drilling deeper. Initiate groundwater sampling by sampling groundwater from the monitoring well where the least contamination is suspected. Decontaminate groundwater, surface water, and soil sampling devices prior to initial use and between collection of each sample to prevent the possible introduction of contaminants into successive samples.

5.4 CLEANING SOLUTIONS AND TECHNIQUES

Decontamination can be accomplished using a variety of techniques and fluids. The preferred method of decontaminating major equipment, such as drill bits, augers, drill string, and pump drop-pipe, is steam cleaning. To steam clean, use a portable, high-pressure steam cleaner equipped with a pressure hose and fittings. For this method, thoroughly steam wash equipment, and rinse it with potable tap water to remove particulates and contaminants.

Where appropriate, disposable materials are recommended. A rinse decontamination procedure is acceptable for equipment, such as bailers, water level meters, new and re-used soil sample liners, and hand tools. The decontamination procedure shall consist of the following: (1) wash with a non-phosphate detergent (alconox, liquinox, or other suitable detergent) and potable water solution; (2) rinse in a bath with potable water; (3) spray with laboratory-grade isopropyl alcohol; (4) rinse in a bath with deionized or distilled water; and (5) spray with deionized or distilled water. If possible, disassemble equipment prior to cleaning. Add a second wash at the beginning of the process if equipment is very soiled.

Decontaminating submersible pumps requires additional effort because internal surfaces become contaminated during usage. Decontaminate these pumps by washing and rinsing the outside surfaces using the procedure described for small equipment or by steam cleaning. Decontaminate the internal surfaces by recirculating fluids through the pump while it is operating. This recirculation may be done using a relatively long (typically 4 feet) large-diameter pipe (4-inch or greater) equipped with a bottom cap. Fill the pipe with the decontamination fluids, place the pump within the capped pipe, and operate the pump while recirculating the fluids back into the pipe. The decontamination sequence shall include: (1) detergent and potable water; (2) potable water rinse; (3) potable water rinse; and (4) deionized water rinse. Change the decontamination fluids after each decontamination cycle.

Solvents other than isopropyl alcohol may be used, depending upon the contaminants involved. For example, if polychlorinated biphenyls or chlorinated pesticides are contaminants of concern, hexane may be used as the decontamination solvent. However, if samples are also to be analyzed for volatile organics, hexane shall not be used. In addition, some decontamination solvents have health effects that must be considered. Decontamination water shall consist of distilled or deionized water. Steam-distilled water shall not be used in the decontamination process as this type of water usually contains elevated concentrations of metals. Decontamination solvents to be used during field activities will be specified in CTO WP and site-specific health and safety plan.

Rinse equipment used for measuring field parameters, such as pH, temperature, specific conductivity, and turbidity with deionized or distilled water after each measurement. Also wash new, unused soil sample liners and caps with a fresh detergent solution and rinse them with potable water followed by distilled or deionized water to remove any dirt or cutting oils that might be on them prior to use.

5.5 CONTAINMENT OF RESIDUAL CONTAMINANTS AND CLEANING SOLUTIONS

A decontamination program for equipment exposed to potentially hazardous materials requires a provision for catchment and disposal of the contaminated material, cleaning solution, and wash water.

When contaminated material and cleaning fluids must be contained from heavy equipment, such as drilling rigs and support vehicles, the area must be properly floored, preferably with a concrete pad that slopes toward a sump pit. If a concrete pad is impractical, planking can be used to construct solid flooring that is then covered by a nonporous surface and sloped toward a collection sump. If the decontamination area lacks a collection sump, use plastic sheeting and blocks or other objects to create a bermed area for collection of equipment decontamination water. Situate items, such as auger flights, which can be placed on metal stands or other similar equipment, on this equipment during decontamination to prevent contact with fluids generated by previous equipment decontamination. Store clean equipment in a separate location to prevent recontamination. Collect decontamination fluids contained within the bermed area and store them in secured containers as described below.

Use wash buckets or tubs to catch fluids from the decontamination of lighter-weight drilling equipment and hand-held sampling devices. Collect the decontamination fluids and store them on site in secured containers, such as U.S. Department of Transportation-approved drums, until their disposition is determined by laboratory analytical results. Label containers in accordance with Procedure I-A-6, *Investigation-Derived Waste Management*.

5.6 EFFECTIVENESS OF DECONTAMINATION PROCEDURES

A decontamination program must incorporate quality control measures to determine the effectiveness of cleaning methods. Quality control measures typically include collection of equipment blank samples or wipe testing. Equipment blanks consist of analyte-free water that has been poured over or through the sample collection equipment after its final decontamination rinse. Wipe testing is performed by wiping a cloth over the surface of the equipment after cleaning. Procedure III-B, *Field QC Samples (Water, Soil)* provides further descriptions of these samples and their required frequency of collection. These quality control measures provide "after-the fact" information that may be useful in determining whether or not cleaning methods were effective in removing the contaminants of concern.

6. Records

Describe the decontamination process in the field logbook.

7. Health and Safety

Field Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-A-6, *Investigation-Derived Waste Management*.

Procedure III-B, *Field QC Samples (Water, Soil)*.

9. Attachments

None.

This page intentionally left blank

Land Surveying

1. Purpose

This standard operating procedure sets forth protocols for acquiring land surveying data to facilitate the location and mapping of geologic, hydrologic, geotechnical data, and analytical sampling points and to establish topographic control over project sites for use by United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the *Uniform Federal Policy-Quality Assurance Project Plan* (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 BOUNDARY SURVEY

Boundary surveys are conducted by Certified Land Surveyors in order to delineate a legal property line for a site or section of a site.

3.2 GLOBAL POSITIONING SYSTEM (GPS)

A GPS is a system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

3.3 WAYPOINT

A waypoint is a reference point or set of coordinates that precisely identify a location.

4. Responsibilities

The prime contractor CTO Manager is responsible for determining the appropriate land surveying protocols for the project and ensuring this procedure is properly implemented. The CTO Manager is responsible for ensuring that all personnel involved in land surveying shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager (FM) is responsible for ensuring that the appropriate protocols are conducted according to this procedure and the project-specific sampling plan. In virtually all cases, subcontractors will conduct these procedures. The FM is responsible for overseeing the activities of the subcontractor and ensuring that sampling points and topographic features are properly surveyed.

Field personnel are responsible for the implementation of this procedure.

5. Procedures

5.1 THEODOLITE/ELECTRONIC DISTANCE MEASUREMENT (EDM)

Follow the procedures listed below during theodolite/EDM land surveying conducted under the NAVFAC Pacific ER Program:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- An authorized manufacturer's representative shall inspect and calibrate survey instruments in accordance with the manufacturer's specifications regarding procedures and frequencies. At a minimum, instruments shall be calibrated no more than 6 months prior to the start of the survey work.
- Standards for all survey work shall be in accordance with National Oceanic and Atmospheric Administration standards and, at a minimum, with accuracy standards set forth below. The horizontal accuracy for the location of all grid intersection and planimetric features shall be (\pm) 0.1 feet. The horizontal accuracy for boundary surveys shall be 1 in 10,000 feet (1:10,000). The vertical accuracy for ground surface elevations shall be (\pm) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be (\pm) 0.01 feet.
- Reference surveys to the local established coordinate systems, and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.
- Reference surveyed points to mean sea level (lower low water level).
- Jointly determine appropriate horizontal and vertical control points prior to the start of survey activities. If discrepancies in the survey (e.g., anomalous water level elevations) are observed, the surveyor may be required to verify the survey by comparison to a known survey mark. If necessary, a verification survey may be conducted by a qualified third party.
- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified by the CTO Manager.
- Begin and end all surveys at the designated horizontal and vertical control points to determine the degree of accuracy of the surveys.

- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and biodegradable paint.
- Clearly mark the point on a monitoring well casing that is surveyed by filing grooves into the casing on either side of the surveyed point.

5.2 GLOBAL POSITIONING SYSTEM (GPS) TO CONDUCT LAND SURVEY

Follow the procedures listed below during GPS land surveying conducted under the NAVFAC Pacific ER Program:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- An authorized manufacturer's representative shall inspect and calibrate survey instruments in accordance with the manufacturer's specifications regarding procedures and frequencies. At a minimum, instruments shall be calibrated no more than 6 months prior to the start of the survey work.
- Standards for all survey work shall be in accordance with National Oceanic and Atmospheric Administration standards and, at a minimum, with accuracy standards set forth below. The horizontal accuracy for the location of all grid intersection and planimetric features shall be (\pm) 0.1 feet. The horizontal accuracy for boundary surveys shall be 1 in 10,000 feet (1:10,000). The vertical accuracy for ground surface elevations shall be (\pm) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be (\pm) 0.01 feet. Accuracy requirements shall be specified in the project work plan (WP).
- Reference surveys to the local established coordinate systems, and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.
- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified in the project WP.
- Begin and end all surveys at the designated horizontal and vertical control points (as applicable) to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and biodegradable paint.
- Clearly mark the point on a monitoring well casing that is surveyed by filing grooves into the casing on either side of the surveyed point.

5.3 GLOBAL POSITIONING SYSTEM (GPS) TO POSITION SAMPLE LOCATIONS OR LOCATE SITE FEATURES

Experienced field personnel may use a GPS system unit to position sample locations (e.g. grid positioned samples) at a site. The decision to use field personnel or a licensed land surveyor will depend on the objectives of the survey (e.g. vertical elevation is not required) and the levels of precision required. Typically when a level of precision greater than (\pm) 3 to 5 meters is required, a licensed surveyor will be required. When a level of precision of (\pm) 3 to 5 meters is sufficient to meet project requirements (i.e., when laying sampling grids, identifying significant site features, or locating features identified in geographic information system [GIS] figures) experienced field personnel may use commercially available, consumer-grade GPS units. Follow the procedures listed below to locate samples or site features using GPS:

- A commercially available GPS unit with wide angle averaging system (WAAS), topographic map display, and waypoint storage capabilities should be used.
- If waypoints are to be imported into a GIS database, the same grid projection system should be used. For Guam this is typically WGS84, Zone 55N. For Hawaii this will either be NAD83 Zone 3 and 4 or WGS84 Zone 5N.
- If a permanent reference point near the site is available, it is recommended that the reference point is surveyed each day the GPS unit is used.
- When laying out a sampling grid from a GIS map, upload the coordinates from GIS to the GPS unit, including coordinates for an easily identified, permanent, nearby feature (i.e., building corner, roadway intersection, or USGS benchmark).
- If during the initial site walk, the permanent feature identified does not overlay within (\pm) 5 meters as identified in the GPS unit, field corrections of the waypoints should be made.
- Field corrections can be made by adding/subtracting the difference in x,y coordinates between the field measurement of the permanent site feature and the anticipated x,y coordinates. This correction should then be applied to the x,y coordinates for each sampling location to be marked. Corrected x,y coordinates can then be uploaded into the GPS unit.
- Sampling points and site features can then be located in the field using the GPS units “Go To” function. When the distance to the sampling point or feature remains close to zero, the location can be marked.
- If no field corrections to the sampling location need to be made, or if sampling locations are to be surveyed by a licensed surveyor at a later date, no additional waypoints need to be taken. If significant changes to the sampling location are made, GPS coordinates at the corrected location shall be stored and labeled.
- It is recommended that GPS coordinates be uploaded to a storage device such as a personal computer at the end of each day.
- Field logs shall indicate manufacturer and model number for GPS unit used, map datum and projection used, and any field corrections made. If the GPS unit cannot lock onto a WAAS system at the site, this should also be noted.

6. Records

The surveyor shall record field notes daily using generally accepted practices. The data shall be neat, legible, and easily reproducible. Copies of the surveyor's field notes and calculation forms generated during the work shall be obtained and placed in the project files.

Surveyor's field notes shall, at a minimum, clearly indicate:

- The date of the survey
- General weather conditions
- The name of the surveying firm
- The names and job titles of personnel performing the survey work
- Equipment used, including serial numbers
- Field book designations, including page numbers

A land surveyor registered in the state or territory in which the work was done shall sign, seal, and certify the drawings and calculations submitted by the surveyor.

Dated records of land surveying equipment calibration shall be provided by the surveyor and placed in the project files. Equipment serial numbers shall be provided in the calibration records.

7. Health and Safety

Field personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1-7. 13 July 2012.

9. Attachments

None.

This page intentionally left blank

Data Validation

1. Purpose

This procedure describes the presentation format and information provided in the data validation reports under the United States (U.S.) Navy Environmental Restoration (ER) Program for Naval Facilities Engineering Command (NAVFAC), Pacific. The objective of data validation is to provide data of known quality to the end user. This procedure also establishes the method by which a Contract Task Order (CTO) Manager selects and confirms the content of data validation reports and is consistent with protocol in the *Department of Defense Quality Systems Manual (QSM) for Environmental Laboratories* (DoD QSM) (DoD 2013).

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the most recent version of the Uniform Federal Policy-Quality Assurance Project Plan (UFP QAPP) Part 1 (DoD 2005a), 2A (DoD 2012) and 2B (2005b) as well as the DoD Quality Systems Manual (DoD 2013). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA manager) shall also concur with any deviations.

3. Definitions

Acronyms and abbreviations used in all data validation procedures and reports are defined in Attachment II-A-1. Commonly used terms are defined in Attachment II-A-2.

4. Responsibilities

The CTO Manager, the QA Manager or Technical Director, and the CTO QA Coordinator are responsible for ensuring that this procedure is implemented by data validation personnel.

Data validation personnel are responsible for implementing this procedure for all data validation reports.

5. Procedure

5.1 INTRODUCTION

This procedure addresses the validation of data obtained under the NAVFAC Pacific ER Program using primarily U.S. Environmental Protection Agency (EPA) Solid Waste (SW)-846 methods (EPA 2007). Based on the data validation requirements identified in the CTO project planning documents, the analytical data may undergo “Level B,” “Level C,” or “Level D” data validation or

some combination of these validation levels. This procedure establishes the required format and content of the various validation reports.

5.1.1 Confirmation of Data Validation Reports

Prior to shipment of all completed data validation reports to the CTO Manager, a single draft report for one sample delivery group (SDG) should be submitted. The CTO Manager shall review the draft report to confirm that the report contains the requested information, and respond to the Data Validation Project Manager in a timely manner. Once the requested contents are confirmed, the complete data validation packages should be delivered to the CTO Manager.

5.2 CONTENT AND FORMAT OF THE DATA VALIDATION REPORT

The data validation report will consist of the following four major components:

1. Cover letter
2. Data validation reference package comprising:
 - a. Cover page
 - b. Acronyms and abbreviations list
 - c. Data qualifier reference table
 - d. Qualification code reference table
3. Individual data validation reports by SDG:
 - e. Cover page
 - f. Introduction
 - g. Data validation findings
 - h. Appendix of laboratory reports with applied data qualifiers

A discussion of the contents and format of these components is provided in the following sections.

5.2.1 Cover Letter

The cover letter will contain the generation date of the cover letter, the address of the CTO office, the CTO number, and the CTO Manager's name or designee. The cover letter will list the specific reports being sent under that cover letter. A senior data reviewer must review the report and sign the cover letter to denote approval. Attachment II-A-3 is an example of the cover letter.

5.2.2 Data Validation Reference Package

One data validation reference package shall be provided per CTO and shall contain the reference information needed for interpretation of the individual data validation reports. The following sections shall be included:

5.2.2.1 COVER PAGE

The cover page shall indicate the CTO title and number to which the reference package applies.

5.2.2.2 ACRONYMS AND ABBREVIATIONS LIST

This list shall present all acronyms and abbreviations used in the individual data validation reports. Attachment II-A-1 is an example of the acronyms and abbreviations list.

5.2.2.3 DATA QUALIFIER REFERENCE TABLE

Data qualifiers are applied in cases where the data do not meet the required quality control (QC) criteria or where special consideration by the data user is required.

The data qualifier reference table lists the data qualifiers used in the validation of the analytical data. Attachment II-A-4 is an example of this table.

5.2.2.4 QUALIFICATION CODE REFERENCE TABLE

Qualification codes explain why data qualifiers have been applied and identify possible limitations of data use. Attachment II-A-5 provides the qualification codes used by the NAVFAC Pacific ER Program. Qualification codes are to be provided by data validation personnel on the annotated laboratory reports discussed in Section 5.2.3.4.

5.2.3 Individual Data Validation Reports by SDG

For all analyses, each SDG shall have a unique data validation report. The procedures used to generate the reports are discussed in the following sub-sections.

5.2.3.1 COVER PAGE

The cover page shall indicate the CTO title and number, analysis type, and the SDG(s), which the report addresses.

5.2.3.2 INTRODUCTION

This section will contain a brief description of the CTO information that is pertinent to data validation. This information includes the CTO title and number, CTO Manager, the sample matrices and analyses performed on the samples, the data validation level for the project, and a brief discussion of the methodologies used for data validation. This section will also contain a Sample Identification Table which lists the identification of each sample identification number cross referenced with its associated internal laboratory identification number and COC sample number. Each sample will be listed under every analytical method for which data was validated. Attachment II-A-6 is an example of the sample identification table.

5.2.3.3 DATA VALIDATION FINDINGS

This section shall present the data validation findings of the data reviewer for the CTO data package. The findings shall be determined on the basis of validation criteria established for each analytical method¹ in the DoD QSM (DoD 2013) or the CTO planning document and Procedure II-B through Procedure II-X. For all data validation levels, the data validation findings are divided into the following analytical categories:

- II-B GC/MS Volatile Organics by SW-846 Method 8260

¹ Other methods may be included with approval of the CTO and Data Validation Managers.

- II-C GC/MS Semivolatile Organics by SW-846 8270 (full scan and SIM)
- II-D HRGC/HRMS Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by SW-846 8290
- II-E Organochlorine Pesticides by SW-846 8081
- II-F Polychlorinated Biphenyls as Aroclors by SW-846 8082
- II-G Polychlorinated Biphenyls as Congeners by SW-846 8082
- II-H Total Petroleum Hydrocarbons by SW-846 8015
- II-I Chlorinated Herbicides by SW-846 8151
- II-J Organophosphorus Pesticides by SW-846 8141
- II-K Halogenated and Aromatic Volatiles by SW-846 8021
- II-L Phenols by SW-846 8041
- II-M Ethylene Dibromide/Dibromochloropropane by SW-846 8011
- II-N Polynuclear Aromatic Hydrocarbons by SW-846 8310
- II-O Explosives by SW-846 8330
- II-P Carbamate and Urea Pesticides by EPA Method 632
- II-Q Metals by EPA Method SW-846 6000/7000
- II-R Wet Chemistry Analyses
- II-S Data Quality Assessment Report
- II-T HRGC/HRMS Polychlorinated Biphenyls as Congeners by EPA Method 1668
- II-U Carbamate and Urea Pesticides by SW-846 8321
- II-V Perchlorate by SW-846 6850
- II-W GC/FID/ECD Volatile Organics and Fixed Gases in Soil Gas/Vapor by EPA Method TO-3 and ASTM D1946
- II-X GC/MS Volatile Organics and Fixed Gases in Soil Gas/Vapor by EPA Method TO-14, TO-15, and TO-17

GC/MS	gas chromatography/mass spectrometry
ECD	electron capture detector
FID	flame ionization detector
HRGC/HRMS	high resolution gas chromatograph/high resolution mass spectrometer
SIM	selective ion monitoring

Level C and Level D Data Validation

Data obtained using any analytical methods in the above categories will be validated in terms of meeting criteria for specific QA/QC factors such as holding times, instrument calibration, and blank analyses. A separate discussion of each QA/QC factor under each analytical method will be

presented in the CTO data validation report. The QA/QC factors used to validate data for Level C and Level D validation are presented below for each analytical category.

Volatile Organics by Gas Chromatography/Mass Spectrometry (GC/MS)

1. Sample management (sample preservation, handling, and transport, chain-of-custody, and holding times)
2. GC/MS instrument performance check
3. Calibration (initial calibration, initial calibration verification, and continuing calibration)
4. Method blanks
5. Blank spikes and laboratory control samples (LCSs)
6. Surrogate recovery
7. Matrix spike/matrix spike duplicate (MS/MSD)
8. Field QC samples (trip blanks, equipment blanks, field blanks, field duplicates, and field triplicates)
9. Internal standards performance
10. Target compound identification (Level D only*)
11. Compound quantitation and reporting limits (RLs) (Level D only*)
12. Tentatively identified compounds (Level D only*)
13. System performance (Level D only*)

Semivolatile Organics by Full Scan and SIM GC/MS

1. Sample management (sample preservation, handling, and transport; chain-of-custody; holding times)
2. GC/MS instrument performance check (full scan)
3. Calibration (initial calibration, initial calibration verification, and continuing calibration)
4. Method blanks
5. Blank spikes and LCSs
6. Surrogate recovery
7. MS/MSD
8. Field QC samples (equipment blanks, field blanks, and field duplicates)
9. Internal standards performance
10. Target Compound identification (Level D only*)
11. Compound quantitation and RLs (Level D only*)
12. Tentatively identified compounds (Level D only*)

13. System performance (Level D only*)

Dioxins/Dibenzofurans by HRGC/HRMS

1. Sample management (sample preservation, handling, and transport; chain-of-custody; holding times)
2. HRGC/HRMS instrument performance check
3. Calibration (initial calibration, initial calibration verification, and continuing calibration)
4. Method blanks
5. Blank spikes and LCSs
6. MS/MSD
7. Field QC samples (equipment blanks, field blanks, field duplicates, and field triplicates)
8. Internal standards performance
9. Target compound identification (Level D only*)
10. Compound quantitation and RLs (Level D only*)
11. System performance (Level D only*)

Organochlorine Pesticides by GC

1. Sample management (sample preservation, handling, and transport; chain-of-custody; holding times)
2. Pesticides instrument performance (retention time evaluation, 4,4'-DDT/Endrin breakdown evaluation)
3. Calibration (analytical sequence, initial calibration, initial calibration verification, continuing calibration)
4. Method blanks
5. Blank spikes and LCSs
6. Surrogate recovery
7. MS/MSD
8. Sample cleanup performance
9. Field QC samples (equipment blanks, field blanks, field duplicates, and field triplicates)
10. Target compound identification (Level D only*)
11. Compound quantitation and RLs (Level D only*)

Organic Analyses by GC (QA/QC factors may vary depending on analysis type)

1. Sample management (sample preservation, handling, and transport; chain-of-custody; holding times)

2. Instrument performance
3. Calibration (initial calibration, initial calibration verification and continuing calibration)
4. Method blanks
5. Blank spikes and LCS
6. Surrogate recovery
7. MS/MSD
8. Field QC samples (trip blanks [volatile organic compounds], equipment blanks, field blanks, field duplicates, and field triplicates)
9. Target compound identification (Level D only*)
10. Compound quantitation and RLs (Level D only*)

Organic Analyses by High-Performance Liquid Chromatography (QA/QC factors may vary depending on analysis type)

1. Sample management (sample preservation, handling, and transport; chain-of-custody; holding times)
2. Instrument performance
3. Calibration (initial calibration, initial calibration verification and continuing calibration)
4. Method blanks
5. Blank spikes and LCSs
6. Surrogate recovery
7. MS/MSD
8. Field QC samples (equipment blanks, field blanks, field duplicates, and field triplicates)
9. Target compound identification (Level D only*)
10. Compound quantitation and reporting limits (RLs) (Level D only*)

Organic Analyses by Liquid Chromatography–Mass Spectrometry (QA/QC factors may vary depending on analysis type)

1. Sample management (sample preservation, handling, and transport; chain-of-custody; holding times)
2. Instrument performance
3. Calibration (initial calibration, initial calibration verification, and continuing calibration)
4. Method blanks
5. Blank spikes and LCSs
6. MS/MSD
7. Field QC samples (equipment blanks, field blanks, field duplicates, and field triplicates)

8. Internal standards performance
9. Target compound identification (Level D only*)
10. Compound quantitation and RLs (Level D only*)

Metals

1. Sample management (sample preservation, handling, and transport; chain-of-custody; holding times)
2. Calibration (initial and continuing)
3. Blanks (Calibration blanks and Method [preparation] blanks)
4. Inductively coupled (argon) plasma (spectroscopy) (ICP) interference check sample
5. Blank spikes and LCSs
6. MS/MSD and Matrix duplicates
7. Furnace atomic absorption QC
8. Internal standards performance (MS methods only)
9. ICP serial dilution
10. Sample result verification (Level D only*)
11. Field QC samples (equipment blanks, field blanks, field duplicates, and field triplicates)

Inorganic Analyses by Wet Chemical Methods, (QA/QC factors may vary depending on analysis type)

1. Sample management (sample preservation, handling, and transport; chain-of-custody; and holding times)
2. Calibration (initial and continuing)
3. Method blanks
4. Blank spikes and LCSs
5. MS/MSD and Matrix duplicates
6. Sample result verification (Level D only*)
7. Field QC samples (equipment blanks, field blanks, field duplicates, and field triplicates)

* Sections applicable to Level D validation only will also appear in Level C validation reports with the notation "not applicable for Level C validation."

Level B Data Validation

Data obtained using any analytical methods in the Level B Validation analytical categories will be validated in terms of meeting criteria for specific QA/QC factors such as holding times, blank spike

analyses, and blank analyses. A separate discussion of each QA/QC factor under each analytical method will be presented in the CTO data validation report. The QA/QC factors used to validate data for QA/QC “Level B Validation” are presented below for each analytical category.

Organic Analyses

1. Sample management (sample preservation, handling, and transport; chain-of-custody; and holding times)
2. Method blanks
3. Blank spikes and laboratory control samples
4. Field QC samples (trip blanks (volatile organic compounds), equipment blanks, field blanks, field duplicates, and field triplicates)
5. Surrogate recovery
6. MS/MSD

Inorganic Analyses

1. Sample management (sample preservation, handling, and transport; chain-of-custody; and holding times)
2. Blanks (Calibration and Method blanks)
3. Blank spikes and LCSs
4. Field QC samples (equipment blanks, field blanks, field duplicates, and field triplicates)
5. MS/MSD and Laboratory Duplicates
6. ICP serial dilution

5.2.3.4 LABORATORY REPORTS

Annotated laboratory reports with the appropriate data qualifiers and qualification codes as specified in the NAVFAC Pacific ER Program data validation procedures will be submitted as an appendix to the data validation report. An example is provided as Attachment II-A-7. Records

Copies of all documents generated by data validation personnel will be stored for no less than 10 years. The original validated laboratory data shall be archived to the Federal Records Center at project completion.

6. References

Department of Defense, United States (DoD). 2005a. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

———. 2005b. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2B: Quality Assurance/quality Control Compendium: Minimum QA/QC Activities*. Final Version 1. DoD: DTIC ADA 426957, EPA-505-B-04-900B. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/swerffrr/pdf/-qaqc_v1_0305.pdf.

———. 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2A: Optimized UFP-QAPP Worksheets*. Revision 1. March.

———. 2013. *Department of Defense Quality Systems Manual for Environmental Laboratories*. Version 5.0. Draft Final. Prepared by DoD Environmental Data Quality Workgroup and Department of Energy Consolidated Audit Program Operations Team. July.

Environmental Protection Agency, United States (EPA). 2007. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846*. 3rd ed., Final Update IV. Office of Solid Waste. On-line updates at: www.epa.gov/epaoswer/hazwaste/test/new-meth.htm.

7. Attachments

Attachment II-A-1: Acronyms and Abbreviations

Attachment II-A-2: Definition of Terms

Attachment II-A-3: Sample Cover Letter

Attachment II-A-4: Data Qualifier Reference Table

Attachment II-A-5: Qualification Code Reference Table

Attachment II-A-6: Sample Identification Table

Attachment II-A-7: Example Annotated Laboratory Report Volatile Organics Analysis Data Sheet

**Attachment II-A-1
Acronyms and Abbreviations**

This page intentionally left blank

ACRONYMS AND ABBREVIATIONS

Following is a list of acronyms and abbreviations that may be used in NAVFAC Pacific ER Program data validation reports and the data quality assessment reports.

%D	percent difference
%R	percent recovery
µg/kg	microgram per kilogram
µg/L	microgram per liter
4,4'-DDD	4,4'-dichlorodiphenyldichloroethane
4,4'-DDE	4,4'-dichlorodiphenyldichloroethylene
4,4'-DDT	4,4'-dichlorodiphenyltrichloroethane
AA	atomic absorption
ARRF	average relative response factor
BFB	bromofluorobenzene
BNA	base/neutral/acid
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	Contract Laboratory Program
COC	chain-of-custody
COD	chemical oxygen demand
CTO	contract task order
CVAA	cold vapor atomic absorption
DBCP	Dibromochloropropane
DCB	decachlorobiphenyl
DFTPP	decafluorotriphenylphosphine
DL	detection limit
DoD	Department of Defense
DOE	Department of Energy
DQAR	data quality assessment report
DUP	laboratory duplicate
DVP	data validation procedure
EB	equipment blank
EDB	ethylene dibromide
EDL	estimated detection limit
EICP	extracted ion current profile
EPA	Environmental Protection Agency, United States
FB	field blank
GC	gas chromatography
GC/ECD	gas chromatography/electron capture detector
GC/ELCD	gas chromatography/electrolytic conductivity detector (Hall detector)
GC/FPD	gas chromatography/flame photometric detector
GC/MS	gas chromatography/mass spectrometry

GC/PID	gas chromatography/photoionization detector
GFAA	graphite furnace atomic absorption
GPC	gel permeation chromatography
Hg	mercury
HPLC	high-performance liquid chromatography
HRGC/HRMS	high resolution gas chromatography/high resolution mass spectrometry
HT	holding time
ICB	initial calibration blank
ICP	inductively coupled plasma
ICS	interference check sample
ICV	initial calibration verification
IDL	instrument detection limit
IR	infrared spectroscopy
IRP	installation restoration program
IS	internal standards
LCS	laboratory control sample
LOD	limit of detection
LOQ	limit of quantitation
m/z	mass to charge ratio
MBAS	methyl blue active substance
mg/kg	milligram per kilogram
mg/L	milligram per liter
MS	matrix spike
MSA	method of standard addition
MSD	matrix spike duplicate
NFESC	Naval Facilities Engineering Services Center
ng/kg	nanogram per kilogram
OP	organophosphorus
PAH	polynuclear aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, comparability, completeness
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzodioxin
PCDF	polychlorinated dibenzofuran
PE	performance evaluation
PEM	performance evaluation mixture
PFK	perfluorokerosene
pg/g	picogram per gram
pg/L	picogram per liter
PQO	project quality objective
QA	quality assurance
QAC	quality assurance coordinator
QAPP	quality assurance project plan
QC	quality control
QSM	quality system manual

r	correlation coefficient
r ²	coefficient of determination
RF	response factor
RIC	reconstructed ion chromatogram
RL	reporting limit
RPD	relative percent difference
RRF	relative response factor
RRT	relative retention time
RSD	relative standard deviation
RT	retention time
s/n	signal to noise ratio
SDG	sample delivery group
SICP	selected ion current profiles
SOP	standard operating procedure
SOW	statement of work
SPCC	system performance check compound
SRM	standard reference material
SVOC	semivolatile organic compound
TB	trip blank
TCDD	tetrachlorodibenzodioxin
TCX	tetrachloro-m-xylene
TDS	total dissolved solids
TIC	tentatively identified compound
TOC	total organic carbon
TOX	total organic halides
TPHE	total petroleum hydrocarbons as extractables
UV/VIS	ultraviolet/visible
VOA	volatile organic analysis
VOC	volatile organic compound
VTSR	validated time of sample receipt
WDM	window defining mixture

This page intentionally left blank

**Attachment II-A-2
Definition of Terms**

This page intentionally left blank

DEFINITION OF TERMS

Calibration Curve	–	A plot of response versus concentration of standards.
CCB	–	Continuing Calibration Blank – a deionized water sample run every 10 samples designed to detect any carryover contamination.
CCV	–	Continuing Calibration Verification – a standard run every 10 samples to test instrument performance.
EDL	–	Estimated Detection Limit – The sample specific EDL is the concentration of a given analyte required to produce a signal with a peak height of at least 2.5 times the background signal level.
Field Blank	–	Field blanks are intended to identify contaminants that may have been introduced in the field through source water.
Field Duplicate	–	A duplicate sample generated in the field, not in the laboratory.
Findings	–	Any out-of-control, unacceptable, or out of criteria event which may impact the quality of the data or require corrective action.
GPC	–	Gel Permeation Chromatography – A sample clean-up technique that separates compounds by size and molecular weight. Generally used to remove oily materials from sample extracts.
Holding Time	–	The time from sample collection to sample analysis.
ICB	–	Initial Calibration Blank – the first blank standard run to confirm the calibration curve.
ICV	–	Initial Calibration Verification – the first standard run to confirm the calibration curve.
Initial Calibration	–	The establishment of a calibration curve with the appropriate number of standards and concentration range. The calibration curve plots instrument response versus concentration of standards.
IR	–	Infrared Spectroscopy.
IS	–	Internal Standards – compounds added to every VOA and BNA standard, blank, matrix spike duplicate, and sample extract at a known concentration, prior to instrumental analysis. Internal standards are used as the basis for quantitation of the target compounds.
Laboratory Duplicate	–	A duplicate sample generated in the laboratory.
MDL	–	Method Detection Limit – minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.
MS	–	Matrix Spike – introduction of a known concentration of analyte into a sample to provide information about the effect of the sample matrix on the extraction or digestion and measurement methodology.
m/z	–	The ratio of mass (m) to charge (z) of ions measured by GC/MS.

- Post Digestion Spike – The addition of a known amount of standard after digestion. (Also identified as analytical spike or spike for furnace analysis).
- Primary Analysis – One of two types of pesticide/PCB analysis by GC/EC techniques, the other being confirmation analysis. The primary analysis is used to establish the tentative identification of any pesticides/PCBs detected. The identification is confirmed in the confirmation analysis. If the two analyses are done simultaneously, either may be considered the primary analysis. Either may be used for quantitation if contract criteria are met.
- QA – Quality Assurance – total program for assuring the reliability of data
- QC – Quality Control – routine application of procedures for controlling the monitoring process.
- RL – Reporting Limit – value specified by the client based on sensitivity requirements from project-specific action levels.
- RPD – Relative Percent Difference (between matrix spike and matrix spike duplicate, duplicate laboratory control samples, or blank spikes)
- Serial Dilution – A sample run at a specific dilution to determine whether any significant chemical or physical interferences exist due to sample matrix effects (ICP only).
- SDG – Sample Delivery Group – defined by one of the following, whichever occurs first:
- Case of field samples
 - Each 20 field samples within a case
 - Each 14-day calendar period during which field samples in a case are received, beginning with receipt of the first sample in the SDG
- Level B Validation – Data validation is performed using sample results and QA/QC summaries (i.e., method blanks, LCS, MS/MSDs, surrogates, and serial dilutions). This level of data validation was previously identified as “Standard.”
- Level C Data Validation – Data validation is performed using sample results and QA/QC summaries (including instrument performance, calibration, and internal standard data). This level of data validation was previously identified as “Cursory.”
- Level D Data Validation – Data validation is performed using sample results, QA/QC summaries (including instrument performance, calibration, and internal standard data) and raw data associated to the sample results and QA/QC summaries. This level of data validation was previously identified as “Full.”

**Attachment II-A-3
Sample Cover Letter**

This page intentionally left blank

SAMPLE COVER LETTER

(Date)

(CTO Manager or designee) (company address) Dear (): Enclosed is Revision __ of the data validation reports for CTO (number) as follows: Semi-volatiles SDG S0221 SDG S0350 Pesticides/PCBs SDG S0201 Metals SDG S0221 SDG S0201 The specific sample identifications are listed in the Sample Identification Table(s). The data packages were reviewed according to the data validation procedures referenced in the introduction to each report.

Sincerely,

(Signature)

Data Validation Project Manager

This page intentionally left blank

**Attachment II-A-4
Data Qualifier Reference Table**

This page intentionally left blank

Table II-A-4-1: Data Qualifier Reference Table

Qualifier	Organics	Inorganics
U	The analyte was analyzed for, but was not detected above the method detection limit.	The analyte was analyzed for, but was not detected above the method detection limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."	Not applicable.
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.	Not applicable.
UJ	The analyte was not detected above the method detection limit. However, the associated value is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.	The analyte was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and to meet quality control criteria. The presence or absence of the analyte cannot be verified.	The data are unusable. The sample results are rejected due to serious deficiencies in meeting the Quality Control (QC) criteria. The analyte may or may not be present in the sample.

This page intentionally left blank

**Attachment II-A-5
Qualification Code Reference Table**

This page intentionally left blank

Table II-A-5-1: Qualification Code Reference Table

Qualifier	Organics	Inorganics
H	Holding times were exceeded.	Holding times were exceeded.
S	Surrogate recovery was outside QC limits.	The sequence or number of standards used for the calibration was incorrect.
C	Calibration %RSD, r, r ² or %D were noncompliant	Correlation coefficient is <0.995.
R	Calibration RRF was <0.05.	%R for calibration is not within control limits
B	Presumed contamination from preparation (method blank)	Presumed contamination from preparation (method) blank or calibration blank
L	Laboratory Control Sample/Laboratory Control Sample Duplicate %R or RPD was not within control limits	Laboratory Control Sample/Laboratory Control Sample Duplicate %R or RPD was not within control limits
Q	MS/MSD recovery was poor	MS/MSD recovery was poor.
E	MS/MSD or Duplicate RPD was high.	MS/MSD or Duplicate RPD or difference was high.
I	Internal standard performance was unsatisfactory	ICP ICS results were unsatisfactory.
A	Not applicable.	ICP Serial Dilution %D were not within control limits
M	Instrument Performance Check (BFB or DFTPP) was noncompliant	Not applicable.
T	Presumed contamination from trip blank.	Not applicable.
F	Presumed contamination from FB or ER.	Presumed contamination from FB or ER.
D	The analysis with this flag should not be used because another more technically sound analysis is available.	The analysis with this flag should not be used because another more technically sound analysis is available.
P	Instrument performance for pesticides was poor	Post Digestion Spike recovery was not within control limits
V	Unusual problems found with the data that have been described in the validation report where a description of the problem can be found.	Unusual problems found with the data that have been described in where a description of the problem can be found.

This page intentionally left blank

**Attachment II-A-6
Sample Identification Table**

This page intentionally left blank

Table II-A-6-1: Sample Identification Table

EPA Identification	Sample Identification	Lab Identification Number	COC Sample Number	Matrix
FB001	FB-BS04-E01-D10.0	2720-1	DA001	water
FB002	FB-BS04-B01-D10.0	2720-2	DA002	water
FB003	FB-BS04-B02-D10.0	2720-3	DA003	water
FB004	FB-SS01-S01-D0.5	2720-4	DA004	soil
FB005	FB-BS01-S01-D10.0	2720-5	DA005	soil
FB006	FB-SS02-S01-D0.5	2720-6	DA006	soil
FB007	FB-BS02-S01-D10.0	2720-7	DA007	soil
FB008	FB-BS02-D01-D10.0	2720-8	DA008	soil
FB009	FB-SS03-S01-D0.5	2720-9	DA009	soil
FB010	FB-BS03-S01-D10.0	2720-10	DA010	soil

This page intentionally left blank

**Attachment II-A-7
Example Annotated Laboratory Report
Volatile Organics Analysis Data Sheet**

This page intentionally left blank

EXAMPLE ANNOTATED LABORATORY REPORT VOLATILE ORGANICS ANALYSIS DATA SHEET

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

CA145

Lab Name: COLUMBIA ANALYTICAL SERVI Contract: EARTH TECH
 Lab Code: COLUMB Case No.: SAS No.: SDG No.: K9804746
 Matrix: (soil/water) SOIL Lab Sample ID: K9804746-013
 Sample wt/vol: 5.1 (g/mL) G Lab File ID: 0727F009
 Level: (low/med) LOW Date Received: 07/17/98
 % Moisture: not dec. 11 Date Analyzed: 07/27/98
 GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0
 Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	11	U
74-83-9	Bromomethane	11	U
75-01-4	Vinyl Chloride	11	U
75-00-3	Chloroethane	11	U
75-09-2	Methylene Chloride	0.8	JB nu (b)
67-64-1	Acetone	2	JB nu (b)
75-15-0	Carbon Disulfide	11	U
75-35-4	1,1-Dichloroethene	11	U
75-34-3	1,1-Dichloroethane	11	U
540-59-0	1,2-Dichloroethene (total)	11	U
67-66-3	Chloroform	11	U
107-06-2	1,2-Dichloroethane	11	U
78-93-3	2-Butanone	11	U
71-55-6	1,1,1-Trichloroethane	11	U
56-23-5	Carbon Tetrachloride	11	U
75-27-4	Bromodichloromethane	11	U
78-87-5	1,2-Dichloropropane	11	U
10061-01-5	cis-1,3-Dichloropropene	11	U
79-01-6	Trichloroethene	11	U
124-48-1	Dibromochloromethane	11	U
79-00-5	1,1,2-Trichloroethane	11	U
71-43-2	Benzene	11	U
10061-02-6	trans-1,3-Dichloropropene	11	U
75-25-2	Bromoform	11	U
108-10-1	4-Methyl-2-Pentanone	11	U
591-78-6	2-Hexanone	11	U
127-18-4	Tetrachloroethene	0.2	JJ
79-34-5	1,1,2,2-Tetrachloroethane	11	U
108-88-3	Toluene	0.2	JB nu (b)
108-90-7	Chlorobenzene	11	U
100-41-4	Ethylbenzene	11	U
100-42-5	Styrene	0.4	JB nu (b)
1330-20-7	Xylene (Total)	0.2	JB nu (b)

FORM I VOA

WJ 03.0

01513

"U.S. NAVY PACDIV IRP VALIDATED"

This page intentionally left blank

Laboratory QC Samples (Water, Soil)

1. Purpose

This section sets forth the standard operating procedure for identifying the number and type of laboratory quality control (QC) samples that will be analyzed during each contract task order (CTO) associated with the United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific. Laboratory QC analyses serve as a check on the precision and accuracy of analytical methods and instrumentation, and the potential contamination that might occur during laboratory sample preparation and analyses. Laboratory QC analyses include blank, surrogate, blank spike, laboratory control sample (LCS), and matrix spike (MS)/matrix spike duplicate (MSD) analyses. These laboratory QC analyses are discussed in general below.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the most recent version of the Uniform Federal Policy-Quality Assurance Project Plan (UFP QAPP) Part 1 (DoD 2005a), 2A (DoD 2012), and 2B (2005b), as well as the DoD Quality Systems Manual (DoD 2013). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 PRECISION

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as a standard deviation, variance, or range, in either absolute or relative terms. Examples of QC measures for precision include laboratory duplicates, laboratory triplicates, and matrix spike/matrix spike duplicates.

3.2 ACCURACY

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias), components which are due to sampling and analytical operations. Examples of QC measures for accuracy include performance evaluation samples, matrix spikes, LCSs, and equipment blanks.

3.3 MATRIX

A specific type of medium (e.g., surface water, drinking water), in which the analyte of interest may be contained. Medium is a substance (e.g., air, water, soil), which serves as a carrier of the analytes of interest (EPA 2010).

3.4 METHOD BLANK

An analyte-free matrix (water, soil, etc.) subjected to the entire analytical process to demonstrate that the analytical system itself does not introduce contamination.

3.5 MATRIX SPIKE

A sample prepared by adding a known concentration of a target analyte to an aliquot of a specific homogenized environmental sample for which an independent estimate of the target analyte concentration is available. The MS is accompanied by an independent analysis of the unspiked aliquot of the environmental sample. Spiked samples are used to determine the effect of the matrix on a method's recovery efficiency.

3.6 LABORATORY CONTROL SAMPLES AND BLANK SPIKES

A sample of known composition prepared using reagent-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is analyzed using the sample preparation, reagents, and analytical methods employed for regular samples.

3.7 SURROGATES

A pure substance with properties that mimic the analyte of interest (organics only). Surrogates are typically brominated, fluorinated, or isotopically labeled compounds unlikely to be found in environmental samples. These analytes are added to samples to evaluate analytical efficiency by measuring recovery.

3.8 INTERNAL STANDARDS

A pure substance added to both samples and laboratory standards at a known concentration with the purpose of providing a basis of comparison in the quantitation of analytes of interest. Internal standards are primarily used to increase the accuracy and precision of analytical methods where the primary source of variability is in sample preparation or sample injection on instrument.

4. Responsibilities

The prime contractor's QA Manager or Technical Director, as well as QC coordinators are responsible for ensuring that sample analytical activities during all CTOs are in compliance with this procedure.

The CTO QC Coordinators and the Laboratory Manager are responsible for identifying instances of non-compliance with this procedure and ensuring that future laboratory analytical activities are in compliance with it.

5. Procedures

Laboratory QC checks include all types of samples specified in the requested analytical methods, such as the analysis of laboratory blank, duplicate, and MS samples. QC requirements are specified in each analytical method and in Appendix B, *Quality Control Requirements*, and Appendix C, *Laboratory Control Sample (LCS) Control Limits and Requirements*, of the *Department of Defense Quality Systems Manual for Environmental Laboratories* Version 5.0 (or most current version)

(DoD QSM). Types of QC samples are discussed in general below. Detailed discussion and minimum QA/QC requirements are presented in the DoD QSM (DoD 2013).

A comprehensive discussion of the minimum number of laboratory QC samples can be found in the *Uniform Federal Policy for Quality Assurance Project Plans, Part 2B, Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities* (DoD 2005b). However, additional QA/QC samples may be necessary based on the project quality objectives. Information pertaining to laboratory QC samples shall be documented in Worksheet 28 Laboratory QC Samples Table of the project UFP QAPP-style planning document.

5.1 LABORATORY BLANKS

Laboratory blank samples are analyzed to assess the degree to which laboratory contamination by reagent or method preparation may have affected sample analytical results. At a minimum, one laboratory blank will be analyzed per matrix per analytical method for each batch of at most 20 samples. In evaluating the blank results, all blank data are reviewed to identify any compounds detected in the blanks. The laboratory shall be contacted to discuss detection of analytes in blank samples only in the event of unusual contamination, but not for common laboratory contaminants at low levels. The following compounds are considered to be common laboratory contaminants: acetone, methylene chloride, 2-butanone, and common phthalate esters. The data for samples analyzed during the same time period as the blank are then evaluated to identify the presence of any contaminants found in the blanks. The presence of the blank contaminants found in associated samples is then evaluated to avoid potential misinterpretation of actual sample constituents. Briefly, as discussed in the data validation procedures, any analyte detected above the LOQ in both the sample and the associated blank is qualified as not detected if the sample concentration is less than five times the blank concentration (5× rule). For common laboratory contaminants (methylene chloride, acetone, 2-butanone, and common phthalate esters), a 10× rule applies.

5.2 LABORATORY REPLICATES (DUPLICATES AND TRIPPLICATES)

Replicates are analyzed to evaluate the reproducibility, or precision, of the analytical procedures for a given sample. A replicate is two (duplicates) or three (triplicates) representative portions taken from one homogeneous sample by the laboratory and analyzed in the same laboratory (DoD 2005a). One duplicate sample is analyzed for each batch of twenty samples analyzed in a given matrix. Lab triplicates are assigned by the field team and identified on the chain of custody. The identification of a sample for lab triplicate analysis is typically selected from one of the field triplicates to allow for the evaluation of total study error of the sampling and analysis process. Duplicate analyses are normally performed on sample portions analyzed for inorganic constituents. For organic analyses, duplicate analyses are performed on MS samples (Section 5.5 of this procedure).

5.3 SURROGATES

Surrogate compounds must be added to all samples, standards, and blanks for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with the sample composition and shall be reported to the client whose sample produced the poor recovery. Surrogate compounds to be included for organic analysis are specified in each analytical method.

5.4 LABORATORY CONTROL SAMPLES AND BLANK SPIKES

LCSs are used to demonstrate that the laboratory process for sample preparation and analysis is under control.

Analytes selected for spiking of LCSs are usually the same compounds used to spike MS/MSD samples and are representative target compounds. Control limits for LCS recoveries are provided in Appendix C of DoD QSM. If no control limits for LCS recoveries are listed in Appendix C of the DoD QSM for a given analyte, the laboratory's in-house derived control limits should be used.

For wet chemistry methods, a single spike of an appropriate control for each method may be used for LCS analyses (i.e., cyanide, a control standard of sodium cyanide from a source other than that used for calibration may be spiked into water samples and analyzed with the water samples). LCSs should be analyzed at a frequency of one per batch of at most twenty samples analyzed of similar matrix.

5.5 MATRIX SPIKES/MATRIX SPIKE DUPLICATES

MS analyses are conducted by the laboratory to assess the accuracy of specific analytical methods and to provide information on the effect of the sample matrix on the analytical methodology. Spike analyses are performed by adding compounds of known concentration to a sample, an unspiked portion of which has previously been analyzed or is concurrently analyzed. The spiked analytes are representative target compounds for each analytical method performed. The spiked sample results are evaluated with the original sample results to evaluate any effects the matrix has on the analysis. One MS is analyzed for each batch of at most 20 samples of similar matrix. Since MS samples only provide information about the specific sample matrix used for the spike, MS analyses should be performed for each type of matrix collected.

For the MSD, a separate aliquot of the sample is separately spiked and analyzed. As discussed in Section 5.2, results of MSD analyses are expressed as a relative percent difference, which is calculated by dividing the difference in concentration between the MSD and the MS sample analyses by the arithmetic mean of their concentrations. One MSD analysis is required for at most each 20 samples of similar matrix.

Acceptance criteria for both the MS and the MSD are based on historic laboratory performance and are laboratory-specific. As a general rule, the acceptance criteria should be no more stringent than the LCS acceptance criteria.

It is important to note that the UFP QAPP Part 2B, QA/QC Compendium: Minimum QA/QC Activities (DoD 2005b) states that for organic analysis, MS and MSDs are not considered a minimum QC activity as long as surrogate spikes properly mimic the analytes of concern and can identify matrix effects. Project quality objectives should be evaluated to determine if organic MS/MSDs are useful for individual projects.

6. Records

Records of QC samples analyzed during ER Program CTO activities will be maintained on laboratory bench sheets, raw data sheets, in the laboratory computerized data system, and on QC summary forms, as requested. Analytical laboratories maintain records in accordance with their quality assurance manual (QAM) as part of performing environmental analytical work under DoD.

Records shall be maintained in accordance with the analytical laboratory subcontract agreement specifications or the laboratory-specific QAM, whichever is more stringent.

7. Health and Safety

Applicable to laboratory personnel only.

8. References

Department of Defense, United States (DoD). 2005a. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

———. 2005b. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2B: Quality Assurance/quality Control Compendium: Minimum QA/QC Activities*. Final Version 1. DoD: DTIC ADA 426957, EPA-505-B-04-900B. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/swerffr/pdf/-qaqc_v1_0305.pdf.

———. 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2A: Optimized UFP-QAPP Worksheets*. Revision 1. March.

———. 2013. *Department of Defense Quality Systems Manual for Environmental Laboratories*. Version 5.0. Final. Prepared by DoD Environmental Data Quality Workgroup and Department of Energy Consolidated Audit Program Operations Team. July.

Environmental Protection Agency, United States (EPA). 2010. Environmental Monitoring and Assessment Program: QA Glossary. November 8. On-line updates available at: http://www.epa.gov/emfjulte/html/pubs/docs/resdocs/qa_terms.html#mm. Accessed 2015.

Procedure I-A-7, *Analytical Data Validation Planning and Coordination*.

9. Attachments

None.

This page intentionally left blank

Field QC Samples (Water, Soil)

1. Purpose

This standard operating procedure describes the number and types of field quality control (QC) samples that will be collected during United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific site field work.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the most recent version of the Uniform Federal Policy-Quality Assurance Project Plan Part 1 (DoD 2005a), 2A (DoD 2012), and 2B (2005b), as well as the DoD Quality Systems Manual (DoD 2013). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the Contract Task Order (CTO) Manager and the Quality Assurance (QA) Manager or Technical Director, as well as QC coordinators responsible for compliance with the procedure. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 TRIP BLANK

Trip blanks are samples that originate from organic-free water (e.g., ASTM Type II water, high performance liquid chromatography grade water, etc.) prepared by the laboratory, shipped to the sampling site, and returned to the laboratory with samples to be analyzed for volatile organic compounds (VOCs). Trip blanks are analyzed to assess whether contamination was introduced during sample shipment (DoD 2005a). Trip blanks are prepared using the same sample container (typically a 40 ml VOA vial) as that used to collect field samples.

3.2 EQUIPMENT BLANK SAMPLES

An equipment blank (i.e., “decontamination rinsate,” or “equipment rinsate”) sample consists of a sample of water free of measurable contaminants poured over or through decontaminated field sampling equipment that is considered ready to collect or process an additional sample. Equipment blanks are to be collected from non-dedicated sampling equipment to assess the adequacy of the decontamination process.

3.3 FIELD BLANKS

A blank used to provide information about contaminants that may be introduced during sample collection, storage, and transport. It can also be a clean sample carried to the sampling site, exposed to sampling conditions, transported to the laboratory, and treated as an environmental sample.

3.4 FIELD DUPLICATE

A generic term for two field samples taken at the same time in approximately the same location is referred to as a field duplicate. The location of the duplicate (distance and direction from primary sample) should be specified in the project planning documents. They are intended to represent the same population and are taken through all steps of the analytical procedure in an identical manner and provide precision information for the data collection activity. There are two categories of field duplicate samples defined by the collection method: co-located field duplicates and subsample field duplicates. Co-located field duplicates are two or more independent samples collected from side-by-side locations at the same point in time and space so as to be considered identical. Co-located samples are collected from adjacent locations or liners (e.g., laterally or vertically, in separate containers), or water samples collected from the same well at the same time that have not been homogenized. Subsample field duplicate samples are obtained from one sample collection at one sample location.

3.5 FIELD REPLICATES

Two or more field replicates are used with incremental sampling approaches to statistically evaluate the sampling precision or error for each decision unit (DU). The location of the replicates (distance and direction from primary sample) and the number of DUs with replicates should be specified in the project planning documents. Increments for replicate samples are collected from completely separate locations (i.e., separate systematic random or stratified random grid). Triplicate samples (i.e., primary incremental sample plus two replicates) are required for incremental sampling and are more useful than just duplicates for statistical evaluation. The replicate samples are collected, prepared, and analyzed in the same manner as carried out for the primary sample.

3.6 TEMPERATURE INDICATORS (BLANKS)

A temperature indicator sample is often referred to as a temperature blank, but it is not analyzed nor does it measure introduced contamination. It may be a small sample bottle or VOA vial filled with distilled water that is placed in each shipping container to evaluate if samples were adequately cooled during sample shipment.

3.7 SOURCE WATER

Source water is water free from measurable contaminants that is used as the final decontamination rinse water.

4. Responsibilities

The prime contractor CTO Manager and QA Manager or Technical Director are responsible for ensuring that field QC samples are collected and analyzed according to this procedure. The CTO Manager is responsible for ensuring that all personnel involved in sampling or testing shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QC Coordinator is responsible for determining the QC sample requirements.

The Laboratory Manager is responsible for ensuring that field QC samples are analyzed according to the specifications of the project statement of work and the analytical methods used.

The Field Manager is responsible for ensuring that all project field staff follow these procedures.

Field sampling personnel are responsible for the implementation of this procedure.

5. Procedures

Field QC checks may include submission of trip blank, equipment blank, field blank, duplicate, triplicate, and temperature indicator (blank) samples to the laboratory. Types of field QC samples are discussed in general below. Table III-B-1 identifies the minimum frequency at which field QC samples should be collected, with the actual frequency to be determined by the individual project needs. For additional information on field QC frequency, see the State of Hawaii Department of Health 2009 *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*.

A comprehensive discussion of the minimum types and numbers of field QC samples can be found in the *Uniform Federal Policy for Quality Assurance Project Plans, Part 2B, Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities* (DoD 2005).

Table III-B-1: Field QC Samples per Sampling Event

Type of Sample	Minimum QC Sample Frequency	
	Metals	Organic
Trip blank (for volatiles only)	N/A	1/analytical method/cooler
Equipment blank	5%	5%
Field blank	1/decontamination water source/event ^a /for all analytes	
Field replicates ^b	10%	10%
Temperature Indicator (blank)	1/shipping container	

% percent
N/A not applicable

^a A sampling event is considered to be from the time sampling personnel arrive at a site until they leave for more than a week. The use of controlled-lot source water makes one sample per lot, rather than per event, an option.

^b To the extent practical, field replicates should be collected from the same locations as the samples designated for a laboratory matrix spike/matrix spike duplicate (organic analysis) where applicable, or from the sample used as a laboratory duplicate (inorganic analysis).

5.1 TRIP BLANKS

The laboratory prepares trip blanks using organic-free water, and then sends them to the field. The laboratory shall place trip blanks in sample coolers prior to transport to the site so that they accompany the samples throughout the sample collection/handling/transport process. Once prepared, trip blanks should not be opened until they reach the laboratory. One set of two 40-milliliter vials per volatile analysis forms a trip blank and accompanies each cooler containing samples to be analyzed for volatiles. Trip blanks are only analyzed for volatiles. Results of trip blank analyses are used to assess whether samples have been contaminated by volatiles during sample handling and transport to the laboratory.

Trip blanks are not typically associated with tissue samples; however, project-specific quality objectives shall determine if trip blanks for tissue samples are required.

5.2 EQUIPMENT BLANK SAMPLES

Collect equipment blank samples by pumping the source water over and/or through the decontaminated sampling equipment. Collect this runoff water into the sample containers directly or with the use of a funnel, if necessary. The source water may be pumped or poured by tipping the jug of water upside down over the equipment. Results of equipment blank samples are used to evaluate whether equipment decontamination was effective.

At a minimum, equipment blank samples should be collected at a rate of 5 percent of the total samples planned for collection for each sampling technique used. This rate may be adjusted depending on the nature of the investigation (site inspection, remedial investigation, remedial site evaluation, long-term monitoring) and the associated project quality objectives (PQOs). Equipment blank samples will be analyzed for the same parameters as the samples collected with that particular equipment. If analytes pertinent to the project are found in the equipment blanks, the frequency of equipment blank samples may be increased after decontamination procedures have been modified to further evaluate the effectiveness of the decontamination procedure.

When disposable or dedicated sampling equipment is used, equipment blank samples do not need to be collected.

Sampling devices (e.g., gloved hands, dip nets, or traps) used for collection of tissue samples are generally non-intrusive into the organisms collected, so equipment blank samples will not be collected as long as the devices have been properly cleaned following Procedure I-F, *Equipment Decontamination*, and appear clean.

5.3 FIELD BLANKS

Field blanks, consisting of samples of the source water used as the final decontamination rinse water, will be collected on site by field personnel by pouring the source water into sample containers and then analyzed to assess whether contaminants may have been introduced during sample collection, storage, and transport.

The final decontamination rinse water source (the field blank source water) and equipment blank source water should all be from the same purified water source. Tap water used for steam cleaning augers or used in the initial decontamination buckets need not be collected and analyzed as a field blank since augers typically do not touch the actual samples and the final decontamination rinse water should be from a purified source.

Field blanks should be collected at a minimum frequency of one per sampling event per each source of water. A sampling event is considered to be from the time sampling personnel arrive at a site until they leave for more than a week. Field blanks will be analyzed for the same parameters as the samples collected during the period that the water sources are being used for decontamination. Additional field blanks may be required based on PQOs.

5.4 FIELD DUPLICATES

Field duplicates consist of either co-located or subsampled samples. Field duplicates for ground water and surface water samples are generally considered to be co-located samples. Soil duplicate samples may be homogenized and subsampled in the field (or at the laboratory) to form an original

and duplicate sample, or may be an additional volume of sample collected in a separate sample container to form a co-located sample.

The interpretation of co-located duplicate data may be more complex than subsample duplicate data because of the number of variables associated with the results of this type of duplicate sample. Duplicate soil samples for VOC analysis shall always be co-located (i.e., not homogenized or otherwise processed or subsampled). Duplicates will be analyzed for the same analytical parameters as their associated original sample. Collection of both co-located and subsampled versions of the same sample may be performed to aid in approximating sampling and analysis error.

Field duplicates for biological tissue samples will consist of subsamples of the original sample. Twice the required volume of organisms for one sample will be collected and placed into one food-grade, self-sealing bag. The sample will later be homogenized in the laboratory and subsampled, producing an original and a duplicate sample. Tissue duplicate samples will be analyzed for the same analytical parameters as their associated original samples.

5.5 FIELD REPLICATES

Field replicates are completely separate incremental replicate samples (collected from a set of systematic random or stratified random locations within the DU that are different from those used for the primary incremental samples). A different random starting location is determined for each replicate collected in the selected DU. Field replicates are typically collected in sets of three (the primary sample and two replicate samples) to produce a triplicate.

Replicate sample increments are collected from the same sampling grid established through the DU for the primary incremental sample, though at different systematic random locations than initially used. The replicate increments should not be collected from the same points or co-located with those used for the primary incremental sample. Replicate samples are sent to the laboratory as “blind” samples, meaning the laboratory does not know they represent replicate samples of the primary incremental sample.

5.6 TEMPERATURE INDICATORS (BLANKS)

Temperature indicators (blanks) may be prepared in the lab or field by filling a small sample bottle or VOA vial with distilled water and sealing the container. One temperature indicator sample should be placed in each sample cooler or shipping container. Upon arrival at the laboratory, the temperature of the bottle is measured to determine if samples were adequately cooled during the shipment.

6. Records

Records of QC samples analyzed during ER Program CTO activities will be maintained on laboratory bench sheets, raw data sheets, in the laboratory computerized data system, and on QC summary forms, as requested. Analytical laboratories maintain records in accordance with their quality assurance manual (QAM) as part of performing environmental analytical work under DoD. Records shall be maintained in accordance with the analytical laboratory subcontract agreement specifications or the laboratory-specific QAM, whichever is more stringent.

7. Health and Safety

Field personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005a. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

———. 2005b. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2B: Quality Assurance/quality Control Compendium: Minimum QA/QC Activities*. Final Version 1. DoD: DTIC ADA 426957, EPA-505-B-04-900B. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/swerffrr/pdf/-qaqc_v1_0305.pdf.

———. 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2A: Optimized UFP-QAPP Worksheets*. Revision 1. March.

———. 2013. *Department of Defense Quality Systems Manual for Environmental Laboratories*. Version 5.0. Draft Final. Prepared by DoD Environmental Data Quality Workgroup and Department of Energy Consolidated Audit Program Operations Team. July.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-F, *Equipment Decontamination*.

Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*.

9. Attachments

None.

Logbooks

1. Purpose

This standard operating procedure describes the activities and responsibilities pertaining to the identification, use, and control of logbooks and associated field data records for use by United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management approved professional guidance for the ER Program and is consistent with protocol in the most recent version of the Uniform Federal Policy-Quality Assurance Project Plan Appendix A. Section 1.4 *Field Documentation SOPs* (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the Contract Task Order (CTO) Manager and the Quality Assurance Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 LOGBOOK

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person assigned responsibility for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 DATA FORM

A data form is a predetermined format used for recording field data that may become, by reference, a part of the logbook (e.g., soil boring logs, trenching logs, surface soil sampling logs, groundwater sample logs, and well construction logs are data forms).

4. Responsibilities

The prime contractor CTO Manager or delegate is responsible for determining which team members shall record information in field logbooks and for obtaining and maintaining control of the required logbooks. The CTO Manager shall review the field logbook on at least a monthly basis. The CTO Manager or designee is responsible for reviewing logbook entries to determine compliance with this procedure and to ensure that the entries meet the project requirements.

A knowledgeable individual such as the Field Manager, CTO Manager, or quality control (QC) Supervisor shall perform a technical review of each logbook at a frequency commensurate with the level of activity (weekly is suggested, or, at a minimum, monthly). Document these reviews by the

dated signature of the reviewer on the last page or page immediately following the material reviewed.

The Field Manager is responsible for ensuring that all project field staff follow these procedures and that the logbook is completed properly and daily. The Field Manager is also responsible for submitting copies to the CTO Manager, who is responsible for filing them and submitting a copy to the Navy (if required by the CTO Statement of Work).

The logbook user is responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. The logbook user is also responsible for safeguarding the logbook while having custody of it.

Field personnel are responsible for the implementation of this procedure.

All NAVFAC Pacific ER Program field personnel are responsible for complying with Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

5. Procedure

The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Store the logbook in a clean location and use it only when outer gloves used for personal protective equipment (PPE) have been removed.

Individual data forms may be generated to provide systematic data collection documentation. Entries on these forms shall meet the same requirements as entries in the logbook and shall be referenced in the applicable logbook entry. Individual data forms shall reference the applicable logbook and page number. At a minimum, include names of all samples collected in the logbook even if they are recorded elsewhere.

Enter field descriptions and observations into the logbook, as described in Attachment III-D-1, using indelible black ink.

Typical information to be entered includes the following:

- Dates (month/day/year) and times (military) of all onsite activities and entries made in logbooks/forms
- Site name, and description
- Site location by longitude and latitude, if known
- Weather conditions, including estimated temperature and relative humidity
- Fieldwork documentation, including site entry and exit times
- Descriptions of, and rationale for, approved deviations from the work plan or field sampling plan
- Field instrumentation readings
- Names, job functions, and organizational affiliations of personnel on-site

- Photograph references
- Site sketches and diagrams made on-site
- Identification and description of sample morphology, collection locations and sample numbers as described in Procedure I-A-8, *Sample Naming*
- Sample collection information, including dates (month/day/year) and times (military) of sample collections, sample collection methods and devices, station location numbers, sample collection depths/heights, sample preservation information, sample pH (if applicable), analysis requested (analytical groups), etc., as well as chain-of-custody (COC) information such as sample identification numbers cross-referenced to COC sample numbers
- Sample naming convention
- Field QC sample information
- Site observations, field descriptions, equipment used, and field activities accomplished to reconstruct field operations
- Meeting information
- Important times and dates of telephone conversations, correspondence, or deliverables
- Field calculations
- PPE level
- Calibration records
- Contractor and subcontractor information (address, names of personnel, job functions, organizational affiliations, contract number, contract name, and work assignment number)
- Equipment decontamination procedures and effectiveness
- Laboratories receiving samples and shipping information, such as carrier, shipment time, number of sample containers shipped, and analyses requested
- User signatures

The logbook shall reference data maintained in other logs, forms, etc. Correct entry errors by drawing a single line through the incorrect entry, then initialing and dating this change. Enter an explanation for the correction if the correction is more than for a mistake.

At least at the end of each day, the person making the entry shall sign or initial each entry or group of entries.

Enter logbook page numbers on each page to facilitate identification of photocopies.

If a person's initials are used for identification, or if uncommon acronyms are used, identify these on a page at the beginning of the logbook.

At least weekly and preferably daily, the preparer shall photocopy (or scan) and retain the pages completed during that session for backup. This will prevent loss of a large amount of information if the logbook is lost.

6. Records

Retain the field logbook as a permanent project record. If a particular CTO requires submittal of photocopies of logbooks, perform this as required.

7. Health and Safety

Store the logbook in a clean location to keep it clean and use it only when outer gloves used for PPE have been removed.

8. References

Department of Defense, United States (DoD). 2005a. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Procedure I-A-8, *Sample Naming*.

9. Attachments

Attachment III-D-1: Description of Logbook Entries

**Attachment III-D-1
Description of Logbook Entries**

This page intentionally left blank

Logbook entries shall be consistent with Section A.1.4 *Field Documentation SOPs* of the UFP-QAPP Manual (DoD 2005) and contain the following information, as applicable, for each activity recorded. Some of these details may be entered on data forms, as described previously.

Name of Activity	For example, Asbestos Bulk Sampling, Charcoal Canister Sampling, Aquifer Testing.
Task Team Members and Equipment	Name all members on the field team involved in the specified activity. List equipment used by serial number or other unique identification, including calibration information.
Activity Location	Indicate location of sampling area as indicated in the field sampling plan.
Weather	Indicate general weather and precipitation conditions.
Level of PPE	Record the level of PPE (e.g., Level D).
Methods	Indicate method or procedure number employed for the activity.
Sample Numbers	Indicate the unique numbers associated with the physical samples. Identify QC samples.
Sample Type and Volume	Indicate the medium, container type, preservative, and the volume for each sample.
Time and Date	Record the time and date when the activity was performed (e.g., 0830/08/OCT/89). Use the 24-hour clock for recording the time and two digits for recording the day of the month and the year.
Analyses	Indicate the appropriate code for analyses to be performed on each sample, as specified in the WP.
Field Measurements	Indicate measurements and field instrument readings taken during the activity.
Chain of Custody and Distribution	Indicate chain-of-custody for each sample collected and indicate to whom the samples are transferred and the destination.
References	If appropriate, indicate references to other logs or forms, drawings, or photographs employed in the activity.
Narrative (including time and location)	Create a factual, chronological record of the team's activities throughout the day including the time and location of each activity. Include descriptions of general problems encountered and their resolution. Provide the names and affiliations of non-field team personnel who visit the site, request changes in activity, impact the work schedule, request information, or observe team activities. Record any visual or other observations relevant to the activity, the contamination source, or the sample itself. It should be emphasized that logbook entries are for recording data and chronologies of events. The logbook author must include observations and descriptive notations, taking care to be objective and recording no opinions or subjective comments unless appropriate.
Recorded by	Include the signature of the individual responsible for the entries contained in the logbook and referenced forms.
Checked by	Include the signature of the individual who performs the review of the completed entries.

This page intentionally left blank

Record Keeping, Sample Labeling, and Chain-Of-Custody

1. Purpose

The purpose of this standard operating procedure is to establish standard protocols for all United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific field personnel for use in maintaining field and sampling activity records, writing sample logs, labeling samples, ensuring that proper sample custody procedures are used, and completing chain-of-custody/analytical request forms.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the most recent version of the Uniform Federal Policy-Quality Assurance Project Plan (UFP QAPP) Part 1 (DoD 2005a), 2A (DoD 2012), and 2B (2005b), as well as the DoD Quality Systems Manual (DoD 2013). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 LOGBOOK

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person responsible for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 CHAIN-OF-CUSTODY

Chain-of-custody (COC) is documentation of the process of custody control. Custody control includes possession of a sample from the time of its collection in the field to its receipt by the analytical laboratory, and through analysis and storage prior to disposal.

4. Responsibilities

The prime contractor CTO Manager is responsible for determining which team members shall record information in the field logbook and for checking sample logbooks and COC forms to ensure compliance with these procedures. The CTO Manager shall review COC forms on a monthly basis at a minimum.

The prime contractor CTO Manager and QA Manager or Technical Director are responsible for evaluating project compliance with the Project Procedures Manual. The QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Laboratory Project Manager or Sample Control Department Manager is responsible for reporting any sample documentation or COC problems to the CTO Manager or CTO Laboratory Coordinator within 24 hours of sample receipt.

The Field Manager is responsible for ensuring that all field personnel follow these procedures. The CTO Laboratory Coordinator is responsible for verifying that the COC/analytical request forms have been completed properly and match the sampling and analytical plan. The CTO Manager or CTO Laboratory Coordinator is responsible for notifying the laboratory, data managers, and data validators in writing if analytical request changes are required as a corrective action. These small changes are different from change orders, which involve changes to the scope of the subcontract with the laboratory and must be made in accordance with a respective contract (e.g., Comprehensive Long-Term Environmental Action Navy, remedial action contract).

NAVFAC Pacific ER Program field personnel are responsible for following these procedures while conducting sampling activities. Field personnel are responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. All NAVFAC Pacific ER Program field personnel are responsible for complying with Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

5. Procedures

This procedure provides standards for documenting field activities, labeling the samples, documenting sample custody, and completing COC/analytical request forms. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented.

5.1 RECORD KEEPING

The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct each day's events. Field logs such as soil boring logs and groundwater sampling logs will also be used. These procedures are described in Procedure III-D, *Logbooks*.

5.2 SAMPLE LABELING

Affix a sample label with adhesive backing to each individual sample container with the exception of pre-tared containers. Record the following information with a waterproof marker (ballpoint pen for containers for volatile analyses) on each label:

- Project name or number (optional)
- COC sample number
- Date and time of collection
- Sampler's initials
- Matrix (optional)
- Sample preservatives (if applicable)

- Analysis to be performed on sample (This shall be identified by the method number or name identified in the subcontract with the laboratory)
- Indicate if sample is to be used as the matrix spike (MS)/matrix spike duplicate (MSD) or laboratory triplicate sample

With the exception of sample containers with pre-tared labels, place clear tape over each label (preferably prior to sampling) to prevent the labels from tearing off, falling off, or being smeared, and to prevent loss of information on the label.

These labels may be obtained from the analytical laboratory or printed from a computer file onto adhesive labels.

For volatile soil organic analyses (VOA), labels are not to be affixed to vials that are pre-tared by the laboratory. Instead, on each of the VOA vials in the sample set (typically three per sample), mark the sample COC Sample identification (ID) on the vial in ballpoint pen. Then wrap the vials together in bubble wrap and place one sample label on the bubble wrap and cover with tape. It is imperative that the COC Sample ID be clearly marked on each vial as this will help prevent laboratory error if the vials are inadvertently separated after removal from the bubble wrap.

5.3 CUSTODY PROCEDURES

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. Maintain custody of samples in accordance with the U.S. Environmental Protection Agency (EPA) COC guidelines prescribed in U.S. Environmental Protection Agency (EPA) *NEIC Policies and Procedures*, National Enforcement Investigations Center, Denver, Colorado, revised August 1991 (EPA 1978); EPA *RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD)*, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA OSWER Directive 9355 3-01) (EPA 1988, Appendix 2 of the *Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports* (Cal/EPA 1988), and *Test Methods for Evaluating Solid Waste* (EPA 2007). A description of sample custody procedures is provided below.

5.3.1 Sample Collection Custody Procedures

According to the EPA guidelines, a sample is considered to be in custody if one of the following conditions is met:

- It is in one's actual physical possession or view
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal)
- It is retained in a secured area with restricted access
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal

Place custody seals on sample containers (on bubble wrap for pre-tared containers) immediately after sample collection and on shipping coolers if the cooler is to be removed from the sampler's custody.

Place custody seals in such a manner that they must be broken to open the containers or coolers. Label the custody seals with the following information:

- Sampler's name or initials
- Date and time that the sample/cooler was sealed

These seals are designed to enable detection of sample tampering. An example of a custody seal is shown in Attachment III-E-1.

Field personnel shall also log individual samples onto COC forms (carbon copy or computer generated) when a sample is collected or just prior to shipping. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 5.4, indicating sample identification number, matrix, date and time of collection, number of containers, analytical methods to be performed on the sample, and preservatives added (if any). The samplers will also sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. When a cooler is ready for shipment to the analytical laboratory, the person delivering the samples for transport will sign and indicate the date and time on the accompanying COC form. One copy of the COC form will be retained by the sampler and the remaining copies of the COC form shall be placed inside a self-sealing bag and taped to the inside of the cooler. Each cooler must be associated with a unique COC form. Whenever a transfer of custody takes place, both parties shall sign and date the accompanying carbon copy COC forms, and the individual relinquishing the samples shall retain a copy of each form. One exception is when the samples are shipped; the delivery service personnel will not sign or receive a copy because they do not open the coolers. The laboratory shall attach copies of the completed COC forms to the reports containing the results of the analytical tests. An example COC form is provided in Attachment III-E-2.

5.3.2 Laboratory Custody Procedures

The following custody procedures are to be followed by an independent laboratory receiving samples for chemical analysis; the procedures in their Naval Facilities Engineering and Expeditionary Warfare Center-evaluated Laboratory Quality Assurance Plan must follow these same procedures. A designated sample custodian shall take custody of all samples upon their arrival at the analytical laboratory. The custodian shall inspect all sample labels and COC forms to ensure that the information is consistent, and that each is properly completed. The custodian will also measure the temperature of the temperature blank in the coolers upon arrival using either a National Institute for Standards and Technology calibrated thermometer or an infra-red temperature gun. The custodian shall note the condition of the samples including:

- If the samples show signs of damage or tampering
- If the containers are broken or leaking
- If headspace is present in sample vials
- Proper preservation of samples (made by pH measurement, except volatile organic compounds (VOCs) and purgeable total petroleum hydrocarbons (TPH) and temperature). The pH of VOC and purgeable TPH samples will be checked by the laboratory analyst after the sample aliquot has been removed from the vial for analysis.

- If any sample holding times have been exceeded

All of the above information shall be documented on a sample receipt sheet by the custodian.

Discrepancies or improper preservation shall be noted by the laboratory as an out-of-control event and shall be documented on an out-of-control form with corrective action taken. The out-of-control form shall be signed and dated by the sample control custodian and any other persons responsible for corrective action. An example of an out-of-control form is included as Attachment III-E-4.

The custodian shall then assign a unique laboratory number to each sample and distribute the samples to secured storage areas maintained at 4 degrees Celsius (soil samples for VOC analysis are to be stored in a frozen state until analysis). The unique laboratory number for each sample, the COC sample number, the client name, date and time received, analysis due date, and storage shall also be manually logged onto a sample receipt record and later entered into the laboratory's computerized data management system. The custodian shall sign the shipping bill and maintain a copy.

Laboratory personnel shall be responsible for the care and custody of samples from the time of their receipt at the laboratory through their exhaustion or disposal. Samples should be logged in and out on internal laboratory COC forms each time they are removed from storage for extraction or analysis.

5.4 COMPLETING COC/ANALYTICAL REQUEST FORMS

COC form/analytical request form completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

Attachment III-E-2 is an example of a generic COC/analytical request form that may be used by field personnel. Multiple copies may be tailored to each project so that much of the information described below need not be handwritten each time. Attachment III-E-3 is an example of a completed site-specific COC/analytical request form, with box numbers identified and discussed in text below.

Box 1 *Project Manager:* This name shall be the name that will appear on the report. Do not write the name of the Project Coordinator or point of contact for the project instead of the CTO manager.

Project Name: Write the project name as it is to appear on the report.

Project Number: Write the project number as it is to appear on the report. It shall include the project number and task number. Also include the laboratory subcontract number.

Box 2 *Bill to:* List the name and address of the person/company to bill only if it is not in the subcontract with the laboratory.

Box 3 *Sample Disposal Instructions:* These instructions will be stated in the Master Service Agreement or each CTO statement of work with each laboratory.

Shipment Method: State the method of shipment (e.g., hand carry; air courier via FED EX, AIR BORNE, or DHL).

Comment: This area shall be used by the field team to communicate observations, potential hazards, or limitations that may have occurred in the field or additional information regarding analysis (e.g., a specific metals list, samples expected to contain high analyte concentrations).

Box 4 *Cooler Number:* This will be written on the inside or outside of the cooler and shall be included on the COC. Some laboratories attach this number to the trip blank identification, which helps track volatile organic analysis samples. If a number is not on the cooler, field personnel shall assign a number, write it on the cooler, and write it on the COC.

QC Level: Enter the reporting/QC requirements (e.g., Full Data Package, Summary Data Package).

Turn around time (TAT): TAT will be determined by a sample delivery group (SDG), which may be formed over a 14-day period, not to exceed 20 samples. Once the SDG has been completed, standard TAT is 21 calendar days from receipt of the last sample in the SDG. Entering NORMAL or STANDARD in this field will be acceptable. If quicker TAT is required, it shall be in the subcontract with the laboratory and reiterated on each COC to remind the laboratory.

Box 5 *Type of containers:* Write the type of container used (e.g., 1 liter glass amber, for a given parameter in that column).

Preservatives: Field personnel must indicate on the COC the correct preservative used for the analysis requested. Indicate the pH of the sample (if tested) in case there are buffering conditions found in the sample matrix.

Box 6 *COC sample number:* This is typically a five-character alpha-numeric identifier used by the contractor to identify samples. The use of this identifier is important since the labs are restricted to the number of characters they are able to use. See Procedure I-A-8, *Sample Naming*.

Description (sample identification): This name will be determined by the location and description of the sample, as described in Procedure I-A-8, *Sample Naming*. This sample identification should not be submitted to the laboratory, but should be left blank. If a computer COC version is used, the sample identification can be input, but printed with this block black. A cross-referenced list of COC Sample Number and sample identification must be maintained separately.

Identify if sample requires laboratory subsampling.

Date Collected: Record the collection date to track the holding time of the sample. Note: For trip blanks, record the date it was placed in company with samples.

Time Collected: When collecting samples, record the time the sample is first collected. Use of the 24-hour military clock will avoid a.m. or p.m. designations (e.g., 1815 instead of 6:15 p.m.). Record local time; the laboratory is responsible for calculating holding times to local time.

Lab Identification: This is for laboratory use only.

Box 7 *Matrix and QC:* Identify the matrix (e.g., water, soil, air, tissue, fresh water sediment, marine sediment, or product). If a sample is expected to contain high analyte concentrations (e.g., a tank bottom sludge or distinct product layer), notify the laboratory in the comment section. Mark an "X" for the sample(s) that have extra volume for laboratory QC matrix spike/matrix spike duplicate (MS/MSD) or laboratory triplicate purposes. The sample provided for MS/MSD purposes is usually a field duplicate.

Box 8 *Analytical Parameters:* Enter the parameter by descriptor and the method number desired (e.g. benzene, toluene, ethylbenzene, and xylenes 8260B, polynuclear aromatic hydrocarbons 8270C, etc.). Whenever practicable, list the parameters as they appear in the laboratory subcontract to maintain consistency and avoid confusion.

If the COC does not have a specific box for number of sample containers, use the boxes below the analytical parameter, to indicate the number of containers collected for each parameter.

Box 9 *Sampler's Signature:* The person who collected samples must sign here.

Relinquished By: The person who turned over the custody of the samples to a second party other than an express mail carrier, such as FEDEX, must sign here.

Received By: Typically, a representative of the receiving laboratory signs here. Or, a field crew member who delivered the samples in person from the field to the laboratory might sign here. A courier, such as Federal Express, does not sign here because they do not open the coolers. It must also be used by the prime contracting laboratory when samples are to be sent to a subcontractor.

Relinquished By: In the case of subcontracting, the primary laboratory will sign the Relinquished By space and fill out an additional COC to accompany the samples being subcontracted.

Received By (Laboratory): This space is for the final destination (e.g., at a subcontracted laboratory).

Box 10 *Lab Number and Questions:* This box is to be filled in by the laboratory only.

- Box 11 *Control Number:* This number is the “COC” followed by the first contractor identification number in that cooler, or contained on that COC. This control number must be unique (i.e., never used twice). Record the date the COC is completed. It should be the same date the samples are collected.
- Box 12 *Total No. of Containers/row:* Sum the number of containers in that row.
- Box 13 *Total No. of Containers/column:* Sum the number of containers in that column. Because COC forms contain different formats depending on who produced the form, not all of the information listed in items 1 to 13 may be recorded; however, as much of this information as possible shall be included.

COC forms tailored to each CTO can be drafted and printed onto multi-ply forms. This eliminates the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number; QC Level; TAT; and the same general comments each time.

Complete one COC form per cooler. Whenever possible, place all volatile organic analyte vials into one cooler in order to reduce the number of trip blanks. Complete all sections and be sure to sign and date the COC form. One copy of the COC form must remain with the field personnel.

6. Records

The COC/analytical request form shall be faxed or e-mailed to the CTO Laboratory Coordinator for verification of accuracy. Following the completion of sampling activities, the sample logbook and COC forms will be transmitted to the CTO Manager for storage in project files. The data validators shall receive a copy also. The original COC/analytical request form shall be submitted by the laboratory along with the data delivered. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the data validators and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

7. Health and Safety

Not applicable.

8. References

California Environmental Protection Agency (Cal/EPA). 1988. *Technical Guidance Manual, Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports*. Solid Waste Disposal Program, Hydrogeology Section, Land Disposal Branch, Division of Water Quality, State Water Resources Control Board. August.

Department of Defense, United States (DoD). 2005a. Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

———. 2005b. Uniform Federal Policy for Quality Assurance Project Plans, Part 2B: Quality Assurance/quality Control Compendium: Minimum QA/QC Activities. Final Version 1. DoD: DTIC ADA 426957, EPA-505-B-04-900B. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/swerffr/pdf/-qaqc_v1_0305.pdf.

———. 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2A: Optimized UFP-QAPP Worksheets*. Revision 1. March.

———. 2013. *Department of Defense Quality Systems Manual for Environmental Laboratories*. Version 5.0. Draft Final. Prepared by DoD Environmental Data Quality Workgroup and Department of Energy Consolidated Audit Program Operations Team. July.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Environmental Protection Agency, United States (EPA). 1978. *NEIC Policies and Procedures*. EPA-330/9-78-001-R. Revised August 1991. National Enforcement Investigation Center. Denver. May.

———. 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. Interim Final. EPA/540/G-89/004. Office of Emergency and Remedial Response. October.

———. 2007. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846*. 3rd ed., Revision 6. Office of Solid Waste. November. On-line updates at: <http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm>.

Procedure I-A-8, *Sample Naming*.

Procedure III-D, *Logbooks*.

9. Attachments

Attachment III-E-1, Chain-of-Custody Seal

Attachment III-E-2, Generic Chain-of-Custody/Analytical Request Form

Attachment III-E-3, Sample Completed Chain-of-Custody

Attachment III-E-4, Sample Out-of-Control Form

This page intentionally left blank

**Attachment III-E-1
Chain-of-Custody Seal**

This page intentionally left blank

CHAIN-OF-CUSTODY SEAL

CUSTODY SEAL	
Company Name (808) XXX-XXXX	
Sampler's Name/Initials: _____	Date: _____ Time: _____

This page intentionally left blank

Attachment III-E-2
Generic Chain-of-Custody/Analytical Request Form

This page intentionally left blank

Chain-of-Custody

Control Number: 94H0

Bill To: Company: Address:	Date: _____ Page _____ of _____ Sample Disposal Shipment Comments:	
CTO/DO Manager: CTO/DO Name: CTO/DO Number: Driver results to the address above or as stated in contract Cooler No:	# of containers: _____ Preservatives: Matrix/OC	TPH 8015B CLP VOA CLP SVOA CLP Pesticides CLP Metals EPA 8080 (PCBs only) EPA 8240 EPA 8270 Total Lead by EPA 6010 Extra Volume MS/MSD HOLD Total # of Containers
QC Level: _____ TAT: _____ Sample Date Sample ID (EPA ID) Sample ID (Heavy Use Only)	Water Other (drum, sludge, etc.) Field Duplicate (MS/MSD)	SOI Water Other (drum, sludge, etc.) Field Duplicate (MS/MSD)
Date Collected Time Collected Lab ID	Date Collected Time Collected Lab ID	Date Collected Time Collected Lab ID
Samplers Signature Relinquished By: Received By: Relinquished By: Received By (LAB):	Date Date Date Date Date	Date Date Date Date Date
TOTALS: _____ For Lab Use		
Lab No.: _____ Date sent: _____/_____/_____ Temperature: _____ °C		
Clear COC match samples: Y or N Broken seals: Y or N Received within holding time: Y or N COC seal intact: Y or N Any other problems: Y or N If problems, client contacted: Y or N		

Original (white), Lab Copy (yellow), Field Copy (pink)

Generic Chain-of-Custody/Analytical Request Form

This page intentionally left blank

**Attachment III-E-3
Sample Completed Chain-of-Custody**

This page intentionally left blank

This page intentionally left blank

**Attachment III-E-4
Sample Out-of-Control Form**

This page intentionally left blank

OUT OF CONTROL FORM	Status	Date	Initial
	Noted OOC		
	Submit for CA*		
	Resubmit for CA*		
	Completed		

Date Recognized:		By:		Samples Affected (List by Accession AND Sample No.)
Dated Occurred:		Matrix		
Parameter (Test Code):		Method:		
Analyst:		Supervisor:		
1. Type of Event (Check all that apply)		2. Corrective Action (CA)* (Check all that apply)		
<input type="checkbox"/>	Calibration Corr. Coefficient <0.995	<input type="checkbox"/>	Repeat calibration	
<input type="checkbox"/>	%RSD>20%	<input type="checkbox"/>	Made new standards	
<input type="checkbox"/>	Blank >MDL	<input type="checkbox"/>	Reran analysis	
<input type="checkbox"/>	Does not meet criteria:	<input type="checkbox"/>	Sample(s) redigested and rerun	
<input type="checkbox"/>	Spike	<input type="checkbox"/>	Sample(s) reextracted and rerun	
<input type="checkbox"/>	Duplicate	<input type="checkbox"/>	Recalculated	
<input type="checkbox"/>	LCS	<input type="checkbox"/>	Cleaned system	
<input type="checkbox"/>	Calibration Verification	<input type="checkbox"/>	Ran standard additions	
<input type="checkbox"/>	Standard Additions	<input type="checkbox"/>	Notified	
<input type="checkbox"/>	MS/MSD	<input type="checkbox"/>	Other (please explain)	
<input type="checkbox"/>	BS/BSD	<input type="checkbox"/>		
<input type="checkbox"/>	Surrogate Recovery	<input type="checkbox"/>		
<input type="checkbox"/>	Calculations Error	<input type="checkbox"/>		

<input type="checkbox"/>	Holding Times Missed	
<input type="checkbox"/>	Other (Please explain	Comments:

3. Results of Corrective Action	
<input type="checkbox"/>	Return to Control (indicated with)
<input type="checkbox"/>	Corrective Actions Not Successful - DATA IS TO BE FLAGGED with _____.

Analyst:	Date:
Supervisor:	Date:
QA Department:	Date:

Sample Handling, Storage, and Shipping

1. Purpose

This standard operating procedure sets forth the methods for use by the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel engaged in handling, storing, and transporting samples.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the most recent version of the Uniform Federal Policy-Quality Assurance Project Plan (UFP QAPP) Part 1 (DoD 2005a), 2A (DoD 2012), and 2B (2005b), as well as the DoD Quality Systems Manual (DoD 2013). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

None.

4. Responsibilities

The prime contractor CTO Manager and the Laboratory Project Manager are responsible for identifying instances of non-compliance with this procedure and ensuring that future sample transport activities are in compliance with this procedure.

The Field Manager is responsible for ensuring that all samples are shipped according to this procedure.

Field personnel are responsible for the implementation of this procedure.

The QA Manager or Technical Director is responsible for ensuring that sample handling, storage, and transport activities conducted during all CTOs are in compliance with this procedure.

All field personnel are responsible for complying with Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

5. Procedures

5.1 HANDLING AND STORAGE

Immediately following collection, label all samples according to Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*. In addition, when more than one volatile organic analyte

(VOA) vial is used to collect one sample, the chain-of-custody (COC) identification (ID) will be written on the VOA vials (even pre-tared vials) with a ball point pen for that sample. The lids of the containers shall not be sealed with duct tape, but should be covered with custody seals (except pre-tared containers which should have the custody seal placed on the outside of the protective bubble wrap). Wrap glass sample containers on the sides, tops, and bottoms with bubble wrap or other appropriate padding to prevent breakage during transport. When collecting three VOA vials per sample, it is acceptable to wrap all three vials together and store in one plastic bag. Store all glass containers for water samples in an upright position, never stacked or placed on their sides. Samples will be maintained as close to 4 degrees Celsius (°C) as possible from the time of collection through transport to the analytical laboratory, using refrigerators and/or freezers when appropriate. Place all containers into self-sealing bags and into an insulated cooler with wet ice while still in the field. Samples should occupy the lower portion of the cooler, while the ice should occupy the upper portion. Place an absorbent material (e.g., proper absorbent cloth material) on the bottom of the cooler to contain liquids in case of spillage. Ship samples as soon after collection as possible to allow the laboratory to meet holding times for analyses. Check with the laboratory for operating/sample receipt hours prior to all traditional and non-traditional holidays to ensure sample shipment will be received. When not shipping samples directly upon field collection, store samples in a refrigerator or freezer (never freeze water samples) until shipped to the laboratory.

5.2 PACKING

Each cooler must contain a temperature blank (small plastic bottle with sterile water) to confirm cooler temperature upon receipt at the laboratory. Water samples can be used as such, but it is best to include a designated temperature blank bottle, typically supplied by the laboratory with the coolers.

One trip blank must be included in each cooler containing samples for volatile analysis (e.g., volatile organic compounds, total petroleum hydrocarbons-gasoline range organics).

Cooler must be lined completely in ice at the bottom and all four sides. After confirming all project samples are accounted for and labeled correctly, place samples in cooler. Record sample IDs on cooler-specific COC(s). Pack glass containers for water samples in an upright position, never stacked or placed on their sides. Fill all empty space between sample containers with bubble wrap or other appropriate material (not Styrofoam). Place a layer of ice on top of samples and fill all empty space between ice and cooler lid with bubble wrap or other appropriate material.

Place laboratory copies of completed COC(s), and soil permit if applicable, into resealable bag and tape to underside of cooler lid.

5.3 SHIPPING

Follow all appropriate U.S. Department of Transportation regulations (e.g., 49 Code of Federal Regulations [CFR], Parts 171-179) for shipment of air, soil, water, and other samples. Elements of these procedures are summarized below.

5.3.1 Hazardous Materials Shipment

Field personnel must state whether any sample is suspected to be a hazardous material. A sample should be assumed to be hazardous unless enough evidence exists to indicate it is non-hazardous. If not suspected to be hazardous, shipments may be made as described in the Section 5.3.3 for non-hazardous materials. If hazardous, follow the procedures summarized below.

Any substance or material that is capable of posing an unreasonable risk to life, health, or property when transported is classified as hazardous. Perform hazardous materials identification by checking the list of dangerous goods for that particular mode of transportation. If not on that list, materials can be classified by checking the Hazardous Materials Table (49 CFR 172.102 including Appendix A) or by determining if the material meets the definition of any hazard class or division (49 CFR Part 173), as listed in Attachment III-F-2.

All persons shipping hazardous materials must be properly trained in the appropriate regulations, as required by HM-126F, Training for Safe Transportation of Hazardous Materials (49 CFR HM-126F Subpart H). The training covers loading, unloading, handling, storing, and transporting of hazardous materials, as well as emergency preparedness in the case of accidents. Carriers, such as commercial couriers, must also be trained. Modes of shipment include air, highway, rail, and water.

When shipping hazardous materials, including bulk chemicals or samples suspected of being hazardous, the proper shipping papers (49 CFR 172 Subpart C), package marking (49 CFR 172 Subpart D), labeling (49 CFR 172 Subpart E), placarding (49 CFR 172 Subpart F, generally for carriers), and packaging must be used. Attachment III-F-1 shows an example of proper package markings. Refer to a copy of 49 CFR each time hazardous materials/potentially hazardous samples are shipped.

According to Section 2.7 of the International Air Transport Association Dangerous Goods Regulations publication, very small quantities of certain dangerous goods may be transported without certain marking and documentation requirements as described in 49 CFR Part 172. However, other labeling and packing requirements must still be followed. Attachment III-F-2 shows the volume or weight for different classes of substances. A “Dangerous Goods in Excepted Quantities” label must be completed and attached to the associated shipping cooler (Attachment III-F-3). Certain dangerous goods are not allowed on certain airlines in any quantity.

As stated in item 4 of Attachment III-F-4, the Hazardous Materials Regulations do not apply to hydrochloric acid (HCl), nitric acid (HNO₃), sulfuric acid (H₂SO₄), and sodium hydroxide (NaOH) added to water samples if their pH or percentage by weight criteria are met. Hazardous Materials Regulations also do not apply to methanol (MeOH) for soil samples if the percentage by weight criterion is met. These samples may be shipped as non-hazardous materials as discussed below.

5.3.2 Non-hazardous Materials Shipment

If the samples are suspected to be non-hazardous based on previous site sample results, field screening results, or visual observations, if applicable, then samples may be shipped as non-hazardous.

If preservatives (HCl, HNO₃, H₂SO₄, NaOH, or MeOH) are used, ensure their individual pH or percentage by weight criteria, as shown in item 4 of Attachment III-F-4, are met to continue shipping as non-hazardous samples.

When a cooler is ready for shipment to the laboratory, place the receiving laboratory address on the top of the cooler, place chain-of-custody seals on the coolers as discussed in Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*, place soil permit labels on top if applicable, and seal the cooler with waterproof tape.

5.3.3 Shipments from Outside the Continental United States

Shipment of sample coolers to the continental U.S. from locations outside the continental U.S. is controlled by the U.S. Department of Agriculture (USDA) and is subject to their inspection and regulation. A “USDA Soil Import Permit” is required to prove that the receiving analytical laboratory is certified by the USDA to receive and properly dispose of soil. In addition, all sample coolers must be inspected by a USDA representative, affixed with a label indicating that the coolers contain environmental samples, and accompanied by shipping forms stamped by the USDA inspector prior to shipment. In addition, the U.S. Customs Service must clear samples shipped from U.S. territorial possessions or foreign countries upon entry into the U.S. As long as the commercial invoice is properly completed (see below), shipments typically pass through U.S. Customs Service without the need to open coolers for inspection.

In Hawaii, soil sample shipments are typically brought to the courier at the airport where the courier contacts a USDA representative to make an inspection. Alternatively, the contractor may enter into an agreement with the USDA to ship soil samples. In this way, the USDA does not need to inspect each soil sample shipment. If the contractor maintains a Domestic Soil Permit, place the permit label and the soil origination label (Attachment III-F-9) on the top of the cooler. Place a copy of the receiving laboratory’s soil permit with the COC inside the cooler. Confirm custody seals were placed on each container (Section 5.1) to ensure proper chain-of-custody control in the event coolers are opened for inspection.

In Guam, shipments can be dropped off directly to the Federal Express branch or to the courier at the airport. Alternatively, the courier can pick up shipments at each site provided that arrangements have been made regarding pickup time and location. USDA inspections occur outside of Guam. The laboratory’s soil permit shall be placed with the COC inside the cooler, and the soil origination label (see Attachment III-F-9) should be placed on top of the cooler.

The USDA does not need to inspect water sample shipments.

Completion and use of proper paperwork will, in most cases, minimize or eliminate the need for the USDA and U.S. Customs Service to inspect the contents. Attachment III-F-5 shows an example of how paperwork may be placed on the outside of coolers for non-hazardous materials. For hazardous materials, refer to Section 5.3.1.

In summary, tape the paperwork listed below to the outside of the coolers to assist sample shipments. If a shipment is made up of multiple pieces (e.g., more than one cooler), the paperwork need only be attached to one cooler, provided that the courier agrees. All other coolers in the shipment need only be taped and have address and COC seals affixed.

1. **Courier Shipping Form & Commercial Invoice.** See Attachment III-F-6, and Attachment III-F-7 for examples of the information to be included on the commercial invoice for soil and water. Place the courier shipping form and commercial invoice inside a clear, plastic, adhesive-backed pouch that adheres to the package (typically supplied by the courier) and place it on the cooler lid as shown in Attachment III-F-5.
2. **Soil Import Permit (soil only).** See Attachment III-F-8 and Attachment III-F-9 for examples of the soil import permit and soil samples restricted entry labels. The laboratory shall supply these documents prior to mobilization. The USDA in Hawaii often does stop

shipments of soil without these documents. Staple together the 2 inch × 2 inch USDA label (described below), and soil import permit, and place them inside a clear plastic pouch. The courier typically supplies the clear, plastic, adhesive-backed pouches that adhere to the package.

Placing one restricted entry label as shown in Attachment III-F-5 (covered with clear packing tape) and one stapled to the actual permit is suggested.

The USDA does not control water samples, so the requirements for soil listed above do not apply.

3. **Chain-of-Custody Seals.** The laboratory should supply the seals. CTO personnel must sign and date these. At least two seals should be placed in such a manner that they stick to both the cooler lid and body. Placing the seals over the tape (as shown in Attachment III-F-5), then covering it with clear packing tape is suggested. This prevents the seal from coming loose and enables detection of tampering.
4. **Address Label.** Affix a label stating the destination (laboratory address) of each cooler.
5. **Special Requirements for Hazardous Materials.** See Section 5.3.1.

Upon receipt of sample coolers at the laboratory, the sample custodian shall inspect the sample containers as discussed in Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*. The samples shall then be either immediately extracted and/or analyzed, or stored in a refrigerated storage area until they are removed for extraction and/or analysis. Whenever the samples are not being extracted or analyzed, they shall be returned to refrigerated storage.

6. Records

Maintain records as required by implementing these procedures.

7. Health and Safety

Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2012) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005a. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

———. 2005b. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2B: Quality Assurance/quality Control Compendium: Minimum QA/QC Activities*. Final Version 1. DoD: DTIC ADA 426957, EPA-505-B-04-900B. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/swerffrr/pdf/-qaqc_v1_0305.pdf.

———. 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Part 2A: Optimized UFP-QAPP Worksheets*. Revision 1. March.

———. 2013. *Department of Defense Quality Systems Manual for Environmental Laboratories*. Version 5.0. Draft Final. Prepared by DoD Environmental Data Quality Workgroup and Department of Energy Consolidated Audit Program Operations Team. July.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody*.

9. Attachments

Attachment III-F-1: Example Hazardous Materials Package Marking

Attachment III-F-2: Packing Groups

Attachment III-F-3: Label for Dangerous Goods in Excepted Quantities

Attachment III-F-4: SW-846 Preservative Exception

Attachment III-F-5: Non-Hazardous Material Cooler Marking Figure for Shipment From Outside The Continental United States

Attachment III-F-6: Commercial Invoice – Soil

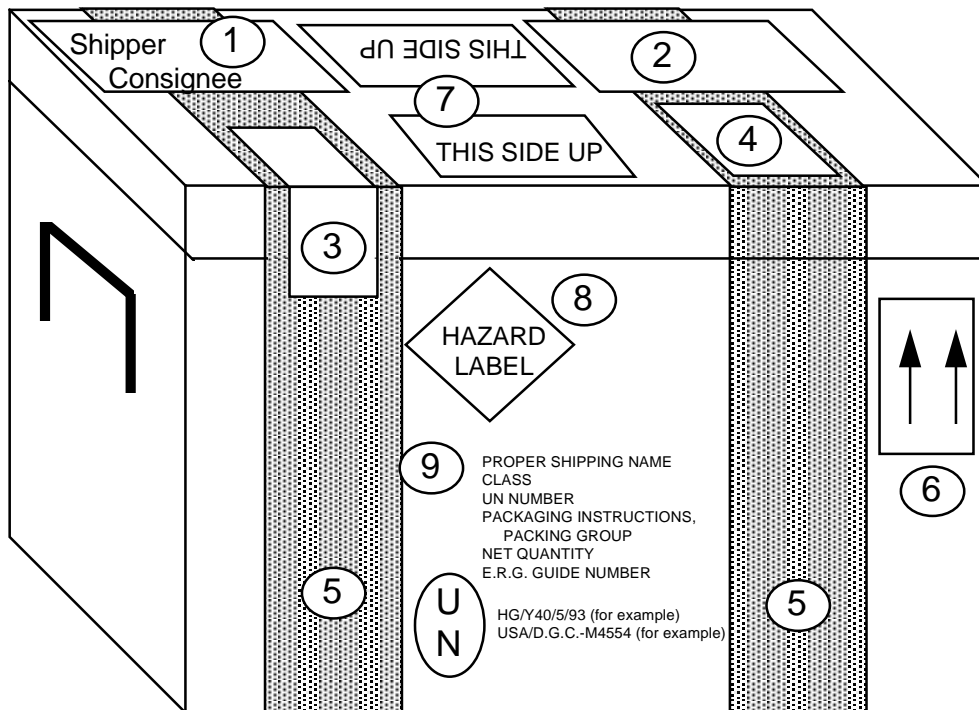
Attachment III-F-7: Commercial Invoice – Water

Attachment III-F-8: Soil Import Permit

Attachment III-F-9: Soil Samples Restricted Entry Labels

Attachment III-F-1
Example Hazardous Material Package Marking

This page intentionally left blank



- | | |
|--|---|
| 1 AIR BILL/COMMERCIAL INVOICE | 6 DIRECTION ARROWS STICKER - TWO REQUIRED |
| 2 USDA PERMIT (Letter to Laboratory from USDA) | 7 THIS SIDE UP STICKERS |
| 3 CUSTODY SEAL | 8 HAZARD LABEL |
| 4 USDA 2" X 2" SOIL IMPORT PERMIT | 9 HAZARDOUS MATERIAL INFORMATION |
| 5 WATERPROOF STRAPPING TAPE | 10 PACKAGE SPECIFICATIONS |

This page intentionally left blank

**Attachment III-F-2
Packing Groups**

This page intentionally left blank

PACKING GROUP OF THE SUBSTANCE CLASS or DIVISION of PRIMARY or SUBSIDIARY RISK	PACKING GROUP I		PACKING GROUP II		PACKING GROUP III	
	Inner	Outer	Inner	Outer	Inner	Outer
1: Explosives	----- Forbidden ^(Note A) -----					
2.1: Flammable Gas	----- Forbidden ^(Note B) -----					
2.2: Non-Flammable, non-toxic gas	----- See Notes A and B -----					
2.3: Toxic gas	----- Forbidden ^(Note A) -----					
3. Flammable liquid	30 mL	300 mL	30 mL	500 mL	30 mL	1 L
4.1 Self-reactive substances	Forbidden		Forbidden		Forbidden	
4.1: Other flammable solids	Forbidden		30 g	500 g	30 g	1 kg
4.2: Pyrophoric substances	Forbidden		Not Applicable		Not Applicable	
4.2 Spontaneously combustible substances	Not Applicable		30 g	500 g	30 g	1 kg
4.3: Water reactive substances	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
5.1: Oxidizers	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
5.2: Organic peroxides ^(Note C)	See Note A		30 g or 30 mL	500 g or 250 mL	Not Applicable	
6.1: Poisons - Inhalation toxicity	Forbidden		1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.1: Poisons - oral toxicity	1 g or 1 mL	300 g or 300 mL	1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.1: Poisons - dermal toxicity	1 g or 1 mL	300 g or 300 mL	1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.2: Infectious substances	----- Forbidden ^(Note A) -----					
7: Radioactive material ^(Note D)	----- Forbidden ^(Note A) -----					
8: Corrosive materials	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
9: Magnetized materials	----- Forbidden ^(Note A) -----					
9: Other miscellaneous materials ^(Note E)	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L

Note A: Packing groups are not used for this class or division.

Note B: For inner packagings, the quantity contained in receptacle with a water capacity of 30 mL. For outer packagings, the sum of the water capacities of all the inner packagings contained must not exceed 1 L.

Note C: Applies only to Organic Peroxides when contained in a chemical kit, first aid kit or polyester resin kit.

Note D: See 6.1.4.1, 6.1.4.2 and 6.2.1.1 through 6.2.1.7, radioactive material in excepted packages.

Note E: For substances in Class 9 for which no packing group is indicated in the List of Dangerous Goods, Packing Group II quantities must be used.

This page intentionally left blank

**Attachment III-F-3
Label for Dangerous Goods in Excepted Quantities**

This page intentionally left blank

DANGEROUS GOODS IN EXCEPTED QUANTITIES

This package contains dangerous goods in excepted small quantities and is in all respects in compliance with the applicable international and national government regulations and the IATA Dangerous Goods Regulations.

Signature of Shipper

Title

Date

Name and address of Shipper

This package contains substance(s) in Class(es)
(check applicable box(es))

Class:	2	3	4	5	6	8	9
	0	0	0	0	0	0	0

and the applicable UN Numbers are:

This page intentionally left blank

**Attachment III-F-4
SW-846 Preservative Exception**

This page intentionally left blank

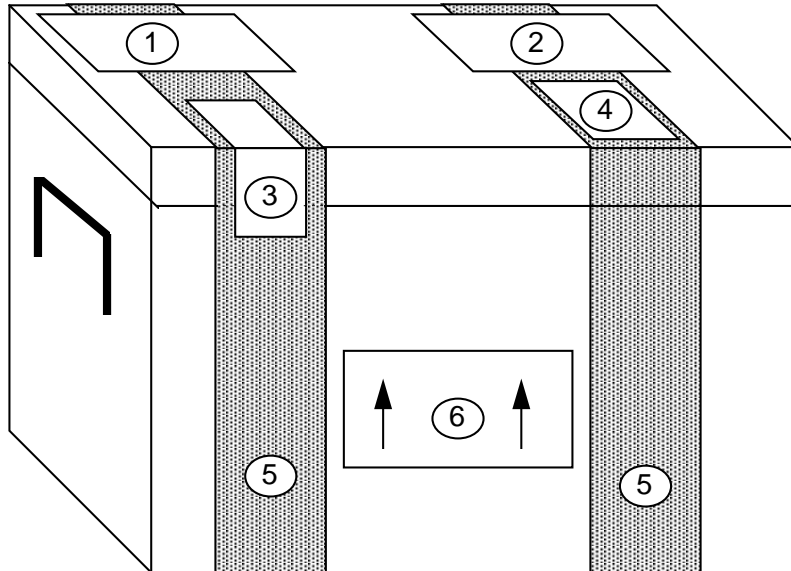
<u>Measurement</u>	<u>Vol. Req.</u> (mL)	<u>Container</u> ²	<u>Preservative</u> ^{3,4}	<u>Holding Time</u> ⁵
MBAS	250	P,G	Cool, 4°C	48 Hours
NTA	50	P,G	Cool, 4°C	24 Hours

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 31, p. 72-82 (1976) Method D-3370.
2. Plastic (P) or Glass (G). For metals, polyethylene with a polypropylene cap (no liner) is preferred.
3. Sample preservation should be performed immediately upon sample collection. For composite samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
4. When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table 1, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentration of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO₃) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H₂SO₄) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
5. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of sample under study are stable for the longer time, and has received a variance from the Regional Administrator. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.
6. Should only be used in the presence of residual chlorine.

This page intentionally left blank

Attachment III-F-5
Non-Hazardous Material Cooler Marking Figure for Shipment from
outside the Continental United States

This page intentionally left blank



- ① AIR BILL/COMMERCIAL INVOICE
- ② USDA PERMIT (Letter to Laboratory from USDA)
- ③ CUSTODY SEAL
- ④ USDA 2" X 2" SOIL IMPORT PERMIT
- ⑤ WATERPROOF STRAPPING TAPE
- ⑥ DIRECTION ARROWS STICKER - TWO REQUIRED

This page intentionally left blank

**Attachment III-F-6
Commercial Invoice – Soil**

This page intentionally left blank

DATE OF EXPORTATION 1/1/94			EXPORT REFERENCES (i.e., order no., invoice no., etc.) <CTO #>						
SHIPPER/EXPORTER (complete name and address) Joe Smith Ogden c/o <hotel name> <hotel address>			CONSIGNEE Sample Receipt <Lab Name> <Lab Address>						
COUNTRY OF EXPORT Guam, USA			IMPORTER - IF OTHER THAN CONSIGNEE						
COUNTRY OF ORIGIN OF GOODS Guam, USA									
COUNTRY OF ULTIMATE DESTINATION USA									
INTERNATIONAL AIR WAYBILL NO.			<div style="border: 1px solid black; width: 200px; height: 40px; margin: 0 auto;"></div>					(NOTE: All shipments must be accompanied by a Federal Express International Air Waybill)	
MARKS/NOS	NO. OF PKGS	TYPE OF PACKAGING	FULL DESCRIPTION OF GOODS	QTY	UNIT OF MEASURE	WEIGHT	UNIT VALUE	TOTAL VALUE	
	3	coolers	Soil samples for labora analysis only				\$1.00	\$3.00	
	TOTAL NO. OF PKGS.					TOTAL WEIGHT		TOTAL INVOICE VALUE	
	3							\$3.00	
Check one <input type="checkbox"/> F.O.B. <input type="checkbox"/> C&F <input type="checkbox"/> C.I.F.									

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.
 DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.
 I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT
 SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

Joe Smith, Ogden

Joe Smith

1/1/94

 Name/Title

 Signature

 Date

This page intentionally left blank

**Attachment III-F-7
Commercial Invoice – Water**

This page intentionally left blank

DATE OF EXPORTATION 1/1/94		EXPORT REFERENCES (i.e., order no., invoice no., etc.) <CTO #>						
SHIPPER/EXPORTER (complete name and address) Joe Smith Ogden c/o <hotel name> <hotel address>		CONSIGNEE Sample <Lab Name> <Lab Address>						
COUNTRY OF EXPORT Guam, USA		IMPORTER - IF OTHER THAN CONSIGNEE						
COUNTRY OF ORIGIN OF GOODS Guam, USA								
COUNTRY OF ULTIMATE DESTINATION USA								
INTERNATIONAL AIR WAYBILL NO.					(NOTE: All shipments must be accompanied by a Federal Express International Air Waybill)			
MARKS/NOS	NO. OF PKGS	TYPE OF PACKAGING	FULL DESCRIPTION OF GOODS	QTY	UNIT OF MEASURE	WEIGHT	UNIT VALUE	TOTAL VALUE
	3	coolers	Water samples for lab analysis only				\$1.00	\$3.00
	TOTAL NO. OF PKGS.					TOTAL WEIGHT		TOTAL INVOICE VALUE
	3							\$3.00
Check one <input type="checkbox"/> F.O.B. <input type="checkbox"/> C&F <input type="checkbox"/> C.I.F.								

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.
 DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.
 I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT
 SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

Joe Smith, Ogden

Joe Smith

1/1/94

Name/Title

Signature

Date

This page intentionally left blank

**Attachment III-F-8
Soil Import Permit**

This page intentionally left blank



UNITED STATES
DEPARTMENT OF
AGRICULTURE

Animal and Plant
Health Inspection
Service
Plant Protection and
Quarantine

Soil Permit

Permit
Number: S-52299

Issued To:
Columbia Analytical Services
(Lee Wolf)
1317 S. 13th Avenue
Kelso, Washington 98626

TELEPHONE: (360) 577-7222

Under the authority of the Federal Plant Pest Act of May 23, 1957, permission is hereby granted to the facility/individual named above subject to the following conditions:

1. Valid for shipments of soil not heat treated at the port of entry, only if a compliance agreement (PPQ Form 519) has been completed and signed. Compliance Agreements and Soil permits are non-transferable. If you hold a Soil Permit and you leave your present employer or company, you must notify your local USDA office promptly.
2. To be shipped in sturdy, leakproof, containers.
3. To be released without treatment at the port of entry.
4. To be used only for analysis and only in the facility of the permittee at Columbia Analytical Services, located in Kelso, Washington.
5. No use of soil for growing purposes is authorized, including the isolation or culture of organisms imported in soil.
6. All unconsumed soil, containers, and effluent is to be autoclaved, incinerated, or heat treated by the permittee at the conclusion of the project as approved and prescribed by Plant Protection and Quarantine.
7. This permit authorizes shipments from all foreign sources, including Guam, Hawaii, Puerto Rico, and the U.S. Virgin Islands through any U.S. port of entry.

JUNE 30, 2006

Expiration Date

Deborah M. Knott
Approving Official DEBORAH M. KNOTT

WARNING: Any alteration, forgery, or unauthorized use of this Federal form is subject to civil penalties of up to \$250,000 (7 U.S.C. § 7734(b)) or punishable by a fine of not more than \$10,000, or imprisonment of not more than 5 years, or both (18 U.S.C. § 1001).

PPQ FORM 525B (8/94)

Pt. 1 - PERMITTEE

This page intentionally left blank

Attachment III-F-9
Soil Samples Restricted Entry Label and Soil Origin Label

This page intentionally left blank

U.S. DEPARTMENT OF AGRICULTURE

**ANIMAL AND PLANT HEALTH INSPECTION
SERVICE**

PLANT PROTECTION AND QUARANTINE

HYATTSVILLE, MARYLAND 20782

SOIL SAMPLES

RESTRICTED ENTRY

The material contained in this package
is imported under authority of the
Federal Plant Pest Act of May 23, 1957.

For release without treatment if
addressee is currently listed as
approved by Plant Protection and
Quarantine.

PPQ FORM 550 *Edition of 12/77 may be used*

(JAN 83)

Soil Samples Restricted Entry Label

SOIL ENCLOSED

Origin of Soil _____

Soil Origin Label



SOIL GAS SAMPLING

SOP#: 2042
DATE: 06/01/96
REV. #: 0.0

1.0 SCOPE AND APPLICATION

Soil gas monitoring provides a quick means of waste site evaluation. Using this method, underground contamination can be identified, and the source, extent, and movement of the pollutants can be traced.

This standard operating procedure (SOP) outlines the methods used by U.S. EPA/ERT in installing soil gas wells; measuring organic vapor levels in the soil gas using a Photoionization Detector (PID), Flame Ionization Detector (FID) and/or other air monitoring devices; and sampling the soil gas using Tedlar bags, Tenax sorbent tubes, and/or Summa canisters.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

A 3/8" diameter hole is driven into the ground to a depth of four to five feet using a commercially available slam bar. Soil gas can also be sampled at other depths by the use of a longer bar or bar attachments. A 1/4" O.D. stainless steel probe is inserted into the hole. The hole is then sealed around the top of the probe using modeling clay. The gas contained in the interstitial spaces of the soil is sampled by pulling the sample through the probe using an air sampling pump. The sample may be stored in Tedlar bags, drawn through sorbent cartridges, or analyzed directly using a direct reading instrument. The air sampling pump is not used for Summa canister sampling of soil gas. Sampling is

achieved by soil gas equilibration with the evacuated Summa canister.

Other field air monitoring devices, such as the combustible gas indicator (MSA CGI/02 Meter, Model 260) and the Organic Vapor Analyzer (Foxboro OVA, Model 128), can also be used dependent on specific site conditions. Measurement of soil temperature using a temperature probe may also be desirable. Bagged samples are usually analyzed in a field laboratory using a portable Photovac GC.

Power driven sampling probes may be utilized when soil conditions make sampling by hand unfeasible (i.e., frozen ground, very dense clays, pavement, etc.). Commercially available soil gas sampling probes (hollow, 1/2 = O.D. steel probes) can be driven to the desired depth using a power hammer (e.g., Bosch Demolition Hammer or Geoprobe™). Samples can be drawn through the probe itself, or through Teflon tubing inserted through the probe and attached to the probe point. Samples are collected and analyzed as described above.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Tedlar Bags

Soil gas samples are generally contained in 1.0-L Tedlar bags. Bagged samples are best stored in dark plastic bags placed in coolers to protect the bags from any damage that may occur in the field or in transit. In addition, coolers insure the integrity of the samples by keeping them at a cool temperature and out of direct sunlight. Samples should be analyzed as soon as possible, preferably within 24 - 48 hours.

3.2 Tenax Tubes

Bagged samples can also be drawn onto Tenax or

other sorbent tubes to undergo lab GC/MS analysis. If Tenax tubes are to be utilized, special care must be taken to avoid contamination. Handling of the tubes should be kept to a minimum and only while wearing nylon or other lint-free gloves. After sampling, each tube should be stored in a clean, sealed culture tube; the ends packed with clean glass wool to protect the sorbent tube from breakage. The culture tubes should be kept cool and wrapped in aluminum foil to prevent any photodegradation of samples (see Section 7.4.).

3.3 Summa Canisters

The Summa canisters used for soil gas sampling have a 6 liter sample capacity and are certified clean by GC/MS analysis before being utilized in the field. After sampling is completed, they are stored and shipped in travel cases.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 PID Measurements

A number of factors can affect the response of a PID (such as the HNu PI 101). High humidity can cause lamp fogging and decreased sensitivity. This can be significant when soil moisture levels are high, or when a soil gas well is actually in groundwater. High concentrations of methane can cause a downscale deflection of the meter. High and low temperature, electrical fields, FM radio transmission, and naturally occurring compounds, such as terpenes in wooded areas, will also affect instrument response.

Other field screening instruments can be affected by interferences. Consult the manufacturers manuals.

4.2 FID Measurements

A number of factors can affect the response of an FID (such as the OVA model 128). High humidity can cause the FID to flame out or not ignite at all. This can be significant when soil moisture levels are high, or when a soil gas well is actually in groundwater. The FID can only read organic based compounds (they must contain carbon in the molecular structure). The FID also responds poorly to hydrocarbons and halogenated hydrocarbons (such as gasoline, propane fuel). High and low temperature, electrical fields and FM radio transmission will also affect instrument response.

4.3 Factors Affecting Organic Concentrations in Soil Gas

Concentrations in soil gas are affected by dissolution, adsorption, and partitioning. Partitioning refers to the ratio of component found in a saturated vapor above an aqueous solution to the amount in the solution; this can, in theory, be calculated using the Henry's Law constants. Contaminants can also be adsorbed onto inorganic soil components or "dissolved" in organic components. These factors can result in a lowering of the partitioning coefficient.

Soil "tightness" or amount of void space in the soil matrix, will affect the rate of recharging of gas into the soil gas well.

Existence of a high, or perched, water table, or of an impermeable underlying layer (such as a clay lens or layer of buried slag) may interfere with sampling of the soil gas. Knowledge of site geology is useful in such situations, and can prevent inaccurate sampling.

4.4 Soil Probe Clogging

A common problem with this sampling method is soil probe clogging. A clogged probe can be identified by using an in-line vacuum gauge or by listening for the sound of the pump laboring. This problem can usually be eliminated by using a wire cable to clear probe (see Section 7.1.3.).

4.5 Underground Utilities

Prior to selecting sample locations, an underground utility search is recommended. The local utility companies can be contacted and requested to mark the locations of their underground lines. Sampling plans can then be drawn up accordingly. Each sample location should also be screened with a metal detector or magnetometer to verify that no underground pipes or drums exist.

5.0 EQUIPMENT/APPARATUS

5.1 Slam Bar Method

- C Slam Bar (1 per sampling team).
- C Soil gas probes, stainless steel tubing, 1/4" O.D., 5 ft length.
- C Flexible wire or cable used for clearing the

- C tubing during insertion into the well.
- C "Quick Connect" fittings to connect sampling probe tubing, monitoring instruments, and Gilian pumps to appropriate fittings on vacuum box.
- C Modeling clay.
- C Vacuum box for drawing a vacuum around Tedlar bag for sample collection (1 per sampling team).
- C Gilian pump Model HFS113A adjusted to approximately 3.0 L/min (1 to 2 per sample team).
- C 1/4" Teflon tubing, 2 ft to 3 ft lengths, for replacement of contaminated sample line.
- C 1/4" Tygon tubing, to connect Teflon tubing to probes and quick connect fittings.
- C Tedlar bags, 1.0 L, at least 1 bag per sample point.
- C Soil Gas Sampling labels, field data sheets, logbook, etc.
- C PID/FID, or other field air monitoring devices, (1 per sampling team).
- C Ice chest, for carrying equipment and for protection of samples (2 per sampling team).
- C Metal detector or magnetometer, for detecting underground utilities/pipes/drums (1 per sampling team).
- C Photovac GC, for field-lab analysis of bagged samples.
- C Summa canisters (plus their shipping cases) for sample, storage and transportation.
- C Large dark plastic garbage bags

5.2 Power Hammer Method

- C Bosch demolition hammer.
- C 1/2" O.D. steel probes, extensions, and points.
- C Dedicated aluminum sampling points.
- C Teflon tubing, 1/4".
- C "Quick Connect" fittings to connect sampling probe tubing, monitoring instruments, and Gilian pumps to appropriate fittings on vacuum box.
- C Modeling clay.
- C Vacuum box for drawing a vacuum around Tedlar bag for sample collection (1 per sampling team).
- C Gilian pump Model HFS113A adjusted to approximately 3.0 L/min (1 to 2 per sample team).
- C 1/4" Teflon tubing, 2 ft to 3 ft lengths, for

- C replacement of contaminated sample line.
- C 1/4" Tygon tubing, to connect Teflon tubing to probes and quick connect fittings.
- C Tedlar bags, 1.0 L, at least 1 bag per sample point.
- C Soil Gas Sampling labels, field data sheets, logbook, etc.
- C HNu Model P1101, or other field air monitoring devices, (1 per sampling team).
- C Ice chest, for carrying equipment and for protection of samples (2 per sampling team).
- C Metal detector or magnetometer, for detecting underground utilities/pipes/drums (1 per sampling team).
- C Photovac GC, for field-lab analysis of bagged samples.
- C Summa canisters (plus their shipping cases) for sample, storage and transportation.
- C Generator w/extension cords.
- C High lift jack assembly for removing probes.

5.3 Geoprobe™ Method

The Geoprobe is a hydraulically-operated sampling device mounted in a customized four-wheel drive vehicle. The sampling device can be deployed from the truck and positioned over a sample location. The base of the sampling device is positioned on the ground. The weight of the vehicle is hydraulically raised on the base. As the weight of the vehicle is transferred to the probe, the probe is pushed into the ground. A built-in hammer mechanism allows the probe to be driven past some dense stratigraphic horizons. When the probe reaches the sample depth, up to 50 feet under favorable geologic situations, samples can be collected.

Soil gas can be collected from specific depths in two general ways. One method involves withdrawing a sample directly from the probe rods, after evacuating a sufficient volume of air from the probe rods. The other method involves collecting a sample through tubing attached by an adaptor to the bottom probe rod section. Correctly used, this method provides more reliable results. Manufacturer's instructions and the SOP for the Model 5400 Geoprobe™ Operation should be followed when using this method.

6.0 REAGENTS

- C PID/FID or calibration gases for field air monitoring devices (such as methane and

- C isobutylene).
- C Deionized organic-free water, for decontamination.
- C Methanol, HPLC grade, for decontamination.
- C Ultra-zero grade compressed air, for field blanks.
- C Standard gas preparations for Photovac GC calibration and Tedlar bag spikes.
- C Propane Torch (for decontamination of steel probes)

7.0 PROCEDURES

7.1 Soil Gas Well Installation

1. Initially a hole slightly deeper than the desired depth is made. For sampling up to 5 feet, a 5-ft single piston slam bar is used. For deeper depths, a piston slam bar with threaded 4-foot-long extensions can be used. Other techniques can be used, so long as holes are of narrow diameter and no contamination is introduced.
2. After the hole is made, the slam bar is carefully withdrawn to prevent collapse of the walls of the hole. The soil gas probe is then inserted.
3. It is necessary to prevent plugging of the probe, especially for deeper holes. A metal wire or cable, slightly longer than the probe, is placed in the probe prior to inserting into the hole. The probe is inserted to full depth, then pulled up three to six inches, then cleared by moving the cable up and down. The cable is removed before sampling.
4. The top of the sample hole is sealed at the surface against ambient air infiltration by using modeling clay molded around the probe at the surface of the hole.
5. If conditions preclude hand installation of the soil gas wells, the power driven system may be employed. The generator powered demolition hammer is used to drive the probe to the desired depth (up to 12 Ft may be attained with extensions). The probe is pulled up 1-3 inches if the retractable point is used. No clay is needed to seal the hole. After sampling, the probe is retrieved using

the high lift jack assembly.

6. If semi-permanent soil gas wells are required, the dedicated aluminum probe points are used. These points are inserted into the bottom of the power driven probe and attached to the Teflon tubing. The probe is inserted as in step 5. When the probe is removed, the point and Teflon tube remain in the hole, which may be sealed by backfilling with clean sand, soil, or bentonite.

7.2 Screening with Field Instruments

1. The well volume must be evacuated prior to sampling. Connect the Gilian pump, adjusted to 3.0 L/min, to the sample probe using a section of Teflon tubing as a connector. The pump is turned on, and a vacuum is pulled through the probe for approximately 15 seconds. Longer time is required for sample wells of greater depths.
2. After evacuation, the monitoring instrument(s) (i.e. HNu or OVA) is connected to the probe using a Teflon connector. When the reading is stable, or peaks, the reading is recorded on soil gas data sheets.
3. Of course, readings may be above or below the range set on the field instruments. The range may be reset, or the response recorded as a greater than or less than figure. Recharge rate of the well with soil gas must be considered when resampling at a different range setting.

7.3 Tedlar Bag Sampling

1. Follow step 7.2.1 to evacuate well volume. If air monitoring instrument screening is performed prior to sample taking, evacuation is not necessary.
2. Use the vacuum box and sampling train (Figure 1) to take the sample. The sampling train is designed to minimize the introduction of contaminants and losses due to adsorption. All wetted parts are either Teflon or stainless steel. The vacuum is drawn indirectly to avoid contamination from sample pumps.

3. The Tedlar bag is placed inside the vacuum box, and attached to the sampling port. The sample probe is attached to the sampling port via Teflon tubing and a "Quick Connect" fitting.
4. A vacuum is drawn around the outside of the bag, using a Gilian pump connected to the vacuum box evacuation port, via Tygon tubing and a "Quick Connect" fitting. The vacuum causes the bag to inflate, drawing the sample.
5. Break the vacuum by removing the Tygon line from the pump. Remove the bagged sample from the box and close valve. Record data on data sheets or in logbooks. Record the date, time, sample location ID, and the PID/FID instrument reading(s) on sample bag label.

CAUTION: Labels should not be pasted directly onto the bags, nor should bags be labeled directly using a marker or pen. Inks and adhesive may diffuse through the bag material, contaminating the sample. Place labels on the edge of the bags, or tie the labels to the metal eyelets provided on the bags. Markers with inks containing volatile organics (i.e., permanent ink markers) should not be used.

Chain of Custody Sheets must accompany all samples submitted to the field laboratory for analysis.

7.4 Tenax Tube Sampling

Samples collected in Tedlar bags may be adsorbed onto Tenax tubes for further analysis by GC/MS.

7.4.1 Additional Apparatus

- A. Syringe with a luer-lock tip capable of drawing a soil gas or air sample from a Tedlar bag onto a Tenax/CMS sorbent tube. The syringe capacity is dependent upon the volume of sample begin drawn onto the sorbent tube.
- B. Adapters for fitting the sorbent tube between the Tedlar bag and the sampling syringe. The adapter attaching the Tedlar bag to the sorbent tube consists of a reducing union (1/4" to 1/16" O.D. -- Swagelok cat. #

SS-400-6-ILV or equivalent) with a length of 1/4" O.D. Teflon tubing replacing the nut on the 1/6" (Tedlar bag) side. A 1/4" I.D. silicone O-ring replaces the ferrules in the nut on the 1/4" (sorbent tube) side of the union.

The adapter attaching the sampling syringe to the sorbent tube consists of a reducing union (1/4" to 1/16" O.D. -- Swagelok Cat. # SS-400-6-ILV or equivalent) with a 1/4" I.D. silicone O-ring replacing the ferrules in the nut on the 1/4" (sorbent tube) side and the needle of a luer-lock syringe needle inserted into the 1/16" side. (Held in place with a 1/16" ferrule.) The luer-lock end of the needle can be attached to the sampling syringe. It is useful to have a luer-lock on/off valve situated between the syringe and the needle.

- C. Two-stage glass sampling cartridge (1/4" O.D. x 1/8" I.D. x 5 1/8") contained in a flame-sealed tube (Manufacturer: Supelco Custom Tenax/Spherocarb Tubes) containing two sorbent sections retained by glass wool:

Front section: 150 mg of Tenax-GC
 Back section: 150 mg of CMS (Carbonized Molecular Sieve)

These tubes are prepared and cleaned in accordance with EPA Method EMSL/RTP-SOP-EMD-013 by the vendor. The vendor sends ten tubes per lot made to the REAC GC/MS Laboratory and they are tested for cleanliness, precision, and reproductability.

- D. Teflon-capped culture tubes or stainless steel tube containers for sorbent tube storage and shipping. These containers should be conditioned by baking at 120 degrees C for at least two hours. The culture tubes should contain a glass wool plug to prevent sorbent tube breakage during transport. Reconditioning of the containers should occur between uses or after extended periods of disuse (i.e., two weeks or more).
- E. Nylon gloves or lint-free cloth. (Hewlett Packard Part # 8650-0030 or equivalent.)

7.4.2 Sample Collection

Handle sorbent tubes with care, using nylon gloves (or other lint-free material) to avoid contamination.

Immediately before sampling, break one end of the sealed tube and remove the Tenax cartridge.

Connect the valve on the Tedlar bag to the sorbent tube adapter. Connect the sorbent tube to the sorbent tube adapter with the Tenax (white granular) side of the tube facing the Tedlar bag. Connect the sampling syringe assembly to the CMS (black) side of the sorbent tube. Fittings on the adapters should be finer-tight. Open the valve on the Tedlar bag. Open the on/off valve of the sampling syringe. Depending on work plan stipulations, at least 10% of the soil gas samples analyzed by this GC method must be submitted for confirmational GC/MS analysis (according to modified methods TO-1 [Tenax absorbent] and TO-2 [Carbon Molecular Sieve (CMS) absorbent]). Each soil gas sample must be absorbed on replicate Tenax/CMS tubes. The volume absorbed on a Tenax/CMS tube is dependent on the total concentration of the compounds measured by the photovac/GC or other applicable GC:

<u>Total Concentration (ppm)</u>	<u>Sample Volume (mL)</u>
>10	Use Serial Dilution
10	10 - 50
5	20-100
1	100-250

After sampling, remove the tube from the sampling train with gloves or a clean cloth. DO NOT LABEL OR WRITE ON THE TENAX/CMS TUBE.

Place the sorbent tube in a conditioned stainless steel tube holder or culture tube. Culture tube caps should be sealed with Teflon tape.

7.4.3 Sample Labeling

Each sample tube container (not tube) must be labeled with the site name, sample station number, date sampled, and volume sampled.

Chain of custody sheets must accompany all samples to the laboratory.

7.4.4 Quality Assurance (QA)

Before field use, a QA check should be performed on each batch of sorbent tubes by analyzing a tube by thermal desorption/cryogenic trapping GC/MS.

At least one blank sample must be submitted with each set of samples collected at a site. This trip blank must be treated the same as the sample tubes except no sample will be drawn through the tube.

Sample tubes should be stored out of UV light (i.e., sunlight) and kept on ice until analysis. Samples should be taken in duplicate, when possible.

7.5 Summa Canister Sampling

1. Follow step 7.2.1 to evacuate well volume. If PID/FID readings were taken prior to taking a sample, evacuation is not necessary.
2. Attach a certified clean, evacuated 6-liter Summa canister via the 1/4" Teflon tubing.
3. Open valve on Summa canister. The soil gas sample is drawn into the canister by pressure equilibration. The approximate sampling time for a 6 liter canister is 20 minutes.
4. Site name, sample location, number, and date must be recorded on a chain of custody form and on a blank tag attached to the canister.

8.0 CALCULATIONS

8.1 Field Screening Instruments

Instrument readings are usually read directly from the meter. In some cases, the background level at the soil gas station may be subtracted:

$$\text{Final Reading} = \text{Sample Reading} - \text{Background}$$

8.2 Photovac GC Analysis

Calculations used to determine concentrations of individual components by Photovac GC analysis are beyond the scope of this SOP and are covered in ERT SOP #2109, *Photovac GC Analysis for Soil Water and Air/Soil Gas*.

9.0 CALIBRATION

9.1 Field Instruments

It is recommended that the manufacturers' manuals be consulted for correct use and calibration of all instrumentation.

9.2 Gilian Model HFS113A Air Sampling Pumps

Flow should be set at approximately 3.0 L/min; accurate flow adjustment is not necessary. Pumps should be calibrated prior to bringing into the field.

10.0 QUALITY ASSURANCE/ QUALITY CONTROL

10.1 Sample Probe Contamination

Sample probe contamination is checked between each sample by drawing ambient air through the probe via a Gilian pump and checking the response of the FID/PID. If readings are higher than background, replacement or decontamination is necessary.

Sample probes may be decontaminated simply by drawing ambient air through the probe until the HNu reading is at background. More persistent contamination can be washed out using methanol and water, then air drying. For persistent volatile contamination, use of a portable propane torch may be needed. Using a pair of pliers to hold the probe, run the torch up and down the length of the sample probe for approximately 1-2 minutes. Let the probe cool before handling. When using this method, make sure to wear gloves to prevent burns. Having more than one probe per sample team will reduce lag times between sample stations while probes are decontaminated.

10.2 Sample Train Contamination

The Teflon line forming the sample train from the probe to the Tedlar bag should be changed on a daily basis. If visible contamination (soil or water) is drawn into the sampling train, it should be changed immediately. When sampling in highly contaminated areas, the sampling train should be purged with ambient air, via a Gilian pump, for approximately 30 seconds between each sample. After purging, the

sampling train can be checked using an FID or PID, or other field monitoring device, to establish the cleanliness of the Teflon line.

10.3 FID/PID Calibration

The FID and PIDs should be calibrated at least once a day using the appropriate calibration gases.

10.4 Field Blanks

Each cooler containing samples should also contain one Tedlar bag of ultra-zero grade air, acting as a field blank. The field blank should accompany the samples in the field (while being collected) and when they are delivered for analysis. A fresh blank must be provided to be placed in the empty cooler pending additional sample collection. One new field blank per cooler of samples is required. A chain of custody sheet must accompany each cooler of samples and should include the blank that is dedicated to that group of samples.

10.5 Trip Standards

Each cooler containing samples should contain a Tedlar bag of standard gas to calibrate the analytical instruments (Photovac GC, etc.). This trip standard will be used to determine any changes in concentrations of the target compounds during the course of the sampling day (e.g., migration through the sample bag, degradation, or adsorption). A fresh trip standard must be provided and placed in each cooler pending additional sample collection. A chain of custody sheet should accompany each cooler of samples and should include the trip standard that is dedicated to that group of samples.

10.6 Tedlar Bag Check

Prior to use, one bag should be removed from each lot (case of 100) of Tedlar bags to be used for sampling and checked for possible contamination as follows: the test bag should be filled with ultra-zero grade air; a sample should be drawn from the bag and analyzed via Photovac GC or whatever method is to be used for sample analysis. This procedure will ensure sample container cleanliness prior to the start of the sampling effort.

10.7 Summa Canister Check

From each lot of four cleaned Summa canisters, one is to be removed for a GC/MS certification check. If the canister passes certification, then it is re-evacuated and all four canisters from that lot are available for sampling.

If the chosen canister is contaminated, then the entire lot of four Summas must be recleaned, and a single canister is re-analyzed by GC/MS for certification.

10.8 Options

10.8.1 Duplicate Samples

A minimum of 5% of all samples should be collected in duplicate (i.e., if a total of 100 samples are to be collected, five samples should be duplicated.) In choosing which samples to duplicate, the following criteria applies: if, after filling the first Tedlar bag, and, evacuating the well for 15 seconds, the second HN (or other field monitoring device being used) reading matches or is close to (within 50%) the first reading, a duplicate sample may be taken.

10.8.2 Spikes

A Tedlar bag spike and Tenax tube spike may be desirable in situations where high concentrations of contaminants other than the target compounds are found to exist (landfills, etc.). The additional level of QA/QC attained by this practice can be useful in determining the effects of interferences caused by these non-target compounds. Summa canisters containing samples are not spiked.

11.0 DATA VALIDATION

11.1 Blanks (Field and Tedlar Bag Check)

For each target compound, the level of concentration found in the sample must be greater than three times the level (for that compound) found in the field blank which accompanied that sample to be considered valid. The same criteria apply to target compounds detected in the Tedlar bag pre-sampling contamination check.

12.0 HEALTH AND SAFETY CONSIDERATIONS

Due to the remote nature of sampling soil gas, special considerations can be taken with regard to health and safety. Because the sample is being drawn from underground, and no contamination is introduced into the breathing zone, soil gas sampling usually occurs in Level D. Ambient air is constantly monitored using the HNu PI101 to obtain background readings during the sampling procedure. As long as the levels in ambient air do not rise above background, no upgrade of the level of protection is needed.

When conducting soil gas sampling, leather gloves should be worn, and proper slam bar techniques should be implemented (bend knees). Also, an underground utility search should be performed prior to sampling. (See Section 4.5).

13.0 REFERENCES

Gilian Instrument Corp., Instruction Manual for Hi Flow Sampler: HFS113, HFS 113 T, HFS 113U, HFS 113 UT, 1983.

HNu Systems, Inc., Instruction Manual for Model PI 101 Photoionization Analyzer, 1975.

N.J.D.E.P., Field Sampling Procedures Manual, Hazardous Waste Programs, February, 1988.

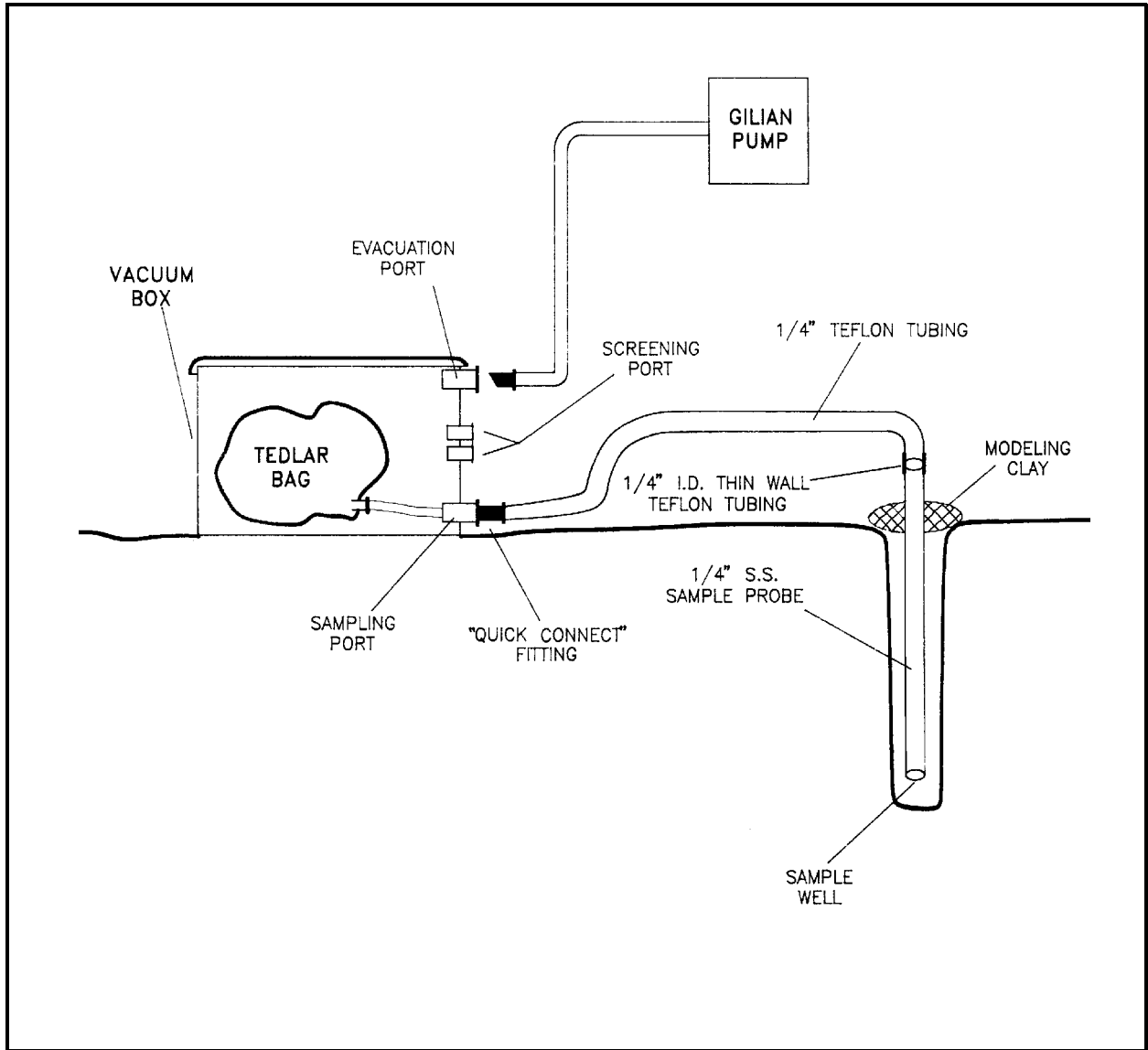
Roy F. Weston, Inc., Weston Instrumentation Manual, Volume I, 1987.

U.S.E.P.A., Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods, 2nd Edition, EPA-600/4-84-076, December, 1984.

APPENDIX A

Figure

FIGURE 1. Sampling Train Schematic



APPENDIX B

HNu Field Protocol

Field Procedure

The following sections detail the procedures that are to be followed when using the HNu in the field.

Startup Procedure

- a. Before attaching the probe, check the function switch on the control panel to ensure that it is in the off position. Attach the probe by plugging it into the interface on the top of the readout module. Use care in aligning the prongs in the probe cord with the plug in; don't force.
- b. Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery area on the scale. If not, recharge the battery. If the red indicator light comes on, the battery needs recharging.
- c. Turn the function switch to any range setting. Look into the end of the probe for no more than two to three seconds to see if the lamp is on. If it is on, it will give a purple glow. Do not stare into the probe any longer than three seconds. Long term exposure to UV light can damage eyes. Also, listen for the hum of the fan motor.
- d. To ZERO the instrument, turn the function switch to the standby position and rotate the zero adjustment until the meter reads zero. A calibration gas is not needed since this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. Wait 15 to 20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero.

Operational Check

- a. Follow the startup procedure.
- b. With the instrument set on the 0-20 range, hold a solvent-based major market near the probe tip. If the meter deflects upscale, the instrument is working.

Field Calibration Procedure

- a. Follow the startup procedure and the operational check.
- b. Set the function switch to the range setting for the concentration of the calibration gas.
- c. Attach a regulator (HNu 101-351) to a disposable cylinder of isobutylene gas (HNu 101-351). Connect the regulator to the probe of the HNu with a piece of clean Tygon tubing. Turn on the valve on the regulator.
- d. After fifteen seconds, adjust the span dial until the meter reading equals the concentration of the calibration gas used. Be careful to unlock the span dial before adjusting it. If the span has to be set below 3.0, calibration internally or return to equipment maintenance for repair.

- e. Record in the field logbook: the instrument ID no. (EPA decal or serial number if the instrument is a rental); the initial and final span settings; the date and time; concentration and type of calibration has used; and the name of the person who calibrated the instrument.

Operation

- a. Follow the startup procedure, operational check, and calibration check.
- b. Set the function switch to the appropriate range. If the concentration of gases or vapors is unknown, set the function switch to the 0-20 ppm range. Adjust it if necessary.
- c. While taking care not to permit the HNu to be exposed to excessive moisture, dirt, or contamination, monitor the work activity as specified in the Site Health and Safety Plan.
- d. When the activity is completed or at the end of the day, carefully clean the outside of the HNu with a damp disposable towel to remove any visible dirt. Return the HNu to a secure area and place on charge.
- e. With the exception of the probe's inlet and exhaust, the HNu can be wrapped in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside in the event of precipitation.

Procedure I-A-6
Investigation-Derived Waste Management

Investigation-Derived Waste Management

1. Purpose

This standard operating procedure describes the activities and responsibilities of the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific with regard to management of investigation-derived waste (IDW). The purpose of this procedure is to provide guidance for the minimization, handling, labeling, temporary storage, inventory, classification, and disposal of IDW generated under the ER Program. This procedure will also apply to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste generated during implementation of removal or remedial actions. The information presented will be used to prepare and implement work plans (WPs) for IDW-related field activities. The results from implementation of WPs will then be used to develop and implement final IDW disposal plans.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

This procedure focuses on the requirements for minimizing, segregating, handling, labeling, storing, and inventorying IDW in the field. Certain drum inventory requirements related to the screening, sampling, classification, and disposal of IDW are also noted in this procedure.

3. Definitions

3.1 IDW

IDW consists of all materials generated during site investigations that might be contaminated with chemicals of concern. IDW might consist of many types of potentially contaminated materials, including but not limited to, PPE, disposable sampling and decontamination equipment, investigation-derived soil, sludge, and sediment, well development and purge water, and decontamination fluids.

3.2 PPE

PPE, as defined in this procedure, refers to all disposable materials used to protect personnel from contact with potentially contaminated site media, such as inner and outer gloves, Tyvek suits and overboots, and disposable respirator cartridges. Non-consumable items, such as steel-toe boots, respirators, and hard hats are not included in this procedure.

3.3 DISPOSABLE SAMPLING EQUIPMENT

Disposable sampling equipment consists of all single-use equipment that might have come in contact with potentially contaminated site media, including sample bailers, Draeger air monitoring tubes, used soil sampling trowels and spatulas, plastic drop cloths, plastic bags and bucket liners, and sample containers from field analytical test kits.

3.4 INVESTIGATION-DERIVED SOIL, SLUDGE, AND SEDIMENT

Investigation-derived soil consists of all potentially contaminated soil that is disturbed as part of site investigation activities. The most commonly encountered form of IDW soil is drill cuttings brought to the ground surface by drilling. Other forms of disturbed soil, including trenching spoils and excess soil remaining from surface sampling, should not be stored as IDW. Excavated soil should be returned to its source if site conditions permit.

Investigation-derived sludge consists of all potentially contaminated sludge materials generated or disturbed during site investigation activities. Generated sludge might consist of drilling mud used or created during intrusive activities. Other sludge might include solvents or petroleum-based materials encountered at the bottom of storage tanks and grease traps.

Investigation-derived sediment consists of all potentially contaminated sediments that are generated or disturbed during site investigation activities. Generated sediments might include solids that settle out of suspension from well development, purge, or decontamination water (see Definitions 3.5 and 3.6) while stored in 55-gallon drums or during sample filtration. Disturbed sediments might also consist of catch basin sediments or excess sediment from surface water activities.

3.5 WELL DEVELOPMENT AND PURGE WATER

Development water consists of groundwater withdrawn from newly installed monitoring wells in preparation for well purging or pump testing. Monitoring well development methods are discussed in Procedure I-C-2, *Monitoring Well Development*.

Purge water consists of groundwater that is removed from monitoring wells immediately prior to sampling. Well purging methods are discussed in Procedure I-C-3, *Monitoring Well Sampling*. Groundwater derived during aquifer testing shall be addressed on a site-specific basis. Procedures for handling groundwater generated during aquifer testing shall be included in the WP or equivalent document for the CTO.

3.6 DECONTAMINATION FLUIDS

Decontamination fluids consist of all fluids used in decontamination procedures conducted during site investigation activities. These fluids consist of wash water, rinse water, and solvents used for the decontamination of non-consumable PPE, sampling equipment, and drilling equipment. Decontamination procedures are discussed in Procedure I-F, *Equipment Decontamination*.

3.7 NON-IDW TRASH

Non-IDW trash is all waste materials, such as waste paper, drink containers, food, and packaging, generated in the support zone that have not come in contact with potentially contaminated site media.

3.8 NON-INDIGENOUS IDW

Non-indigenous IDW consists of all waste materials from offsite sources that are generated in the transition or contamination reduction zones and have not come in contact with potentially contaminated site media. Non-indigenous IDW includes materials, such as PPE from “clean” field activities (e.g., field blank generation, water sampling events) and refuse from monitoring well installation (e.g., unused sections of well casing, used bentonite buckets, sand bags, and cement bags).

Non-indigenous waste does not include material/waste that is abandoned at the ER site (including the IDW waste storage area) by other parties not associated with the ER work. Disposal of abandoned material/waste in the vicinity of IDW is the responsibility of the property owner (e.g., Navy Region Hawaii) or party responsible for abandoning the material/waste. The ER contractor shall notify the Contracting Officer’s Representative (COR) of the situation as soon as possible so that recovery actions can be coordinated by the Government.

3.9 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) HAZARDOUS WASTE

Under the RCRA, a solid waste that is not excluded from regulation is defined as hazardous if it:

- Is “listed” as a hazardous waste in Chapter 40, Code of Federal Regulations (CFR), Parts 261.31 through 261.33
- Exhibits any of four hazardous “characteristics”—ignitability, corrosivity, reactivity, or toxicity (as determined using the Toxicity Characteristic Leachate Procedure [TCLP]) (40 CFR 261.20-24)
- Is subject to certain “mixture” or “derived-from” rules (40 CFR 261.3).

Under certain circumstances, petroleum- or polychlorinated biphenyl (PCB)-contaminated wastes are not considered RCRA hazardous when they only exhibit toxicity characteristic (40 CFR 261.4(b)(10) and 261.8). If IDW is determined to be RCRA hazardous waste, then RCRA storage, transport, and disposal requirements shall apply unless exempt.

3.10 RCRA LAND DISPOSAL RESTRICTIONS (LDR)

Land disposal, as defined in RCRA, is any placement of RCRA hazardous waste on the land in a waste pile, landfill, impoundment, well, land treatment area, etc. LDRs are regulatory restrictions placed on land disposal, including pre-treatment standards, engineered containment, capacity constraints, and reporting and permitting requirements.

3.11 AREA OF CONTAMINATION (AOC)

The U.S. Environmental Protection Agency (EPA) considers the RCRA AOC to be a single land-based disposal unit, usually a “landfill,” and includes non-discrete land areas in which there is generally dispersed contamination. Storing IDW in a container (i.e., portable storage devices, such as drums and tanks) within the AOC and returning it to its source, whether RCRA hazardous or not, does not trigger RCRA LDRs. In addition, sampling and direct replacement of wastes within an AOC do *not* constitute land disposal.

3.12 CERCLA HAZARDOUS SUBSTANCES

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances are listed in 40 CFR Table 302.4 and include substances regulated by the RCRA Subtitle C, Clean Water Act (CWA), Clean Air Act (CAA), and Toxic Substances Control Act (TSCA). The CFR is updated annually; therefore, the most recent CFR should be referenced for the CERCLA hazardous waste list.

CERCLA hazardous substances are defined independent of their concentration level (i.e., any detection of a listed CERCLA constituent is considered a “CERCLA hazardous substance”). “Reportable quantities” identified for chemicals in 40 CFR Table 302.4 concern only CERCLA and RCRA requirements for notification to EPA when a release has occurred; they do not dictate whether a chemical is a hazardous substance.

The definition of CERCLA hazardous substances excludes “petroleum, including crude oil or any fraction thereof;” natural gas; natural gas liquids; liquefied natural gas; and synthetic gas usable for fuel, unless specifically listed or designated under the act. Excluded fractions of crude oil contain hazardous substances, such as benzene, that are indigenous in those petroleum substances or that are normally mixed with or added to petroleum during the refining process. However, hazardous substances that are (1) added to petroleum after the refining process, (2) increase in concentration as a result of contamination of the petroleum during use, or (3) commingled with petroleum after a release to the environment, are not considered part of the petroleum exclusion provision, and therefore, are regulated under CERCLA. In addition, some waste oils are regulated under CERCLA because they are specifically listed.

The scope of CERCLA hazardous substances includes the smaller subsets of RCRA hazardous wastes, PCB Aroclors, and other constituents. Therefore, a RCRA hazardous waste is always considered a CERCLA hazardous substance for a CERCLA-driven response action; however, a CERCLA hazardous substance is not always a RCRA hazardous waste.

CERCLA only regulates releases or threats of releases of hazardous substances into the environment. If there is no evidence that (1) a release has occurred (based on site history, visual observations, background metals evaluation), (2) there is a threat of release (as from abandoned, discarded, or non-maintained chemical receptacles), or (3) the release has entered the environment (as defined below), then CERCLA does not regulate the constituent even though it is identified on the CERCLA hazardous substance list.

3.12.1 CERCLA Hazardous Substances: TSCA/PCBs

PCBs are a CERCLA hazardous substance. PCBs belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned in 1979. They have a range of toxicity and vary in consistency from thin, light-colored liquids to yellow or black waxy solids. Due to their non-flammability, chemical stability, high boiling point, and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications. Although no longer commercially produced in the United States, PCBs may be present in products and materials produced before the 1979 PCB ban.

If PCBs are detected at concentrations equal to or greater than 50 parts per million (ppm), the sample is considered TSCA-regulated. Current PCB regulations can be found in the CFR at 40 761. The EPA Q and A Manual (EPA 2009), referring to CFR 761.61 explains PCB remediation waste must be managed and disposed of based on the concentration at which the PCBs are found. It is unacceptable to dilute the as-found concentration of the contaminated soil by mixing it with clean soil during excavation or other IDW management activities.

3.13 ENVIRONMENT

Environment means navigable waters, ocean waters, surface water, groundwater, drinking water supply, land surface or subsurface strata, and ambient air, within the U.S. or under federal jurisdiction (see Section 101(8) of CERCLA or 40 CFR 300.5 for complete definition).

3.14 ONSITE AREA

The CERCLA onsite area is defined in 40 CFR 300.400(e)(1) as an area that includes:

- AOC
- All suitable areas in very close proximity to the contamination that are necessary for the implementation of the response action

The delineation of the onsite area is further discussed in Volume 55 Federal Register (FR) Page 8688 and EPA guidance.

Neither CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan, nor RCRA define the terms “area of contamination” or “contamination.” However, the area of contamination is interpreted as containing “varying types and concentrations of contaminants” (55 FR 8760) that may or may not pose a risk to human health or the environment.

The onsite area may also include several noncontiguous aerial extents of contaminations if they share a common nexus (55 FR 8690).

3.15 OFFSITE AREA

The offsite area consists of all areas outside the onsite area.

3.16 CERCLA OFFSITE RULE

The CERCLA offsite rule (400 CFR 300.440) states that IDW containing CERCLA hazardous substances (at any concentration) must be stored, treated, or disposed of offsite only at facilities having current EPA approval to accept such CERCLA wastes. RCRA-permitted facilities (Subtitle C and D) must also have specific EPA approval to accept waste generated at a CERCLA site (even if the waste is RCRA hazardous).

With some restrictions, the offsite rule does not apply to the following:

- Wastes generated during non-CERCLA actions
- Treatability study samples

- Wastes generated during emergency response actions
- Laboratory samples

CERCLA allows IDW to be managed, stored, and disposed of onsite within or near the AOC without the need for EPA approval (i.e., CERCLA facility approval) or RCRA permits. If IDW is to be stored or disposed of on site, the onsite area (and the AOC) should be delineated on a figure in the project field book and revised, based on best professional judgment, as site data become available.

4. Responsibilities

The prime contractor CTO Manager is responsible for preparing WPs and IDW disposal plans and reports in compliance with this procedure, and is responsible for documenting instances of noncompliance. The CTO Manager is responsible for ensuring that all personnel involved in sampling and/or testing shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager is responsible for implementing this IDW procedure and ensuring that all project field staff follow these procedures.

Field personnel are responsible for the implementation of this procedure.

5. IDW Management Procedures

The procedures for IDW management in the field are described below.

5.1 PLANNING FOR IDW MANAGEMENT

The project team should begin planning for IDW issues early in the site investigation planning stage. The proper management of IDW involves all of the following tasks:

- Obtain Navy approval for a designated IDW storage area prior to commencement of field work
 - Complete Navy form, including IDW Tracking Sheet and provide to remedial project manager (RPM) for processing
- Waste generation and minimization
- Chemical screening and characterization of the waste
- Waste handling, storage, and associated maintenance in compliance with all regulations (prepare an IDW drum inventory, ensure storage areas are compliant with type of waste [double containment, TSCA requirements, etc.] maintain condition of drum and labeling, maintain safety and assess controls, comply with permit requirements [for offsite storage])
- Waste transport and disposal within required holding times
- Waste tracking, documentation, record keeping, and reporting

As part of IDW planning, the CTO Manager should consult with the COR and environmental regulatory agencies to clearly identify the primary federal or state regulatory authority that is driving the site investigation. This authority may be CERCLA, RCRA (Subtitle C), RCRA (subtitle D), TSCA, CWA, or an equivalent state program. The primary investigation authority and regulations promulgated under this authority set forth requirements for IDW management. These requirements may differ under the various response authorities. For CERCLA-driven actions, IDW storage and disposal should comply with all applicable or relevant and appropriate requirements (ARARs) and to-be-considered (TBC) criteria to the extent practicable.

Lastly, the CTO Manager should consider the disposal criteria of the anticipated disposal facility when developing the sampling and analysis plan (SAP). Some offsite facilities do not accept waste that is characterized by association with samples collected from the investigation site or they may require analytical data for chemicals that are not of potential concern at the site. Facility disposal criteria may dictate laboratory reporting limits.

If unknown waste is observed onsite, notify the project RPM and COR for further instructions.

5.2 IDW MINIMIZATION

Field managers (FMs) and their designates shall minimize the generation of onsite IDW to reduce the need for special storage or disposal requirements that might result in substantial additional costs and provide little or no reduction in site risks (EPA 1992b). Reduce the volume of IDW by applying minimization practices throughout the course of site investigation activities. These minimization strategies include substitution of biodegradable raw materials; using low-volume IDW-generating drilling techniques; where possible, returning excess material to the source location; using disposable sampling equipment versus generating more decontamination fluids from reusable sampling equipment; using bucket and drum liners; and separating trash from IDW.

Material substitution consists of selecting materials that degrade readily or have reduced potential for chemical impacts to the site and the environment. An example of this practice is the use of biodegradable detergents (e.g., Alconox or non-phosphate detergents) for decontamination of non-consumable PPE and sampling equipment. In addition, field equipment decontamination can be conducted using isopropyl alcohol rather than hexane or other solvents (for most analytes of concern) to reduce the potential onsite chemical impacts of the decontamination solvent. Select decontamination solvents carefully so that the solvents, and their known decomposition products, are *not* potentially RCRA hazardous waste, unless absolutely necessary.

Give priority to drilling methods that minimize potential IDW generation. Select hollow-stem auger and air rotary methods, where feasible, over mud rotary methods. Mud rotary drilling produces waste drilling mud, while hollow stem and air rotary drilling methods produce relatively low volumes of soil waste. Use small-diameter borings and cores when soil is the only matrix to be sampled at the boring location; however, the installation of monitoring wells requires the use of larger-diameter borings.

If possible, return soil, sludge, or sediment removed from borings, containment areas, and shallow test trenches to the source immediately after sampling and/or geological logging of the soils (EPA 1991, 1992b). Immediate replacement of solid waste in the source location during investigation activities avoids RCRA LDRs, which permit movement of IDW within the same AOC without considering land disposal to have occurred, even if the IDW is later determined to contain RCRA

hazardous material (EPA 1991). Place soil IDW from borings and trenches on polyethylene sheeting (e.g., Visqueen) during excavation and segregate it by approximate depth and any apparent contamination (i.e., visible staining). Following excavation, replace the soil IDW from above the saturated layer into the boring or trench and compact it, if possible. Efforts should be made to return the waste to the approximate depth from which it was generated. Soil and sludge IDW generated at or below the saturated layer of a boring or trench should be placed in drums and not returned to the source area. Suspected contaminated soil and sludge IDW generated above the saturated layer of a boring or trench should not be returned below the saturated layer.”

Often monitoring wells are constructed outside the area of concern for soil contamination to sample for potential groundwater contamination or collect characteristic background data. At these locations, soil cuttings generated from above the saturation zone may be immediately disposed of near the wellhead in a shallow pit covered with natural topsoil from the site, and compacted. Contain soil and sludge IDW generated at or below the saturated layer in drums.

Reduce the quantity of decontamination rinse water generated by using dedicated and disposable sampling equipment, such as plastic bailers, trowels, and drum thieves that do not require decontamination. In general, decontamination fluids, and well development and purge water should not be minimized because the integrity of the associated analytical data might be affected.

Minimize the storage of visibly soiled PPE and disposable sampling equipment IDW by implementing decontamination procedures. If, based upon the best professional judgment of the FM, the PPE and disposable sampling equipment can be rendered non-contaminated after decontamination, then double-bag the PPE and disposable sampling equipment and dispose of it off site at a (RCRA Subtitle D) municipal solid waste disposal facility at the end of each work day (EPA 1991, 1992b). Since the decontaminated waste does not contain CERCLA hazardous substances, it need not be disposed of at a CERCLA-approved disposal facility in accordance with the CERCLA offsite rule.

Bucket liners can be used in the decontamination program to reduce the volume of solid IDW generated, and reduce costs on larger projects. The plastic bucket liners can be crushed into a smaller volume than the buckets, and only a small number of plastic decontamination buckets are required for the entire project. The larger, heavy-duty, 55-gallon drum liners can be used for heavily contaminated IDW to provide secondary containment, and reduce the costs of disposal and drum recycling. Drum liners may extend the containment life of the drums in severe climates and will reduce the costs of cleaning out the drums prior to recycling.

All waste materials generated in the support zone are considered non-IDW trash. To minimize the total volume of IDW, separate all trash from IDW, seal it in garbage bags, and properly dispose of it off site as municipal waste at the end of each work day.

Keep excess cement, sand, and bentonite grout prepared for monitoring well construction to a minimum. FMs shall observe well construction to ensure that a sufficient, but not excessive, volume of grout is prepared. Some excess grout may be produced. Unused grout (that should not come in contact with potentially contaminated soil or groundwater) shall be considered non-hazardous trash, and the drilling subcontractor shall dispose of it off site. Surplus materials from monitoring well installation, such as scrap plastic sections, used bentonite buckets, and cement/sand bags that do not

come in contact with potentially contaminated soil, shall be considered non-IDW trash, the drilling subcontractor shall dispose of it off site.

Following proper segregation procedures, as discussed in the next section, can minimize the quantity of contaminated IDW generated.

5.3 SEGREGATION OF IDW BY MATRIX AND LOCATION

It is necessary to properly segregate IDW in order to:

- Avoid commingling contaminated waste with clean waste, thereby creating a larger volume of waste that must be treated as contaminated
- Facilitate the sampling, screening, classification, and disposal of waste that may require different management methods

Take efforts to segregate IDW even when these activities will increase storage container and storage space requirements. These efforts will drastically reduce the sampling and documentation required for characterizing the waste and their associated costs.

In general, segregate IDW by matrix and source location and depth at the time it is generated. IDW from only one matrix shall be stored in a single drum (e.g., soil, sediment, water or PPE shall *not* be mixed in one drum). Groundwater and decontamination water should not be commingled; however, development and purge water from the same well may be stored together.

In general, IDW from separate sources should not be combined in a single drum or stockpile. Take efforts to segregate waste by increments of depth below ground surface. Most importantly, segregate soil IDW generated at or from below the saturated zone from soil generated above this zone (soil below this zone might be impacted by contaminated groundwater, whereas soil above the zone may be “clean”). Similarly, segregate soil above and below an underground storage tank (UST). Label each drum of soil to indicate the approximate depth range from which it was generated; this task may require cuttings to be segregated on plastic sheeting as they are generated or drums to be filled during the trenching or boring operation if this can be done in a safe manner.

It is possible that monitoring well development and purge water will contain suspended solids, which will settle to the bottom of the storage drum as sediment. Include significant observations on the turbidity or sediment load of the development or purge water in the logbook see Procedure III-D, *Logbooks* and Section 5.5). To avoid mixed matrices in a single drum (i.e., sediment and water), it may be necessary to decant the liquids into a separate drum after the sediments have settled out. This segregation may be accomplished during subsequent IDW sampling activities or during consolidation in a holding tank prior to disposal.

Place potentially contaminated well construction materials in a separate drum. No soil, sediment, sludge, or liquid IDW shall be placed in drums with potentially contaminated waste well construction materials. In addition, potentially contaminated well construction materials from separate monitoring wells shall not be commingled.

Store potentially contaminated PPE and disposable sampling equipment in drums separate from other IDW. Segregate PPE from generally clean field activities, such as water sampling, from visibly

soiled PPE, double-bag it, and dispose of it off site as municipal waste. Disposable sampling equipment from activities, such as soil, sediment, and sludge sampling, includes plastic sheeting used as liner material in containment areas around drilling rigs and waste storage areas, disposable sampling equipment, and soiled decontamination equipment. If, according to the Field Manager's best professional judgment, the visibly soiled PPE can be decontaminated and rendered non-hazardous, then double-bag the decontaminated PPE and disposed of it off site as municipal waste (EPA 1991, 1992b). PPE and disposable sampling equipment generated on separate days in the field may be combined in a single drum, provided clean and visibly soiled IDW are segregated as discussed above.

IDW generated from the use of field analytical test kits consists of those parts of the kit that have come into contact with potentially contaminated site media, and used or excess extracting solvents and other reagents. Contain potentially contaminated solid test kit IDW in plastic bags and store it with contaminated PPE or disposable sampling equipment IDW from the same source area as soil material used for the analyses. Segregate the small volumes of waste solvents, reagents, and water samples used in field test kits, and dispose of it accordingly (based upon the characteristics of the solvents as described in this procedure). Most other test kit materials should be considered non-IDW trash, and be disposed of as municipal waste.

Store decontamination fluids in drums separate from groundwater and other IDW. If practical, decontamination fluids generated from different sources should not be stored in the same drum. If decontamination fluids generated over several days or from different sources are stored in a single drum, record information about the dates and IDW sources represented in the drum. Note this information in the field notebook, on the drum label (Section 5.4.3), and in the drum inventory (Section 5.5).

The FM and designated personnel should separate the liquid and sediment portions of the equipment decontamination fluid present in the containment unit used by the drilling or excavation field crew. The contents of this unit normally consist of turbid decontamination fluid above a layer of predominantly coarse-grained sediment. When the contents of the containment unit are to be removed for storage in IDW drums, the FM shall instruct the field crew to place as much of the liquid into drums as possible and transfer the remaining solids into separate drums. Note observations of the turbidity and sediment load of the liquid IDW in the field notebook, on the drum label (Section 5.4.3), and in attachments to the drum inventory (Section 5.5). It is likely that decontamination fluids will contain minor amounts of suspended solids that will settle out of suspension to become sediment at the bottom of IDW storage drums. As noted above, it may be necessary to segregate the drummed water from sediment during subsequent IDW sampling or disposal activities.

Documentation for waste storage containers should include IDW source and segregation information and be maintained as follows:

1. Field logbook should be updated, at least weekly, with all IDW drum additions – update storage area location map to include new drum position and drum number.
2. External drum log (hard copy and electronic copy) should be updated with each IDW drum addition (drum numbers, source, and generation date) and closure of drum (fill date).

5.4 DRUM FILLING, HANDLING, AND LABELING, AND INVENTORYING

Drum handling consists of those actions necessary to prepare an IDW drum for labeling. Drum labeling consists of those actions required to legibly and permanently identify the contents of an IDW drum.

5.4.1 Drum Filling

Each drum of solid IDW shall be completely filled, when possible. For liquid IDW, drums should be left with headspace of approximately 5 percent by volume to allow for expansion of the liquid and potential volatile contaminants.

5.4.2 Drum Handling

IDW shall be containerized using U.S. Department of Transportation-(DOT) approved drums. The drums shall be made of steel or plastic, have a 55-gallon capacity, be completely painted or opaque, and have removable lids (i.e., United Nations Code 1A2 or 1H2). Drums having removable lids with bung holes are preferred to facilitate verification of drum contents. Typically 55-gallon drums are used, however small drums may be used depending on the amount of waste generated. New steel drums are preferred over recycled drums. Recycled drums should not be used for hazardous waste, PCBs or other regulated shipments. For short-term storage of liquid IDW prior to discharge, double-walled bulk steel or plastic storage tanks may be used. For this scenario, consider the scheduling and cost-effectiveness of this type of bulk storage, treatment, and discharge system versus longer-term drum storage.

The Guam Environmental Protection Agency may require double-walled drums or other secondary containment for the storage of liquid IDW. For long-term IDW storage at other project locations, the DOT-approved drums with removable lids are recommended. Verify the integrity of the foam or rubber sealing ring located on the underside of some drum lids prior to sealing drums containing IDW liquids. If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, select another drum lid with a sealing ring that is in sound condition.

To prepare IDW drums for labeling, wipe clean the outer wall surfaces and drum lids of all material that might prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, wipe that material from the drum, and segregate the paper towel or rag used to remove the material with visibly soiled PPE and disposable sampling equipment. Label all IDW drums and place them on appropriate pallets prior to storage.

5.4.3 Drum Labeling

Proper labeling of IDW drums is essential to the success and cost-effectiveness of subsequent waste screening and disposal activities (see Attachment I-A-6-1 and Attachment I-A-6-2). Labels shall be permanent and descriptive to facilitate correlation of field analytical data with the contents of individual IDW drums. Label all IDW drums using the **three distinct labeling methods** described below to ensure durability of the information. These three methods are completing and affixing preprinted NAVFAC Pacific ER Program labels; marking information on drum surfaces with paint; and, affixing aluminum tags to the drum. **Use of the preprinted labels, painted labeling, and aluminum tags is mandatory.** These methods are described below.

5.4.3.1 PREPRINTED LABELS

Complete **two** preprinted NAVFAC Pacific ER Program drum labels as described below and presented in Attachment I-A-6-1. Seal both labels in separate heavy-duty, clear plastic bags, or use permanent markers on weatherproof stickers, to prevent moisture damage.

1. Place one label on the outside of the drum with the label data facing outward. Affix the bag/sticker to the drum at the midpoint of the drum height using a sufficient quantity of adhesive tape (e.g., duct tape, packing/strapping tape) so the bag will remain on the drum as long as possible during storage.
2. Affix the second label (sealed as mentioned above) to the underside of the drum lid, sealing it inside the drum when the lid is replaced.

The use of two or more preprinted labels for outer IDW drum identification purposes should be considered as a short-term backup to the information on the aluminum tags discussed below.

Print the requested information legibly on the drum labels in black, indelible ink. Instructions for entering the required drum-specific information for each label field are presented below:

CTO: Enter the four-digit number of the CTO for the project during which the IDW was generated. Include any initial zeroes in the CTO number (e.g., CTO 0047).

Activity-Site: Enter the name of the Navy activity responsible for the project site (e.g., Naval Supply Center, Naval Facilities Engineering Command Hawaii) and the name of the site where the project is taking place (e.g., Orote, Landfill, Building [Bldg.] 18).

Drum#: Enter the drum identification number according to the convention described below.

(xxxx-AA-DMzzz);

Where:

- xxxx represents the four-digit CTO number
- AA represents the unique site identifier assigned by the CTO Manager for multiple site CTOs (e.g., for CTO 0047, OW denotes Old Westpac, OR denotes Orote)
- DM represents a *drum* identification number
- zzz the sequential drum number for the site, beginning with 001

Date Collected: Enter the date the IDW was generated and placed in the drum. If IDW was generated over a number of days, enter the start and end dates for the period.

Contents: Record the source identification number on the label. Enter a “√” in the box corresponding to the type of IDW placed in the drum. For “Soil” and “Water,” use the line provided to record observations on the condition of the drum contents (e.g., diesel odor, high turbidity, specific liquid IDW type). Check “Solid Waste” for PPE and indicate that PPE is present in the drum. Check

“Other” for disposable sampling equipment and potentially contaminated monitoring well construction materials, and indicate the type of waste on the line provided.

Project Type: Enter a “√” in the box corresponding to the type of investigation. Choices are Remedial Investigation, RCRA Facility Inspection, UST, and Other. If “Other” is specified, indicate the type of project in the “Comments” area, as described below.

Comments: Enter any additional information regarding the drum contents that will assist individuals who will characterize and dispose of the contents of the drum. “Other” project types include Site Inspection, Feasibility Study, Removal/Remedial Action, and Emergency Response activity. In addition, use this space on the label to complete any descriptions that were too large to fit in preceding label fields, such as the turbidity of decontamination water or the site activities from which the PPE was generated.

For Information Contact: Enter the project COR activity / code, address, and phone number.

It is essential that all relevant information recorded on individual drum labels be repeated in the field notebook for later development of the drum inventory database (see Section 5.5 and Procedure III-D, *Logbooks*).

5.4.3.2 PAINTED LABELS

The second method for labeling drums is to paint label information directly on the outer surface of the drum. At a minimum, the information placed on the drum shall include the CTO number, the drum number (following the numbering convention given above), the source identification number and type, the generation date(s), and the telephone number provided at the bottom of the preprinted label appropriate for the project location. The drum surface shall be dry and free of material that could prevent legible labeling. Confine label information to the upper two-thirds of the total drum height. The top surface of the drum lid may be used as an additional labeling area, but this area should only be used *in addition* to the upper two-thirds of the sides of the drum. The printing on the drum shall be large enough to be easily legible. Yellow, white, black, or red paint markers (oil-based enamel paint) that are non-photodegradable are recommended to provide maximum durability and contrast with the drum surface.

5.4.3.3 ALUMINUM TAGS

The third method for labeling drums is to affix an aluminum tag to the drum with neatly printed information that shall consist of the **CTO number**, the **drum identification number**, the **type of contents**, the **generation date(s)**, the **source** identification number and type, and the **telephone number** provided at the bottom of the appropriate preprinted label. Attachment I-A-6-2 to this procedure presents an example of the aluminum tag, which shall measure approximately 1 inch by 3 inches, or larger. When a ballpoint pen is used to fill out the aluminum tag, the information is permanently recorded as indentations on the tag. A fine ballpoint pen shall be used, and block-printed lettering is required for legibility. Indentations on the tag shall be sufficiently deep to be legible after the label has been exposed to weathering for an extended period.

Complete aluminum tags after the drum has been sealed. Affix the tags to the drum using a wire, which passes through predrilled holes in the label and shall be wrapped around the bolt used to seal the drum lid. The wire is the most likely part of the aluminum tag to decay during exposure. Use of

plastic insulated, copper-core electrical wire of appropriate diameter is recommended if long-term exposure to severe weathering is anticipated.

5.4.3.4 WASTE LABELS

Standard green and white non-hazardous and/or other hazardous waste stickers may be used in conjunction with, but not in lieu of, the above labeling procedures.

5.5 DRUM INVENTORY

Accurate preparation of an IDW drum inventory is essential to all subsequent activities associated with IDW drum tracking and disposal. Prepare an inventory for each project in which IDW is generated, stored, and disposed of. This information provided in the inventory report constitutes the results of preparing and implementing an IDW sampling, screening, characterization, and disposal program for each site.

The drum inventory information shall include 10 elements that identify drum contents and indicate their outcome. These elements are discussed in Sections 5.5.1 through 5.5.10.

5.5.1 Navy Activity (Generator)/Site Name

Inventory data shall include the Navy activity and the site name where the IDW was generated (e.g., Fleet Industrial Supply Center Pearl/Red Hill, Naval Magazine Headquarters/USTs).

5.5.2 CTO Number

Inventory data shall include the four-digit CTO number associated with each drum (e.g., 0089) and contract number as necessary.

5.5.3 Drum Number

Include the drum number assigned to each drum in the inventory database. Drum numbers shall adhere to the numbering convention presented in Section 5.4.3.1 (e.g., 0091-LF-DM006).

5.5.4 Storage Location Prior to Disposal

Include the storage location of each drum prior to disposal in the inventory database (e.g., Bldg. 394 Battery Disassembly Area, or Adjacent to West end of Bldg. 54). As part of the weekly inventory, a site visit to the IDW storage location shall be performed to observe the condition of the drums and covers. Drums and covers are considered acceptable when the integrity of the drums and covers are structurally intact, drum identification is legible, and the location of the drum storage is secure. An unacceptable classification will require recommendations to remedy the unacceptable classification.

5.5.5 Origin of Contents

Specify the source identification of the contents of each IDW drum in the inventory database (e.g., soil boring number, monitoring well number, sediment sampling location, or the multiple sources for PPE- or rinse water-generating activities).

5.5.6 IDW Type

Inventory data shall include the type of IDW in each drum (e.g., soil, PPE, disposable sampling equipment, sludge, sediment, development water, steam cleaning water, decontamination rinse water).

5.5.7 Waste Volume

Specify the amount of waste in each drum in the inventory database as a percentage of the total drum volume or an estimated percentage-filled level (e.g., 95 percent maximum for liquid IDW).

5.5.8 Generation Date

Inventory data shall include the date IDW was placed in each drum. If a drum contains IDW generated over more than one day, the start date for the period shall be specified in dd-mmm-yy format. This date is *not* to be confused with a RCRA hazardous waste accumulation date (40 CFR 262).

5.5.9 Expected Disposal Date

Specify the date each drum is expected to be disposed of as part of the inventory in mmm-yy format. This date is for the Navy's information only and shall not be considered contractually binding.

5.5.10 Actual Disposal Date

The actual drum disposal date occurs at the time of onsite disposal, or acceptance by the offsite treatment or disposal facility. Enter this date in the drum inventory data base only when such a date is available in dd-mmm-yy format.

Information required to complete all 10 of the inventory elements for the monthly inventory report described above and summarized in Attachment I-A-6-3, will be located on the IDW labels or provided by the CTO Manager.

Actual disposition of the IDW drum contents will be provided to the Navy.

5.6 IDW CLASSIFICATION

In general, the CTO Manager should follow IDW classification guidance contained in the *Generic IDW Disposal Plans* for Hawaii and Guam (Ogden 1994, 1995) and EPA guidance (EPA 1991, 1992a). The IDW classification process consists of chemical screening and characterization of the waste.

Various federal and state laws and guidance contain requirements for IDW management (handling, storage, transport, disposal, and recordkeeping) based on the type(s) and concentrations of chemicals present in the waste. To ensure that IDW is managed in compliance with these requirements and to evaluate disposal options, the CTO Manager should

- Directly sample and analyze the IDW or associate it with historical data, observed site conditions, and/or samples collected on site at the source of the waste
- Screen the waste to identify the maximum concentrations of individual chemicals in, or associated with, the waste

- Screen waste constituents against chemical background data, if available
- Characterize the waste based on regulated groups of chemical constituents present in the waste
- Screen waste constituents against risk-based health criteria, ARARs, and TBC criteria for onsite disposal, or disposal facility criteria for offsite disposal

Each of the above steps is distinct and should be performed separately to avoid potential mistakes in the IDW classification process. The following subsections discuss these steps in greater detail.

5.6.1 IDW Sampling and Chemical Screening

IDW should be screened to identify chemicals present in the waste and their maximum concentrations. Screening may be facilitated by (1) directly sampling the waste, (2) associating the waste with analytical results from samples collected at the source of the IDW (e.g., a well boring), (3) visual observation of the waste, (4) historical activity data from the site, or (5) a combination of these methods (e.g., association with limited sampling). Composite sampling may be required if the unit volume of IDW is non-homogeneous. Data from samples collected directly from the IDW should take precedence over associated site sample data when making waste management decisions. Procedure I-D-1, *Drum Sampling* discusses methods for drum sampling.

Typically, IDW is screened for chemicals of potential concern at the site and against background data if available. If IDW is generated from outside the suspected AOC (e.g., soil cuttings from the installation of a background monitoring well), assume it is clean, and dispose of it accordingly.

The CTO Manager should consider the disposal criteria of any offsite disposal facility anticipated to be used when developing the SAP. Some offsite facilities do not accept waste that is characterized by association with samples collected from the investigation site or they may require analytical data for chemicals that are not of potential concern at the site. Direct sampling and analysis of the waste may be required for these other constituents. Some disposal facilities prefer to collect and analyze the samples themselves. In addition, disposal facility criteria may dictate laboratory reporting limits. When possible, the CTO Manager should coordinate sampling and data requirements with the disposal subcontractor and anticipated disposal facility. Such efforts may allow IDW sampling to be conducted while the field team is mobilized for the site investigation, rather than conducting a separate IDW sampling event later.

5.6.2 IDW Characterization

Various federal and state laws and guidance contain requirements for IDW management (handling, storage, transport, disposal, and recordkeeping) based on the particular constituent or *group(s) of chemical constituents* present in the waste. Therefore, to ensure that IDW is managed in compliance with these requirements, characterize IDW based on the chemical screening results to determine whether any of the following regulated constituents are present in the waste:

- Petroleum hydrocarbons (regulated by RCRA Subtitle I when released from a UST; see 40 CFR Part 280)
- Hazardous wastes (regulated by RCRA Subtitle C; see 40 CFR 261-299)
- Non-hazardous, solid wastes (regulated by RCRA Subtitle D; see 40 CFR 257-258)

- Hazardous substances and commingled petroleum (regulated by CERCLA; see 40 CFR 300.400 and 302.4)
- PCBs (regulated by TSCA; see 40 CFR 700)
- Asbestos (regulated by CAA for disposal; see 40 CFR 61, Subpart M)
- Radioactive wastes (regulated by the Nuclear Regulatory Commission; see 10 CFR [various parts], 40 CFR, Subchapter F, and other applicable laws)

EPA regulations and guidance do not require IDW to be tested to properly characterize it. Instead waste may be characterized based on historical site data, site observations, analytical data from the source of the IDW, and professional judgment (EPA 1991). Specifically, the EPA has indicated that IDW may be assumed not to be “listed” wastes under RCRA unless available information about the site suggests otherwise (53 FR 51444). Similarly, RCRA procedures for determining whether waste exhibits RCRA hazardous characteristics do not require testing if the decision can be made by “applying knowledge of the hazard characteristic in light of the materials or process used” (40 CFR 262.11(c); EPA 1991). If applicable, the disposal plans and reports should state, “there is no evidence based on site data and observations that the IDW contains listed RCRA wastes or exhibits RCRA characteristics.”

For soil IDW, the potential for exhibiting toxicity may be determined by comparing constituent concentrations in the waste against screening values that are 20 times the TCLP criteria as specified in Section 1.2 of EPA Method Solid Waste-846 1311 *Toxicity Characteristic Leaching Procedure* (EPA 2007). Otherwise, samples associated with the soil can be tested using the TCLP.

5.7 IDW STORAGE

In general, the CTO Manager should follow IDW storage guidance contained in the *Generic IDW Disposal Plans* for Hawaii and Guam (Ogden 1994, 1995) and EPA guidance (EPA 1990, 1991, 1992a).

Always store IDW in a manner that is secure, protected from weather, and protective of human health and the environment. It is preferable to store IDW within the AOC(s) or on site; however, the Navy may assign a specific IDW storage area away from the project site.

If the IDW is determined to be RCRA hazardous, then RCRA storage, transport, and disposal requirements may apply, including a limited **90-day** storage permit exemption period prior to required disposal. If onsite disposal is an option, store RCRA waste within the AOC so that RCRA LDRs will not apply in the future. LDRs may be triggered if the waste is stored within the onsite area, but outside of the AOC or if the waste is removed from and later returned to the AOC for disposal. The AOC concept does not affect the approach for managing IDW that did not come from the AOC, such as PPE, decontamination equipment and fluids, and groundwater. If RCRA hazardous, these wastes must be managed under RCRA and drummed and disposed of off site (EPA 1991).

RCRA waste should not be stored within the AOC prior to disposal when professional judgment suggests the IDW might pose an immediate or permanent public endangerment (EPA 1991b).

Offsite storage of CERCLA waste must comply with the CERCLA offsite rule (40 CFR 300.440).

If the IDW is determined to be TSCA-regulated, then TSCA storage requirements as described in CFR 764.65, transport, and disposal requirements apply, including a limited **30-day** storage period prior to required disposal. Storage requirements are as follows:

1. Storage facilities must provide an adequate roof and walls to prevent rain water from reaching the stored PCBs.
2. Storage facilities must provide an adequate floor that has continuous curbing with a minimum 6-inch-high curb.
3. Storage facilities must contain no drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from the curbed area.
4. Storage facilities must provide floors and curbing constructed of continuous smooth and impervious materials to minimize penetration of PCBs.
5. Storage facilities must not be located at a site that is below the 100-year flood water elevation.
6. PCBs in concentrations of 50 ppm or greater must be disposed of within 1 year after being placed in storage.

PCB waste can also be stored in a RCRA-approved waste storage area for 30 days from date of generation.

NAVFAC Pacific requires that all CERCLA, RCRA, and other types of waste be removed from JBPHH areas within 90 days of its generation, particularly within the shipyard area, and 30 days of generation for TSCA waste. Efforts should also be made to dispose of IDW within the 30- and 90-day periods at other Navy installations, unless the IDW will be managed with remediation waste to be generated during a cleanup action in the near future. The Navy may approve extensions of the storage time limit for wastes that are non-hazardous on a project-specific basis.

5.7.1 Drum Storage

Implement drum storage procedures to minimize potential human contact with the stored IDW and prevent extreme weathering of the stored drums. Place all IDW drums upright on pallets before the drums are stored. RCRA storage requirements include the following: containers shall be in good condition and closed during storage; wastes shall be compatible with containers; storage areas shall have a containment system; and spills or leaks shall be removed as necessary.

Place all IDW drums generated during field activities at a single AOC or designated IDW storage area together in a secure, fenced onsite area to prevent access to the drums by unauthorized personnel. When a secure area is not available, place drums in an area of the site with the least volume of human traffic. At a minimum, place plastic sheeting (or individual drum covers) around the stored drums. Post signage at the IDW storage area stating that drums should not be removed from the area without first contacting the Navy COR.

Liquid IDW drums must be stored under secondary containment (either secondary containment pallets or handmade plastic sheeting/polyvinyl chloride frame containment) and all IDW drums (soil

and water) must utilize secondary containment when stored within 15 feet of a surface water body or storm drain inlet.

Drums from projects involving multiple AOCs shall remain at the respective source areas where the IDW was generated. IDW should not be transferred off site for storage elsewhere, except under rare circumstances, such as the lack of a secure onsite storage area.

Implement proper drum storage practices to minimize damage to the drums from weathering and possible human exposure to the environment. When possible, store drums in dry, shaded areas and cover them with impervious plastic sheeting or tarpaulin material. Make every effort to protect the preprinted drum labels from direct exposure to sunlight, which causes ink on the labels to fade. In addition, store drums in areas that are not prone to flooding. Secure the impervious drum covers appropriately to prevent dislodging by the wind. It may be possible to obtain impervious plastic covers designed to fit over individual drums; nonetheless, repeat the labeling information on the outside of these opaque covers.

Drums in storage shall be placed with sufficient space between rows of drum pallets and shall not be stacked, such that authorized personnel may access all drums for inspection. Proper placement will also render subsequent IDW screening, sampling, and disposal more efficient when individual drum removal is necessary. It is recommended that IDW drums be segregated in separate rows/areas by matrix (i.e., soil, liquid or PPE/other).

If repeated visits are made to the project site, inspect the IDW drums to clear encroaching vegetation, check the condition and integrity of each drum, secondary containment if applicable, check and replace aluminum tags as necessary, and replace or restore the tarpaulin covers.

5.7.2 IDW Stockpiles

Consider IDW stockpiling only when a very large quantity of IDW will be generated. Segregate stockpiled IDW, and inventory it by source location and depth to the extent practicable. Stockpiling and media mixing should not be used as methods to dilute chemical concentrations in the waste. Line stockpiles on the bottom, cover it with sturdy plastic, and locate it in areas where weather elements (e.g., wind, rainfall runoff) will not cause migration of the waste. Never dispose of liquid IDW on a stockpile; drum or store liquid waste in other appropriate containers. Follow applicable regulation and guidance when sampling stockpiled waste for characterization purposes.

5.8 IDW DISPOSAL

Various methods and requirements for onsite and offsite disposal of IDW are discussed in the *Generic IDW Disposal Plans* for Hawaii and Guam (Ogden 1994, 1995) and EPA guidance (EPA 1990, 1991, 1992b). This section explains the disposal evaluation process and highlights some of the more important requirements for onsite and offsite IDW disposal options.

IDW sampling, characterization, and disposal analysis, particularly for onsite disposal, can be unexpectedly complex and require compliance with many different laws (that act as ARARs for IDW management and disposal). Before preparing the IDW disposal plan, compare estimated costs for onsite vs. offsite disposal. Offsite disposal may be more cost effective than devising and documenting the justification for onsite disposal when the quantity of IDW is small (less than 10 drums) and/or the waste fails the initial conservative screening against conservative risk-based

criteria. Also weigh cost savings against the policy preference of the EPA and State of Hawaii Department of Health to manage and dispose of IDW on site, when possible.

5.8.1 Onsite Disposal

In general, the EPA preference is to dispose of IDW on site when the disposal action:

- Does not pose an unacceptable long-term risk to human health and the environment
- Is in accordance with chemical-, location- and action-specific ARARs “to the extent practicable” (40 CFR 300.415(i); 55 FR 8756)
- Does not introduce contaminants into clean soil or other site media
- Does not mobilize or significantly increase concentrations of any hazardous constituents already present in the environment
- Is consistent with the final remedy planned for the site
- Takes into account any community concerns regarding waste storage and the disposal method

Base onsite disposal options on best professional judgment and available site-specific data. For some projects, it may be prudent to store the waste temporarily until additional site data become available (e.g., sample analytical data, preliminary risk-assessment results, AOC delineation, and establishment of background values). Factors to consider include, but are not limited to the following:

- The detected or suspected contaminants, their concentrations, and total volume of IDW
- Media potentially affected (e.g., groundwater drinking source)
- Background metals data for site media
- Site access, conditions, and potential receptors
- Current and future land use
- Public perceptions (especially if drum storage and/or disposal takes place in open view)
- Time limits for IDW storage
- Potential requirements to treat waste before disposing of it on site
- Lack of unpaved areas to disposed of waste on site
- Potential wind, erosion, runoff, or flood conditions that might cause offsite migration of disposed waste
- Proximity to the ocean, surface water, or environmentally sensitive habitats
- Natural attenuation processes
- Need for additional utility survey before excavating to backfill waste
- Need for land use controls required to limit exposure pathways (e.g., backfill waste, provide permanent security around site, replant site to prevent erosion)

Protection of human health can be evaluated by comparing chemical concentrations in the waste to the more conservative of EPA residential regional screening levels), environmental action levels, and chemical-specific ARARs and TBC criteria. Ecological receptors can be protected by screening the IDW against EPA ecological soil screening levels. Onsite disposal of surface and groundwater IDW can be evaluated by initially screening against EPA tap-water PRGs, State Safe Drinking Water Standards (maximum contaminant levels and non-zero maximum contaminant level goals), and/or State Surface Water Quality Standards. These criteria are not always ARARs for the disposal method or site conditions; however, they may be useful to affirmatively show that the disposal is protective. Alternatively, the IDW may be associated with human-health and eco-risk assessment results for the site if the onsite placement of IDW is consistent with exposure pathway assumptions made during the risk assessment (e.g., contaminated soil might not present an unacceptable health risk at depth, but could pose such a risk if disposed of at the ground surface).

In general, return IDW consisting of environmental media to or near its source, and return waste generated from depth to its original depth, if possible and approved by NAVFAC in advance. Bury all contaminated soil and water IDW to be disposed of on site below grade at a depth of at least 3 feet and cover it with clean soil to reduce the potential for future exposure to human and ecological receptors.

Dispose of non-indigenous IDW and contaminated decontamination fluids off site. The cleaning detergent Alconox, often used in the decontamination process, is itself non-hazardous and biodegradable. Small quantities of clean decontamination water containing Alconox may be disposed of to clean areas on site. If onsite disposal is appropriate for RCRA IDW, this waste should be disposed of within the AOC to avoid the need to comply with LDRs.

IDW from several non-contiguous onsite areas may be consolidated and disposed of at one of the areas, provided a nexus exists between the wastes generated and response projects (55 FR 8690-8691).

IDW may also be temporarily disposed of back to the AOC without detailed analysis or documentation if the waste will be addressed with other site contamination during a future response action and will not present a significant short-term threat to human health and the environment.

5.8.2 Offsite Disposal

If onsite disposal is not a viable option, dispose of the IDW at an appropriate offsite treatment and/or disposal facility. Offsite transport and disposal of IDW must comply with all applicable laws and criteria specific to the chosen disposal facility. These requirements may include, but are not limited to the following:

- RCRA LDRs
- RCRA waste storage permits and time limits
- National Pollutant Discharge Elimination System and sewer disposal criteria
- CERCLA offsite rule
- TSCA treatment requirements
- DOT hazardous material transport packaging, manifesting, and security provisions

- International Maritime Organization ocean transport rules
- Certifications and training for waste transport contractors
- State notification requirements when importing certain types of waste

The CERCLA offsite rule (40 CFR 300.440) requires that CERCLA waste be disposed of only at facilities specifically approved by the EPA to receive such waste for treatment, storage, or disposal. The acceptability status of a disposal facility can change quickly (e.g., if there is a release at the facility); therefore, the CTO Manager should contact the EPA Region 9 CERCLA Offsite Rule Coordinator no more than 60 days prior to disposal of the IDW to verify the facility's approval status. The offsite rule applies to any CERCLA-driven remedial or removal action involving the offsite transfer of waste containing hazardous substances regardless of the concentrations present.

RCRA hazardous waste manifests must always be signed by authorized Navy personnel. In some cases, the Navy may authorize contractors to sign non-hazardous manifests. Navy authorization to allow contractor signature of non-hazardous manifests shall be based upon a Navy review of the contractor's RCRA and DOT training records. In addition, the Navy shall always be allowed the opportunity to review/approve non-hazardous manifests and waste profiles prior to waste disposal efforts.

Disposal of liquid IDW into the Navy sanitary sewer shall occur only if first approved by the Navy. Requests for disposal to Navy facilities should be coordinated through the COR. Discharge to the public sewer system is discouraged and should occur only if approved by state and local government agencies.

5.9 RECORDS

The CTO Manager is responsible for completing and updating the site-specific IDW drum inventory spreadsheet and submitting it as needed, and reviewing the IDW disposal plan (IDW disposal paperwork).

FMs and designates are responsible for documenting all IDW-related field activities in the field notebook including most elements of the IDW drum inventory spreadsheet. The correct methods for developing and maintaining a field notebook are presented in Procedure III-D, *Logbooks*.

Guidance related to preparing an IDW disposal plan (if required) is presented in the *Generic IDW Disposal Plans* for Hawaii and Guam (Ogden 1994, 1995).

5.9.1 IDW Disposal Documentation

Upon receipt of analytical data from the investigation or from IDW-specific analytical data, the generator information request form will be completed and provided to the IDW subcontractor to begin IDW characterization. Completed IDW disposal paperwork received from the IDW subcontractor should be reviewed for accuracy prior to submitting for Navy review.

The CTO Manager is responsible for submitting backup documentation (actual site or drum sampling results) along with the IDW disposal paperwork to the Navy.

Navy-approved contractor personnel may sign non-hazardous waste IDW documentation. Hazardous waste IDW documentation must be signed by an authorized Navy Environmental Coordinator.

All manifests (non-hazardous and hazardous) must be tracked, and if completed manifests (signed by disposal facility) are not received within 30 days of initial transportation, then contractor must notify the RPM weekly of the shipping status (e-mail is acceptable). Hazardous waste must be disposed of within 45 days of initial transportation. If not, specific IDW transportation details must be supplied to the Navy in order to prepare and file an exception report.

TSCA-regulated waste must be physically destroyed and or buried within 1 year of generation (date placed in IDW drum). Disposal certificates should be provided by the waste facility to the IDW subcontractor and Navy contractor.

Following disposal of IDW, the CTO Manager should prepare a short IDW disposal report summarizing the disposal operation and appending any associated records (e.g., final drum log, waste profiles, transport manifests, bills of lading, disposal facility certifications). Minimal topics to include in the report:

- IDW inventory and storage
- IDW chemical screening and characterization
- IDW transport and disposal
- Manifests
- Drum storage photographs
- Site figure

6. Health and Safety

Field Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

7. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of the Navy (DON). 2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Environmental Protection Agency, United States (EPA). 1990. *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*. EPA/540/G-90-007. OSWER 9355.4-01. Office of Solid Waste and Emergency Response. August.

———. 1991. *Management of Investigation-Derived Wastes During Site Inspections*. EPA-540-G-91-009. Office of Emergency and Remedial Response. May.

———. 1992a. *Guidance for Performing Site Inspections under CERCLA*. EPA/540/R-92/021. Office of Emergency and Remedial Response. September.

———. 1992b. *Guide to Management of Investigation-Derived Wastes*. Quick reference fact sheet. OSWER Dir. 9345.3-03FS. Office of Solid Waste and Emergency Response. January.

———. 2007. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846*. 3rd ed., Revision 6. Office of Solid Waste. November. On-line updates at: <http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm>.

———. 2009. *Revisions to the PCB Q and A Manual*. January.

Ogden Environmental and Energy Services Company, Inc. (Ogden). 1994. *Final Generic IDW Screening, Sampling, Analysis, and Disposal Plan for Various Guam Naval Installations*. Pearl Harbor, HI: Pacific Division, Naval Facilities Engineering Command. September.

———. 1995. *Generic IDW Screening, Sampling, Analysis, and Disposal Plan for Various Hawaii Naval Installations*. Pearl Harbor, HI: Pacific Division, Naval Facilities Engineering Command. April.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-C-2, *Monitoring Well Development*.

Procedure I-C-3, *Monitoring Well Sampling*.

Procedure I-D-1, *Drum Sampling*.

Procedure I-F, *Equipment Decontamination*.

Procedure III-D, *Logbooks*.

8. Attachments

Attachment I-A-6-1: IDW Drum Label

Attachment I-A-6-2: Drum Label – Aluminum Tag

Attachment I-A-6-3: Monthly IDW Drum Inventory Updates

OIL IN SOIL SCREENING KIT

The OIL-IN-SOIL field screening test kit is an inexpensive, simple, and rapid qualitative sampling test for identifying the presence of hydrocarbons including light non-aqueous phase liquids (LNAPLs) and dense non-aqueous phase liquids (DNAPLs) in soil. The OIL-IN-SOIL test kit is a visually enhanced version of the old soil/water shake test for the presence of oils and petroleum products. Users add soil to a line on the label, add water to another line on the label and shake the jar to release the dyes.

The kit comes in 3 colors: One kit uses the original SUDAN IV which colors the hydrocarbon red. The OIL-IN-SOIL Kits also come in a royal blue color called OIL-IN-SOIL RB. A colored ring or spot indicates the presence of oil or petroleum at above 2,500 ppm total petroleum hydrocarbons). A Styrofoam ball turning pink or light blue, depending on the dye used will indicate hydrocarbon down to 500 ppm. Many DNAPLs will give indications below 10 ppm because of their ability to penetrate the styrene used in the jar.

Application: The OIL-IN-SOIL field screening test kits are useful tools for reducing the cost of Phase I and Phase II site assessments, by reducing the time and costs associated with delineating the perimeter, depth, and direction of spills in soil. They are also often used with core samples to identify organic substances.

Environmental Benefits: Rapid delineation of hydrocarbons and DNAPL spill boundaries in soil results in more rapid removal of contaminants from the environment. The OIL-IN-SOIL kit uses a *de minimis* quantity of Sudan IV which is encapsulated in a soluble cube – thus decreasing the hazards to the test user from airborne particulate Sudan IV and overcoming the problems associated with the disposal of larger quantities of a mutagenic dye. We have recently switched to a new manufacturer whose dye is non-mutagenic.

Performance: The OIL-IN-SOIL kits provide an inexpensive, consistent tool for the detection of hydrocarbons (+- 500 ppm total petroleum hydrocarbons) in soil. They are easy to use and require minimal training, thus reducing the need for ongoing expensive technical support on-site. The OIL-IN-SOIL kits have been sold commercially for several years and are used for Phase I and Phase II site assessments by most major environmental companies and several utility companies throughout the USA.

Simple as 1, 2, 3:

1. Add soil to the first line on the label.
2. Add water to the second line on the label.
3. Close and shake the jar to release the dyes and observe the color change.

MANUFACTURER'S GUARANTEE:

We will replace any broken or defective kits purchased through PINE Environmental Services or OIL-IN-SOIL, LLC.

If you are not satisfied with our product, return any defective kits for a refund. We reserve the right not to provide refunds if the kits have been tampered with in any way, or if not used in accordance with the OIL-IN-SOIL Instructions.

A SDS IS NOT NECESSARY FOR THIS PRODUCT BECAUSE OF EXTREMELY SMALL QUANTITIES OF DYES USED IN SUGAR CUBE. However product in oil may be hazardous. SDS for Dyes used is available.

RECOMMENDED PROTECTIVE EQUIPMENT:

Because you are testing for petroleum products, always use gloves and safety glasses when using the OIL-IN-SOIL™ kits.

Shelf Life is at least 10 years when kept away from DIRECT SUNLIGHT or temperatures more than 90° F.

OIL IN SOIL, LLC
Southampton ,PA
USA



OIL IN SOIL, LLC
352 2nd Street Pike , Box 327
Southampton, PA 18966 - USA
Tel: (215) 687-0355

Manufacturers of Soil Screening Kits for:
Diesel Fuel - Heating Oil – Hydraulic Fluid
Gasoline – Lubricating Oil – Mineral Oil –
Kerosene and many other petroleum based
products

OIL-IN-SOIL™

Oil Screening Test Kit

Instruction Manual

© OIL IN SOIL, LLC 2017

Step 3 Replace cap on bottle and shake jar until cube is **completely** dissolved.

"Congratulations on purchasing the easiest and fastest test kit available today for screening hydrocarbons and DNAPL!"

INTRODUCTION:

The OIL-IN-SOIL™ screening kit is composed of a plastic bottle; a label indicating recommended soil and water levels; a small Styrofoam ball, and a cube containing finely dispersed dyes which is glued to the inside of the jar lid.

In the RED version of the screening test kit the cube is impregnated with two dyes:

- OIL RED, a Red Azo Dye (Chemically Equivalent to SUDAN IV™ and NON Mutagenic) soluble in most petroleum products, red color and a
- Fluorescent Green/Yellow water soluble dye to color the water and provide a visual backdrop for the red dye.

The dual dye method is employed to improve detection by the user. The Blue soil test kits all contain only a blue anthraquinone dye and is primarily for users who are red-green colorblind.

USING THE KIT:

OIL-IN-SOIL kits are designed with ease of use in mind. Simply follow the instructions on the label:

Step 1 Fill the bottle with soil to the line "Fill soil to **HERE**" →

Note: Do not compact the soil.

Step 2 Fill the bottle to the line "Fill water to **HERE**" →

Note: ensure water is warm enough to dissolve the cube.

If petroleum is present in the sample a red meniscus (or red spots on the side of the jar) will appear within 30-60 seconds. If color is not immediately apparent in the jar – check the polystyrene ball. The presence of ANY color on the ball (even a faint pink halo or hue) indicates the presence of more than a small quantity in that sample material. Conversely, a "clean white" ball indicates, in general, that there is less than 500ppm petroleum..

Note: Whenever possible, use tap or bottled water for the screening tests. However, salt water can be used if necessary.

Cold water can inhibit the rapid release of viscous hydrocarbons from soil and cause False Negative results. Therefore, at temperatures below 68° F (20° C), we recommend an insulated jug with hot tap water.

**Appendix B:
Analytical Data Package Requirement
for Chemical Analyses**

GC-FID Stage 4 Deliverables

Item No.	Deliverable
1	Chain of custody
2	Sample results with analysis and extraction/preparation dates
3	Summary of MS/MSD/Duplicate recoveries and control limits (listing or link with associated samples)
4	Summary of LCS/LCSD recoveries and control limits (listing or link with associated samples)
5	Method blanks (listing or link with associated samples)
6	Summary of surrogate recoveries
7	Summary of initial calibration data (RF and %RSD, or r if applicable)
8	Summary of continuing calibration (%D)
9	Injection logs
10	Extraction/preparation logs
11	Case narrative to discuss anomalies
12	Raw data associated with the summary forms listed above
13	Raw data for item #2 which includes chromatograms, logbooks, quantitation reports, and spectra

Note: The data deliverable package must have a table of contents and be paginated.

%D percent difference
 %RSD percent relative standard deviation
 MS matrix spike
 MSD matrix spike duplicate
 LCS laboratory control sample
 LCSD laboratory control sample duplicate
 RF response factor

GC-MS Stage 4 Deliverables

Item No.	Deliverable
1	Chain of custody
2	Sample results with analysis and extraction/preparation dates
3	Summary of MS/MSD/Duplicate recoveries and control limits (listing or link with associated samples)
4	Summary of LCS/LCSD recoveries and control limits (listing or link with associated samples)
5	Method blanks (listing or link with associated samples)
6	Summary of instrument blanks - metals only (listing or link with associated samples)
7	Summary of surrogate recoveries
8	Summary of initial calibration data (RRF and %RSD, or r if applicable)
9	Summary of continuing calibration (%D and RRF)
10	Summary of internal standards (area response and retention time)
11	Summary of instrument tuning (listing or link with associated samples, must show 12-hour clock)
12	Injection logs
13	Extraction/preparation logs
14	Case narrative to discuss anomalies
15	Raw data associated with the summary forms listed above
16	Raw data for item #2 which includes chromatograms, logbooks, quantitation reports, and spectra

Note: The data deliverable package must have a table of contents and be paginated.

GC-MS gas chromatography-mass spectrometry
 RRF relative response factor
 %RSD percent relative standard deviation

GC Stage 4 Deliverables

Item No.	Deliverable
1	Chain of custody
2	Sample results with analysis and extraction/preparation dates
3	Summary of MS/MSD/Duplicate recoveries and control limits (listing or link with associated samples)
4	Summary of LCS/LCSD recoveries and control limits (listing or link with associated samples)
5	Method blanks (listing or link with associated samples)
6	Summary of initial calibration data (correlation coefficient, r)
7	Summary of continuing calibration (%D or % recovery), if applicable
8	Injection logs
9	Extraction/preparation logs, if applicable
10	Case narrative to discuss anomalies
11	Raw data associated with the summary forms listed above
12	Raw data for item #2, which includes logbooks, quantitation reports, and spectra

Note: The data deliverable package must contain a table of contents and be paginated.

**Appendix B.1:
Field Sampling, Analytical, and
Quality Management Reference Tables**

Table B-1: Location-Specific Sampling Methods/SOP Requirements

Table B-2: Analyte List and Reference Limits

Table B-3: Preparation and Analytical Requirements for Field and QC Samples

Table B-4: Analytical Services

Table B-1: Location-Specific Sampling Methods/SOP Requirements

Sampling Location/ ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
TBD	Soil gas	1–6	VOCs, TPH-D/O	8	Procedure I-B-3 Soil Gas Sampling
TBD	Unconsolidated material	approx. 1–11	Naphthalene, 1-methylnaphthalene, 2-methylnaphthalene TPH-D/O	10 Composite sample taken from drill core/cuttings duplicate per 10 subsurface soil samples; 1 MIS Sample at the Hume Line excavation 1 MS/MSD pair per 20 subsurface soil samples	Procedure I-B-1 soil sampling
TBD	Perched water	approx. 1–11	Naphthalene, 1- methylnaphthalene, 2-methylnaphthalene, TPH-D/O	4 sample collected from a peristaltic pump or bailer 1 duplicate per 10	Procedure I-B-1 -groundwater sampling
TBD	Investigation derived waste	1–11	TCLP RCRA 8 - 1311/6010/7470 BTEX+HVOC - 8260C TPH-G - 8260C TPH-D/O - 8015C PAHs (full list) - 8270D PCB Aroclors - 8082A MIS Preparation	TBD	Procedure I-B-1 soil sampling

Notes:

Procedures are from the Project Procedures Manual (DON 2015).

Actual number of unconsolidated material samples will be dependent on field observations during coring.

Volumes for field duplicate, and MS/MSD samples will only be collected if sufficient unconsolidated material is present at each sampling interval. If limited volume is present, collecting volume for TPH will take priority.

One equipment blank will be collected during each unconsolidated material sampling event.

BTEX benzene, toluene, ethylbenzene, and xylenes

ft foot or feet

ID identification

PAH polynuclear aromatic hydrocarbon

TBD to be determined

TPH-G total petroleum hydrocarbons-gasoline

Table B-2: Location-Specific Sampling Methods/SOP Requirements

Matrix Unconsolidated Material

Analyte	CAS Number	Screening Criterion ^a Gross Contamination/Direct Exposure/Leaching to Groundwater (mg/kg)	Project LOQ Goal (mg/kg)	Project LOD Goal (mg/kg)	LOQ	Laboratory-Specific Limits (mg/kg)	
						LOD	DL
TPH							
TPH-D (C10–C24)	—	500/220/940	73	22	50	30	9.9
TPH-O (C24-C40)	—	500/9,400/1,000	—	—	50	30	20
PAHs							
1-Methylnaphthalene	90-12-0	500/170/4.2	1.4	0.42	0.005	0.0015	0.00063
2-Methylnaphthalene	91-57-6	500/39/4.1	1.4	0.41	0.005	0.003	0.0021
Naphthalene	91-20-3	500/28/4.4	1.5	0.44	0.005	0.004	0.0016

— no data

mg/kg milligrams per kilogram

TPH total petroleum hydrocarbons

^a DOH Tier 1 EALs (Summer 2016, updated January 2017).

Matrix Perched Water

Analyte	CAS Number	Screening Criterion ^a Gross Contamination/Drinking Water Toxicity (µg/L)	Project LOQ Goal (µg/L)	Project LOD Goal (µg/L)	LOQ	Laboratory-Specific Limits (µg/L)	
						LOD	DL
TPH							
TPH-D (C10–C24)	—	500/400	400	400	110	100	65
TPH-O (C24-C40)	—	500/2,400	500	500	350	300	180
PAHs							
1-Methylnaphthalene	90-12-0	10/27	10	10	0.10	0.032	0.019
2-Methylnaphthalene	91-57-6	10/24	10	10	0.20	0.08	0.039
Naphthalene	91-20-3	21/17	17	17	0.10	0.080	0.031

— NA

µg/L microgram per liter

^a DOH Tier 1 EALs (Summer 2016, updated January 2017).

Table B-3: Preparation and Analytical Requirements for Field and QC Samples

Matrix	Analytical Group	Preparation Reference/Method SOP Analytical Reference/Method SOP	Containers	Sample Volume	Preservation Requirement	Maximum Holding Time (preparation/analysis)
Soil gas	TPH-D, TPH-O	TBD	TBD	TBF	NA	Samples to be analyzed within 14 days.
	VOCs	TBD	TBD	TBD	NA	Samples to be analyzed within 14 days.
Unconsolidated Material	TPH-D, TPH-O	TBD	1 x 8-oz glass jar, Teflon-lined lid	30 g	Cool to ≤ 6°C	Samples extracted within 14 days and analyzed within 40 days following extraction.
	PAHs	TBD	TBD	30 g	Cool to ≤ 6°C	Samples extracted within 14 days and analyzed within 40 days following extraction.
Perched Water	TPH-D, TPH-O	TBD	2 x 250mL glass	250 mL	Cool to ≤ 6°C	Samples extracted within 7 days and analyzed within 40 days following extraction.
	PAHs	TBD	2 x 250mL glass	250 mL	Cool to ≤ 6°C	Samples extracted within 7 days and analyzed within 40 days following extraction.

g gram
HCl hydrochloric acid
L liter
mL milliliter
oz ounce

Table B-4: Analytical Services

Matrix	Analytical Group	Sampling Locations/ ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization (name and address)
Unconsolidated Material	TPH-D, TPH-O PAHs (1-methylnaphthalene, 2-methylnaphthalene, naphthalene)	TBD	TBD	14 business days after samples are received at laboratory	TBD
Perched Water	TPH-D, TPH-O PAHs (1-methylnaphthalene, 2-methylnaphthalene, naphthalene)	TBD	TBD	14 business days after samples are received at laboratory	TBD
Soil gas	TPH-D, TPH-O, VOCs	TBD	—	14 business days after samples are received at laboratory	TBD

ID identification
TBD to be determined

^a Laboratory meets DoD Environmental Laboratory Accreditation Program or American Association of State Highway and Transportation Officials accreditation requirements, as applicable, to support project needs.

**Appendix C:
SVE Operations and Maintenance Manual**

Final

Soil Vapor Extraction System Operations and Maintenance Plan, Revision 1

**Subsite ST32 Onizuka Village
Joint Base Pearl Harbor-Hickam, Hawaii**

August 2016

**Department of the Navy
Naval Facilities Engineering Command Hawaii
400 Marshall Road
JBPHH HI 96860-3139**



**CLEAN IV CTO KB06
Contract Number: N62473-09-D-2622, CTO KB06
Document Control Number: KCH-2622-KB06-0071**

This page intentionally left blank.

Final

Operations and Maintenance Plan for Subsite ST32 Onizuka Village, Revision 1

Contract Number: N62473-09-D-2622

Contract Task Order Number: KB06

Document Control Number: KCH-2622-KB06-0071

August 2016

Prepared for



**Naval Facilities Engineering Command, Hawaii
400 Marshall Road
JBPHH HI 96860-3139**

Prepared by:



**CH2M HILL Kleinfelder, A Joint Venture
1132 Bishop Street Suite 1100, Honolulu, Hawaii 96813
(808) 943-1133**

This page intentionally left blank.

Contents

Section	Page
Acronyms and Abbreviations	v
1.0 Introduction.....	1-1
1.1 Introduction.....	1-1
1.2 Purpose and Objectives	1-1
2.0 Soil Vapor Extraction System Description	2-1
2.1 Site Overview	2-1
2.2 Soil Vapor Extraction System Overview	2-1
2.2.1 Soil Vapor Extraction System Layout.....	2-1
2.2.2 Equipment Building.....	2-1
2.2.3 Electrical Components.....	2-3
2.2.4 Off-grid Photovoltaic System	2-10
2.2.5 Horizontal Soil Vapor Extraction Wells	2-11
2.2.6 Remediation Components.....	2-13
2.3 Monitoring Locations.....	2-17
2.3.1 Vapor Monitoring Points and Pressure Monitoring Points	2-17
2.3.2 Groundwater Wells.....	2-17
2.4 Listing of Supporting Firms and Personnel.....	2-18
3.0 Operation and Maintenance.....	3-1
3.1 Equipment Maintenance	3-1
3.1.1 Blower	3-1
3.1.2 Photovoltaic Array	3-3
3.1.3 Absorbed Glass Mat Battery System	3-4
3.1.4 Liquid Separation and Discharge System.....	3-5
3.1.5 Granular Activated Carbon Changeout.....	3-6
3.1.6 Fire Extinguishers and Safety Equipment	3-7
3.1.7 General Exterior Maintenance.....	3-7
3.2 Soil Vapor Extraction Facility Supporting Information.....	3-8
3.2.1 Soil Vapor Extraction System Supporting Information	3-8
3.2.2 Off-grid Photovoltaic System	3-9
3.3 Sampling.....	3-9
3.3.1 Flow Rate Monitoring and Targets.....	3-9
3.3.2 Exhaust Sampling.....	3-11
3.3.3 Granular Activated Carbon Related Sampling	3-12
3.3.4 Field Documentation and Sample Management	3-13
3.4 Performance Monitoring	3-14
3.5 System Inspections.....	3-15
3.6 Pressure Monitoring Form.....	3-15
4.0 Health and Safety	4-1

Section	Page
5.0 References	5-1

Tables

Table 2-1	Listing of Firms and Personnel involved in System Installation	2-18
Table 3-1	Regular Blower Maintenance Tasks	3-2
Table 3-2	Regular Blower Service Tasks – only an authorized KAESER service representative should carry out service work	3-3
Table 3-3	Recommended Blower Spare Parts	3-3
Table 3-4	Blower Lubricating Oils	3-3
Table 3-5	Target Flow Rates	3-10
Table 3-6	Factory Acceptance Testing Results	3-11

Figures

Figure 1-1	Project Location Map
Figure 2-1	Location of SVE Wells and Monitoring Points
Figure 2-2	SVE Equipment Compound Layout
Figure 2-3	Geologic Cross Section and SVE Well Location Map
Figure 2-4	Conceptual Cross Section of Horizontal Wells SVE-1 – A-A'
Figure 2-5	Conceptual Cross Section of Horizontal Wells SVE-2 – B-B'
Figure 2-6	Conceptual Cross Section of Horizontal Wells SVE-3 – C-C'
Figure 2-7	Equipment Building Plan Layout
Figure 2-8	Equipment Building Sections and Details
Figure 2-9	SVE Piping and Instrumentation Diagram

Appendixes

Appendix A SVE System

Appendix A-1	O&M Manual (Onion Equipment Company)
Appendix A-2	Building Layout, P&ID, and Electrical Schematics
Appendix A-3	Fabrication and Installation Drawings
Appendix A-4	GAC Changeout Procedure
Appendix A-5	Factory Acceptance Testing Checklist
Appendix A-6	Checklist for Monthly Inspection of SVE Process, Wells, and Ancillary Equipment

Appendix B Off-Grid Electrical System

Appendix B-1	O&M Manual for Off-Grid System
Appendix B-2	Electrical Drawings (PV and Control Room)
Appendix B-3	Re-start Inverter/Load Center Rewiring One-line Diagram
Appendix B-4	Inspection Form and Warranty
Appendix B-5	Emergency Shutdown Procedure
Appendix B-6	Checklist for AGM Quarterly Battery Inspection

Appendix C Foundation Design Drawing

Appendix D Performance and Pressure Monitoring Forms

Appendix D-1 Performance Monitoring Log

Appendix D-2 Pressure Monitoring Form

Appendix E CD of Supporting Information

Appendix F Health and Safety Supporting Information

Appendix F-1 Safety Notification

Appendix F-2 O&M Activity Hazard Analysis

Appendix F-3 GAC and Blower Oil Material Safety Data Sheets

This page intentionally left blank.

Acronyms and Abbreviations

%	percent
A	ampere
AC	alternating current
AGM	absorbed glass mat
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
ASTM	ASTM International
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CD	compact disc
cfm/ft	cubic feet per minute per foot
CLEAN	Comprehensive Long-term Environmental Action—Navy
CTO	Contract Task Order
DC	direct current
DON	U.S. Department of the Navy
EAL	environmental action level
FAT	factory acceptance test
GAC	granular activated carbon
HDD	horizontal directional drilling
HDOH	State of Hawaii Department of Health
HDPE	high-density polyethylene
Hg	mercury
HMI	human machine interface
hp	horsepower
JBPHH	Joint Base Pearl Harbor-Hickam
JRTF	(former) John Rodgers Tank Farm
KCH	CH2M HILL Kleinfelder, A Joint Venture
kW	kilowatt
kWh	kilowatt hour
LEL	lower explosive limit
LGAC	liquid-phase granular activated carbon
LOTO	Lock Out/Tag Out

NAVFAC Navy	Naval Facilities Engineering Command United States Department of the Navy
O&M	operation and maintenance
P&ID	process and instrumentation diagram
PAH	polycyclic aromatic hydrocarbon
PID	photoionization detector
PLC	programmable logic controller
PMP	pressure monitoring point
PV	photovoltaic
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RAO	Remedial Action Objectives
SAP	Sampling and Analysis Plan
scfm	standard cubic feet per minute
scfm/ft	standard cubic feet per minute per foot
SOC	State of Charge
SSHP	Site Safety and Health Plan
SVE	soil vapor extraction
T&D	transport and disposal
TCLP	toxicity characteristic leaching procedure
TPH	total petroleum hydrocarbons
USEPA	U.S. Environmental Protection Agency
V	volt
VFD	variable frequency drive
VGAC	vapor-phase granular activated carbon
VI	vapor intrusion
VMP	vapor monitoring point
VOC	volatile organic compound
W	watt
W.C.	water column

1.0 Introduction

1.1 Introduction

This Operations and Maintenance (O&M) Plan describes the methods and procedures to be used while conducting activities associated with the operation, maintenance, sampling, and monitoring of the soil vapor extraction (SVE) system at Subsite ST32 Onizuka Village, located at Joint Base Pearl Harbor-Hickam (JBPHH), Hawaii (**Figure 1-1**). The SVE System includes the SVE Building, the horizontal SVE wells, and an adjacent photovoltaic (PV) array to support off-grid operation. The SVE Building includes the SVE processing unit and electrical components and controls.

This O&M Plan was prepared for the Naval Facilities Engineering Command (NAVFAC) Hawaii by CH2M HILL Kleinfelder, a Joint Venture (KCH) under the NAVFAC Southwest Comprehensive Long-term Environmental Action, Navy (CLEAN) IV Contract N62473-09-D-2622, Contract Task Order (CTO) KB06.

1.2 Purpose and Objectives

The O&M Plan is intended to function as a manual for staff performing operations, maintenance, sampling, and performance monitoring activities in support of the SVE system. Performance monitoring tasks include a review of the physical characteristics of the SVE system components, flow rate measurements, pressure measurements, off-gas monitoring and sampling to support changeout of granular activated carbon, condensate monitoring and sampling, and sampling of vapor monitoring points (VMPs) along the routes of the three SVE wells.

Soil gas sampling to monitor hot spot concentrations in and around the housing units will be conducted under a separate effort, and is therefore not addressed in this O&M Plan. The data collected from the VMPs will be used in conjunction with other performance data to evaluate the effectiveness of the SVE System relative to remedial action objectives (RAOs). The SVE system is expected to operate until soil vapor concentrations are reduced to below State of Hawaii Department of Health (HDOH) Environmental Action Levels (EALs) (HDOH, Fall 2011, revised January 2012) and a rebound study concludes that concentrations will not increase once system operation is discontinued. This O&M Plan will be amended throughout the life of the SVE system, as necessary, to describe additional work activities or for revisions to existing procedures that may be performed as part of O&M. This August 2016 version is issued as Revision 1.

The O&M Plan includes the following:

- A detailed description of the SVE system (including system layout, components, SVE Building features, and monitoring locations)
- Information on the O&M of the various major pieces of equipment

- Supporting information for O&M and installation instructions for major pieces of equipment
- Sampling requirements
- Information on performance monitoring

O&M Plan attachments include the following:

- An appendix with specific O&M manuals for major SVE and off-grid equipment (these documents are also maintained in the SVE Building)
- As-built drawings
- Performance monitoring forms
- Granular activated carbon (GAC) changeout procedures
- O&M Activity Hazard Analysis (AHA) and other supporting information

Standalone related documentation that supports this O&M Plan includes the Accident Prevention Plan (APP) (DON, 2014c) and the Final Treatability Study Implementation Plan for Subsite ST32 Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii (DON, 2014b). The Implementation Plan comprises a Quality Control Plan, Health and Safety and Waste Management Plan, Environmental Protection Plan, and information on the basis of design and technical specifications.

2.0 Soil Vapor Extraction System Description

2.1 Site Overview

Onizuka Village is a military family housing residential community containing 304 homes. The Onizuka Village residential community development was built from 2009 to 2011 on land leased from the United States Department of the Navy (Navy) to Hickam Communities, LLC. As a subsidiary under developer Lend Lease, Hickam Communities, LLC developed and constructed the community and is currently responsible for operations, maintenance, and property management.

From the mid-1940s to the late 1970s, the area currently occupied by Onizuka Village was used as an airfield with a runway, taxiways, and aircraft parking aprons. Historical petroleum releases from petroleum, oil, and lubricants (POL) systems, aircraft refueling activities, or both have resulted in high concentrations of total petroleum hydrocarbons (TPH) in soil vapor at 4 to 6 feet below ground surface (bgs), observed in localized hotspots. The source of the observed soil vapor contamination is likely related to historical fuel releases associated with the former site use as an aircraft parking and refueling area along the flightline. In 2014, the SVE system was constructed as part of a Treatability Study to treat vadose zone soil vapor in hotspot areas to reduce the potential for future vapor intrusion (VI) impacts within nearby residential homes.

2.2 Soil Vapor Extraction System Overview

2.2.1 Soil Vapor Extraction System Layout

The key elements of the SVE system are the SVE wells (installed using horizontal directional drilling), the PV array, and the equipment contained in the SVE Building. The location of the three SVE wells and associated monitoring points are provided in **Figure 2-1** and **Figure 2-2**, respectively. SVE-1 has 370 feet of screen, SVE-2, 200 feet, and SVE-3, 360 feet. The three SVE wells meet at the children's playground in individual vaults. From the three vaults, individual conveyance pipes are bundled together, run under Freedom Avenue, and are terminated at the SVE Building. The horizontal well layout and geologic cross section location map is shown on **Figure 2-3**, and the geologic cross section where each horizontal well is located is shown on **Figures 2-4** through **Figure 2-6**. All horizontal well manway access locations were placed underground and are accessible by vaults, as shown on **Figure 2-1**. The SVE building and PV array were installed adjacent to the western side of Freedom Avenue.

2.2.2 Equipment Building

The SVE building is a steel-frame pre-fabricated enclosure built by Speed Space and delivered to Tetrasolv, who had installed the SVE process and off-grid electrical system in the building before shipment to the site (refer to Section 2.4 for additional contact

information). Installation of the SVE process and PV electrical and other related equipment were then performed, both under contract to the Onion Equipment Company. The building is 36 feet long by 12 feet wide by 9 feet tall, painted brownstone to match specific Base requirements (this color shall be used for any future maintenance). The building was delivered to the site and installed by crane on a slab-on-grade. The slab-on-grade is surrounded by a 10-foot-wide concrete housekeeping apron. The configuration of the slab and housekeeping pad are shown in the foundation as-built drawing in Appendix C. The equipment layout inside the building is included on **Figure 2-7**, sections in **Figure 2-8**, and the process and instrumentation diagram (P&ID) in **Figure 2-9**. A picture of the completed building is shown in Photo 1. The building specifications, including the structural design of the building, are shown in Appendix A-3. The building has two rooms. A smaller room encloses the system electrical and charging components (electrical room) and is accessible by a single man-door. The other, larger, room encloses the process treatment components and is accessible by either a single man-door or a double door located at the end of the building. Concrete landings are also present at the exterior of each doorway.

REQUIREMENT FOR INTRUSIVE WORK: Because of the potential presence of pesticide-impacted soils, training must be provided by Hickam Communities Environmental (coordinated through the Lendlease Assistant Environmental Manager) before any excavation, soil borings, or similar work along the SVE wells, well vaults, SVE Building and fenced area.

A 10-horsepower (hp) Kaeser blower package with sound-attenuating enclosure rated for 275 standard cubic feet per minute (scfm) and 7 inches mercury (Hg) at 3,200 revolutions per minute (10 hp), is used to extract soil vapor from the three SVE wells. The blower also provides the motive force for passing the vapor over the vapor-phase granular activated carbon (VGAC). Any condensation extracted by the blower is contained in the 120-gallon moisture knockout separator, with the collected water purged using a centrifugal pump with level controls and then treated using liquid-phase GAC (LGAC) before discharge to an infiltration gallery outside the building.

For control and monitoring purposes, valves and instrumentation are installed on the three-leg SVE manifold, including an averaging pitot tube flow indicator, vacuum gauges, manual valves, and motor-actuated diaphragm (throttling) valves. A 4-inch main discharge galvanized steel trunk line with a mass flowmeter and a stainless-steel stack are installed on the discharge side of the blower. The discharge stack extends 5 feet above the roof of the building, and ends in a silencer as visible in Photo 1.

Before the acceptance and delivery to Hawaii of the SVE Building with its internal SVE process and electrical components, an onsite Factory Acceptance Test (FAT) was conducted by the KCH project engineer at the Tetrasolv facility. The inspection covered the following elements: general items, preparation for transportation, GAC system, blower system, piping installation, panels and service entrance, and testing protocol. A checklist was developed for use in support of the FAT. Items that needed resolution were identified, the recommended action noted, and the individual items tracked to completion. The completed FAT checklist is presented in Appendix A-5.



Photo 1. SVE system building

2.2.3 Electrical Components

The SVE system is not connected to the JBPHH electrical grid (i.e., is off-grid) and is entirely powered by the PV array located adjacent to the building.

Power conductor wire from the PV array runs in buried polyvinyl chloride (PVC) conduit adjacent to the northeastern side of the building, and enters the building's electrical room through conduit penetrations at the northern corner of the building (Photo 2). Inside the electrical room, the PV conductor wires enter the building in a junction box mounted on the wall. From there, the PV wire carry direct current (DC) to a series of six Outback FM80 charge controllers (Photo 3). The charge controller's function is to manage variable output from the PV array and the batteries to provide a balanced load.

The SVE system building and the PV array are each grounded to two separate 5/8-inch-diameter by 10-foot-long grounding rods. One is installed at the PV array, with the other passing through the sidewalk at the northeastern corner of the SVE building (Photo 2).

Also inside the electrical room is an Outback EnergyCell 2000RE rack mount containing 24 absorbent glass mat (AGM) batteries with connecting straps between the individual cells (Photo 4). Each battery weighs approximately 270 pounds. The battery rack is mounted on a 3/8-inch steel plate anchored to the floor structure of the building.

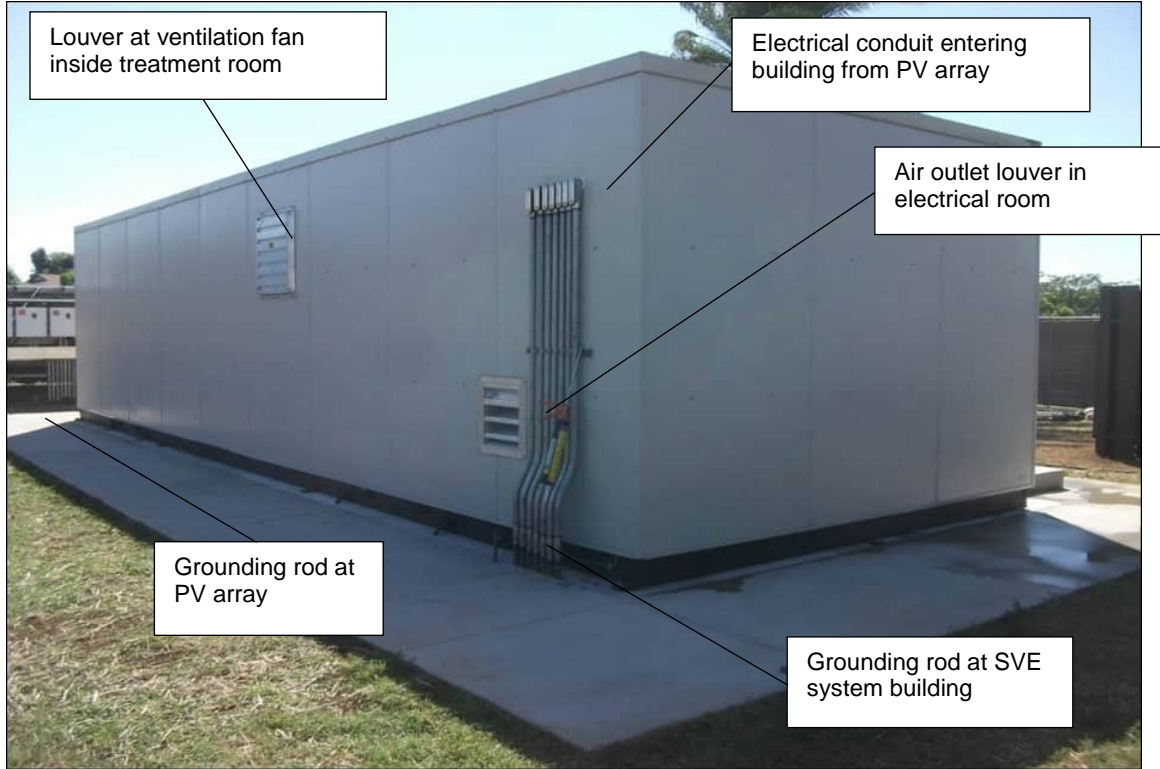


Photo 2. Electrical conduit entering SVE system building, and grounding rod locations

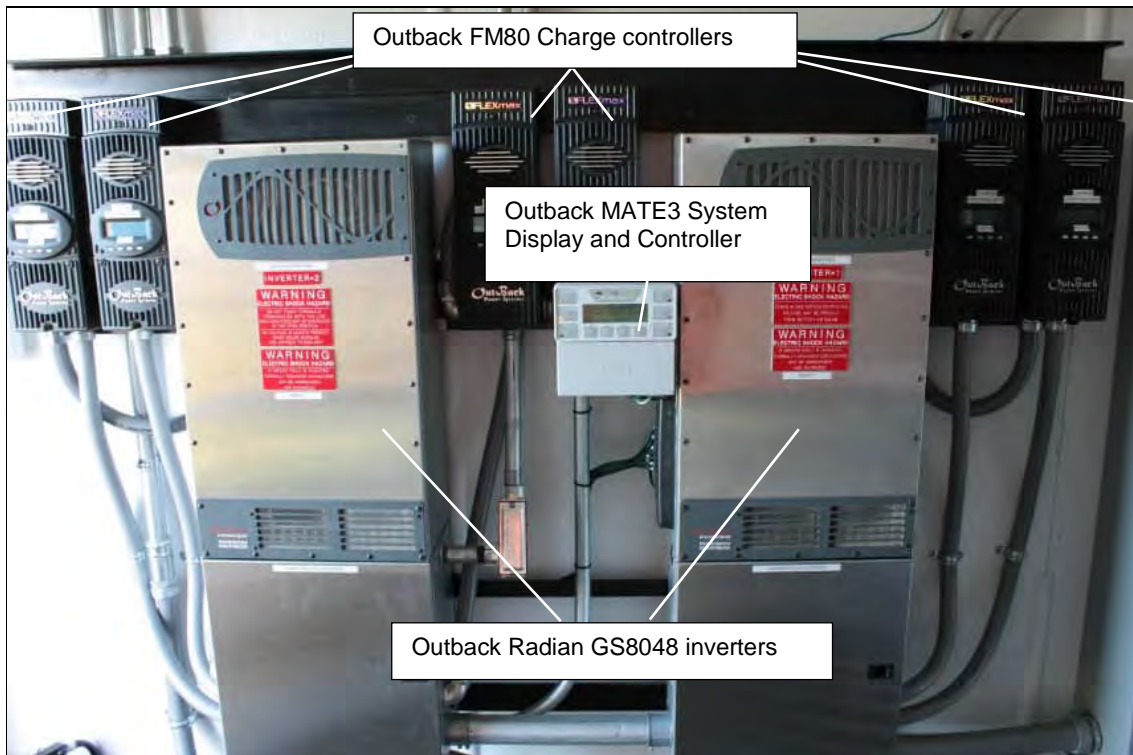


Photo 3. Charge controllers, Radian inverters, and MATE3 power system monitor

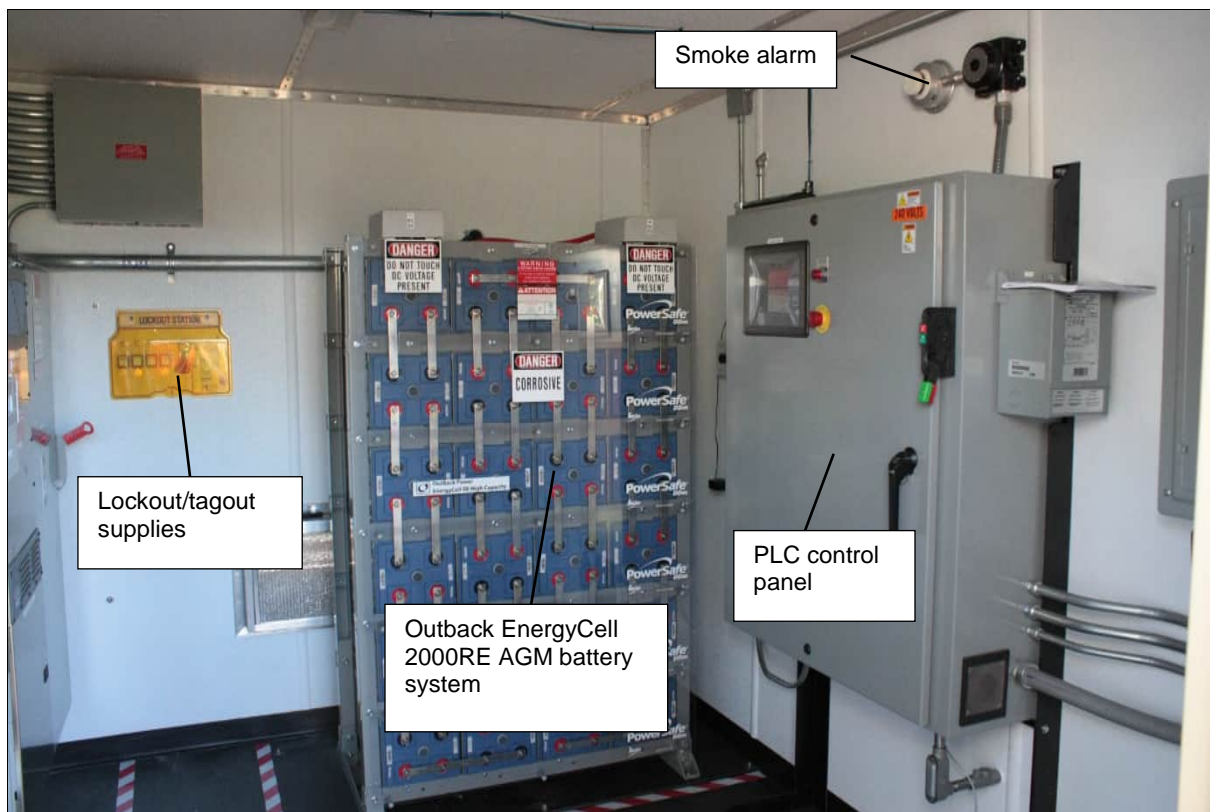


Photo 4. AGM battery system with plastic shields, PLC panel, smoke alarm, and lockout/tagout supplies

SAFETY TIP – the plastic safety shields covering the battery terminals must remain intact and in place at all times to prevent inadvertent contact with the battery terminals or the lead-plated copper inter-cell and inter-module connectors.

Two Outback Radian GS8048 inverters with load centers are mounted adjacent to the charge controllers (Photo 3) and work in a master/slave sequence. Because the PV array generates DC and most system components require alternating current (AC), the inverters convert DC to AC for the SVE process. The AC power goes to an AC breaker panel for ancillary loads. However, from the breaker panel, the AC power for the blower goes through a three-phase power converter. The charge controllers seek out the maximum power available from the PV array and use it to recharge the batteries, allowing the PV array to operate at an ideal voltage. The charge controllers use Maximum Power Point Tracking (refer to the Owner’s Manual in Appendix E for additional details).

An Outback MATE3 System Display and Controller is mounted to the side of the master inverter and functions to monitor and control the Outback power charging and storage system (Photo 3). The plastic cover below the display screen is magnetically held onto the MATE3 and can be easily removed to reveal several function buttons. A code is required to access the MATE3.

A programmable logic controller (PLC) panel located in the electrical room contains a human machine interface (HMI) color touch screen that is the primary control panel for monitoring and controlling the SVE system (Photo 5). The touchscreen control panel is also controllable using a smartphone with a data connection. The “VNC Viewer” application is downloadable for free from the android or iOS app store. Once downloaded, the app will prompt you for a password. Once setup is complete, the operator will be able to view the same HMI touchscreen display as on the PLC panel at the site. System operation through the VNC Viewer is real-time, and programmable controls can be adjusted using the smartphone as a touchscreen.

The Kaeser blower is located inside the process room and is the source of vacuum for the SVE system (Photo 6). The blower requires routine maintenance, including air filter and oil changes. The maintenance schedule and instructions are provided inside the blower manual located in Appendix E.

OPERATIONAL TIP: This blower needs to be run with the correct amount and type of oil and be properly filtered, or major damage may result. Refer to Owner’s Manual (located in Appendix E) and Table 3-4.

Additional electrical components of the SVE system include the following:

- DC disconnect that houses a switch for Lock Out/Tag Out (LOTO) (Photo 7).
- A GENTEC rotary phase converter that produces three-phase power for the blower (Photo 8).
- Two thermostat-controlled exhaust fans; one in the electrical room near the man door and one in the process room behind the VGAC vessels (Photos 8 and 9, respectively).
- Two Pyrotector Model 30-3003 explosion-proof smoke detectors installed in the SVE system; one in the electrical room and one in the process room (Photos 4 and 10, respectively). The smoke detectors are wired in parallel to the PLC, so if either one is activated, all power will be deactivate.
- One RKI Instruments explosive atmosphere detector mounted to the wall of the process room above the floor (Photo 10). The explosive atmosphere detector is pre-wired to deactivate all power in the event of an interior atmosphere that exceeds 25 percent of the lower explosive limit (LEL).
- In the SVE Building, lighting mounted to the ceiling with a standard light switch inside the entry door for both rooms. The process room has explosion-proof lighting mounted to the ceiling with a light switch inside the single man-door. In addition, the exterior of electrical room door is equipped with a solar-powered, motion sensitive exterior light.
- A main AC breaker panel is located inside the electrical room for the lights, flow transmitter, transfer pump, control panel, SVE blower, and exhaust fans (Photo 8).

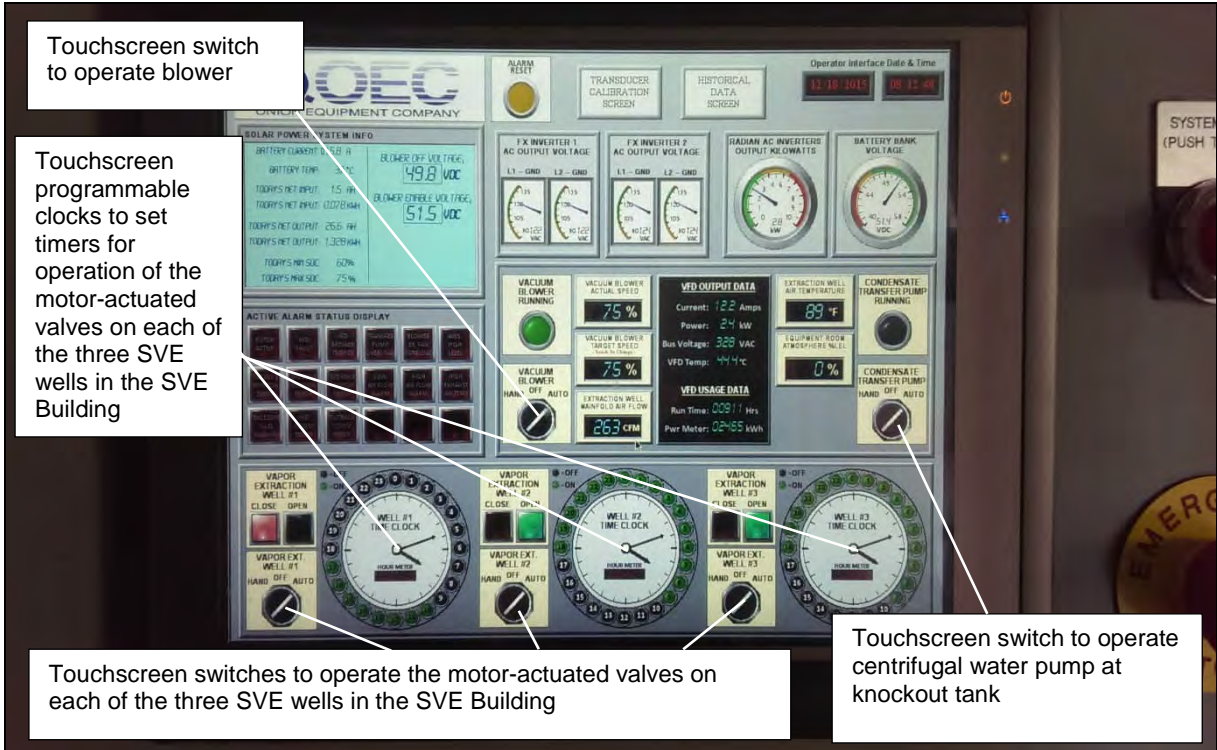


Photo 5. HMI control touchscreen



Photo 6. Inside of the treatment room



Photo 7. DC disconnect cabinet inside electrical room

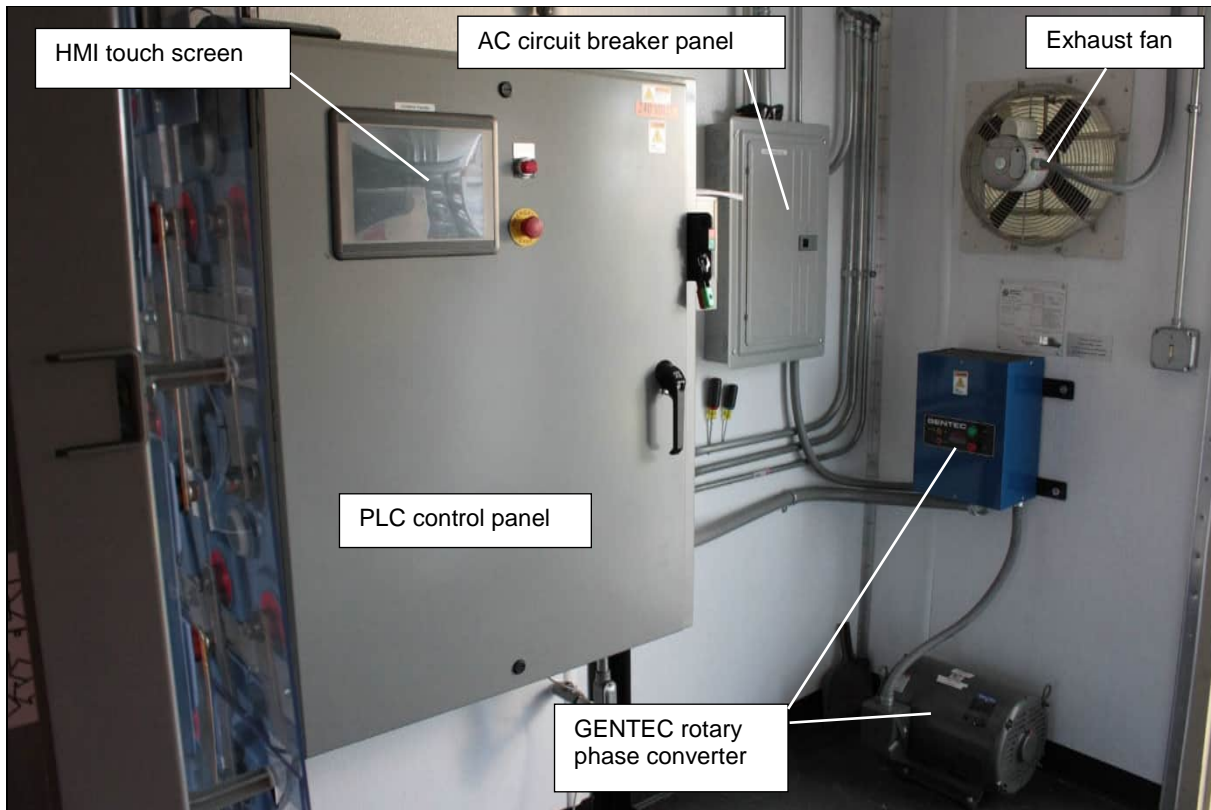


Photo 8. View of a portion of the inside of the electrical room



Photo 9. Location of exhaust fan in treatment room

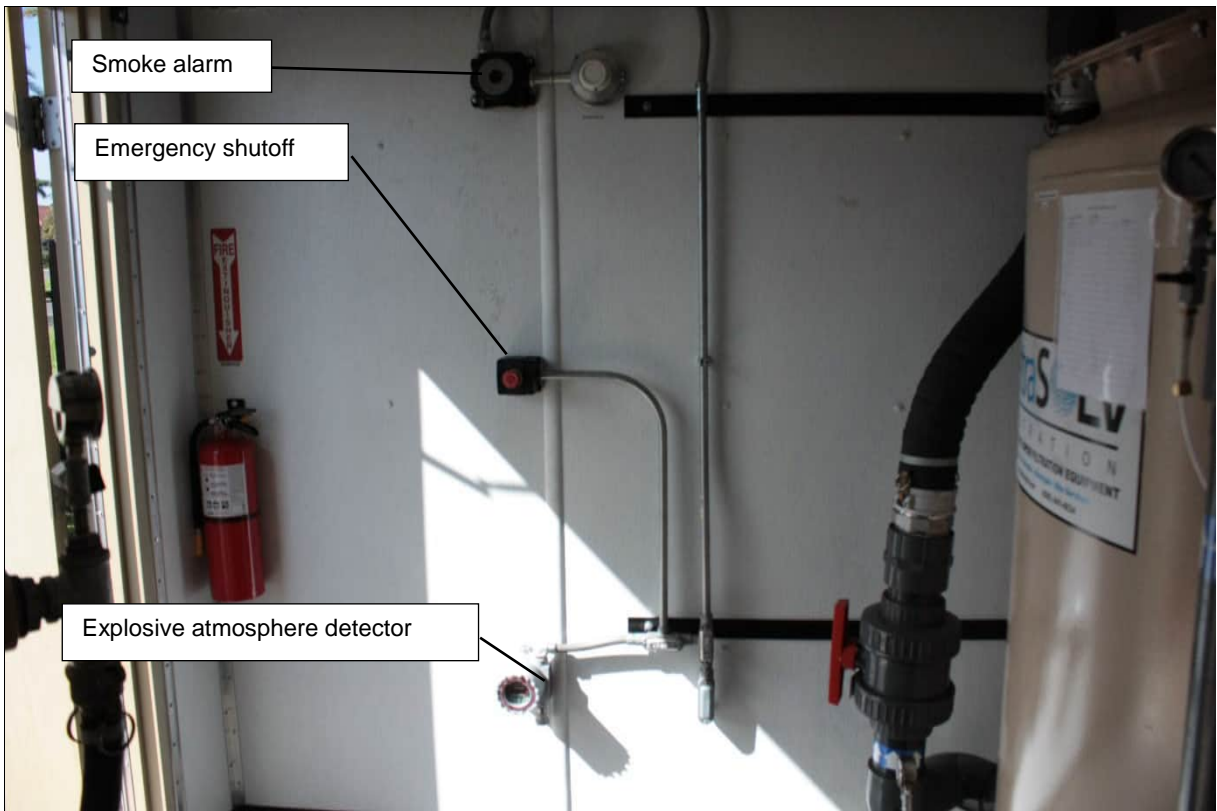


Photo 10. Explosive atmosphere detector

2.2.4 Off-grid Photovoltaic System

A total of 72 Suniva Monocrystalline ground-mounted PV panels (each 260 watts [W]) were installed to provide power to the SVE blower and auxiliary power requirements (Photo 11). These panels are mounted 3 to 5 feet above the ground and are secured on galvanized tubular steel supports and galvanized steel posts set in concrete.



Photo 11. 72-panel PV array

The PV system has been conservatively sized to support the blower and other loads. The SVE blower motor is rated for 11.3 kilowatts (kW) (at 460 V) including de-rate and efficiency factors, plus a 1.5 overpower factor for morning and afternoon operation. The PV array has been designed to supply 15.9 kW, or 40 percent surplus power. Surplus power is accumulated in the Outback EnergyCell 2000RE rack-mount AGM battery system.

The 72 PV panels are wired in six strings of 12 panels each. The PV conductors for each string of panels are bundled and routed into one of six SolarBos DC combiner boxes (Photo 11) mounted onto the PV array support posts. Each combiner box has a DC disconnect on the front panel.

Programmable voltage settings are used for the SVE system to automatically turn on in the morning and off in the evenings. Once the sun rises in the morning and allows the PV array to generate power that increases the battery bank voltage enough to cross a minimum voltage threshold, the blower will automatically turn on and begin operating. Likewise, after sunset, the battery bank voltage will drop. When it crosses a programmable shut-off threshold, the blower will automatically turn off overnight. Both the voltage thresholds can be manually adjusted, but should not require adjustment under normal operating

conditions. However, if changes to these thresholds is required (for example, after sunset run time because of seasonal conditions, degradation in system performance, or similar) this should be done in concert with Coconut Coast Electric, Outback, or both (see contact information in Table 2-1 of [Section 2.4]).

2.2.5 Horizontal Soil Vapor Extraction Wells

Horizontal Directional Drilling (HDD) was used to drill boreholes in which the three SVE wells and the conveyance pipes were installed. The boreholes for the SVE wells were approximately 6.5 inches in diameter and of various lengths. The target depths for the SVE wells was approximately 6 to 7 feet bgs, with the intent of keeping the horizontal borehole at least 5 feet bgs and 2 feet above the water table. The SVE wells are constructed of fiberglass-reinforced epoxy riser pipe and screen. The following SVE well locations are shown in **Figure 2-1**:

- SVE-1 is a 4-inch-diameter well with 170 feet of riser and 370 feet of well screen. Because of the presence of five pre-existing, 30-inch-diameter storm drains running in parallel in between residences at 507 Koaaina Alley and 606 Kulekia Alley, there is a 40-foot-long section of high-density polyethylene (HDPE) cross-over pipe that connects the well screen on either side of the storm drain corridor. The cross-over pipe comes up and over the storm drains and is approximately 3.5 feet bgs at its shallowest depth. The depth of the SVE 1 well screen is approximately 6.5 feet bgs.
- SVE-2 is a 3-inch-diameter well with 170 feet of riser and 200 feet of well screen. The distant end of the well terminates underneath the residence at 433 Opulepule Alley. The depth of the SVE 2 well screen is approximately 7 feet bgs.
- SVE-3 is a 3-inch-diameter well with 160 feet of riser and 360 feet of well screen. The depth of the SVE 3 well screen is approximately 7 feet bgs.

The three SVE wells align to a common area near the children’s playground off the northwestern corner of Kumama Alley inside Onizuka Village (Photo 12). At this location, each SVE well enters a dedicated steel-frame, flush-mount vault with a spring-assist cover (Photo 13). The termination of each well inside its vault includes an HDPE “Y” or “T” with the straight end terminating inside each vault with a female-threaded cleanout cap. The cleanout caps can be removed in the event that well maintenance is needed. The elbow portion of each SVE well connects to an HDPE ball valve, and then to HDPE conveyance pipe inside each vault. The ball valves contain a 2-inch-square operating nut and can be opened or closed using the dedicated wrench for these valves. The 2-inch operating nut wrench is generally stored inside one of the vaults.

OPERATIONAL TIP – If maintenance (such as flushing or redevelopment) is to be performed on any of the SVE wells, the ball valve to that well should be in the closed position to prevent any liquids, slurries, or solids from entering the conveyance pipe.



Photo 12. Location of SVE well vaults inside Onizuka Village



Photo 13. View inside a SVE well vault during installation

From the SVE well vaults inside Onizuka Village, the three conveyance pipes run in a single bundle through a 10-inch-diameter bore, underneath Freedom Avenue, and enter the SVE Building through a cutout in the floor. The maximum depth of the conveyance pipe underneath Freedom Avenue is approximately 12 feet bgs.

2.2.6 Remediation Components

At the entry point of the SVE well conveyance pipes inside the building, each SVE well includes a dedicated throttle valve (G.I.E. cast iron, unlined diaphragm valve), a vacuum gauge (4-inch stainless-steel case, glycerin filled, 0 to 15 inches Hg), and a flow indicator (Dwyer DS-300-3-inch Series averaging pitot tubes with Capsuhelic differential pressure gauges). Each leg is remotely controlled (open/closed) from the PLC by a dedicated Series 92 valve actuator (Photo 14).

Upon entering the SVE Building, vapor is routed across a knockout tank to separate and contain any liquid that may be entrained in the air flow (Photo 15). Once liquid is separated, vapor extracted by the SVE system is discharged to dual treatment trains of VGAC. Each of the two trains contains two 2,000-pound vessels of VGAC (or 4,000 pounds per train) for a total of 8,000 pounds for both trains (Photo 16). One train of two beds in lead-lag configuration is used until the first bed is saturated, after which time one or more beds from the second (back-up) treatment train are connected, using flexible hose. Sample ports are installed at the pre-treatment, intermediate-treatment, and post-treatment points in the process stream for each treatment train to facilitate breakthrough monitoring. Treated vapor effluent is routed through a single exhaust pipe with a silencer, positioned approximately 5 feet above the building roof or approximately 15 feet above ground (Photo 17).

Accumulated liquid inside the knockout tank is drained via a Goulds NPE centrifugal liquid pump through a pair of vessels (in series) containing LGAC to treat the liquid (Photo 18). The knockout tank has a float level set so that when a liquid volume threshold is reached, the centrifugal pump will automatically activate and pump the liquid out of the knockout tank and into the LGAC treatment vessels. Immediately downstream of the water pump, an in-line liquid flow meter (Omega Engineering turbine flow meter model number FTB793) is installed in the water line to quantify the accumulated volume of water pumped from the knockout tank (Photo 15). After treatment, liquid is gravity drained from the LGAC vessels to an infiltration gallery located on the northwestern side of the SVE Building (Photo 19). The infiltration gallery consists of 20 feet of 6-inch-diameter perforated Schedule 40 PVC drain tile, installed in a gravel trench (similar to a French drain system) approximately 5 feet bgs and backfilled with crushed gravel.

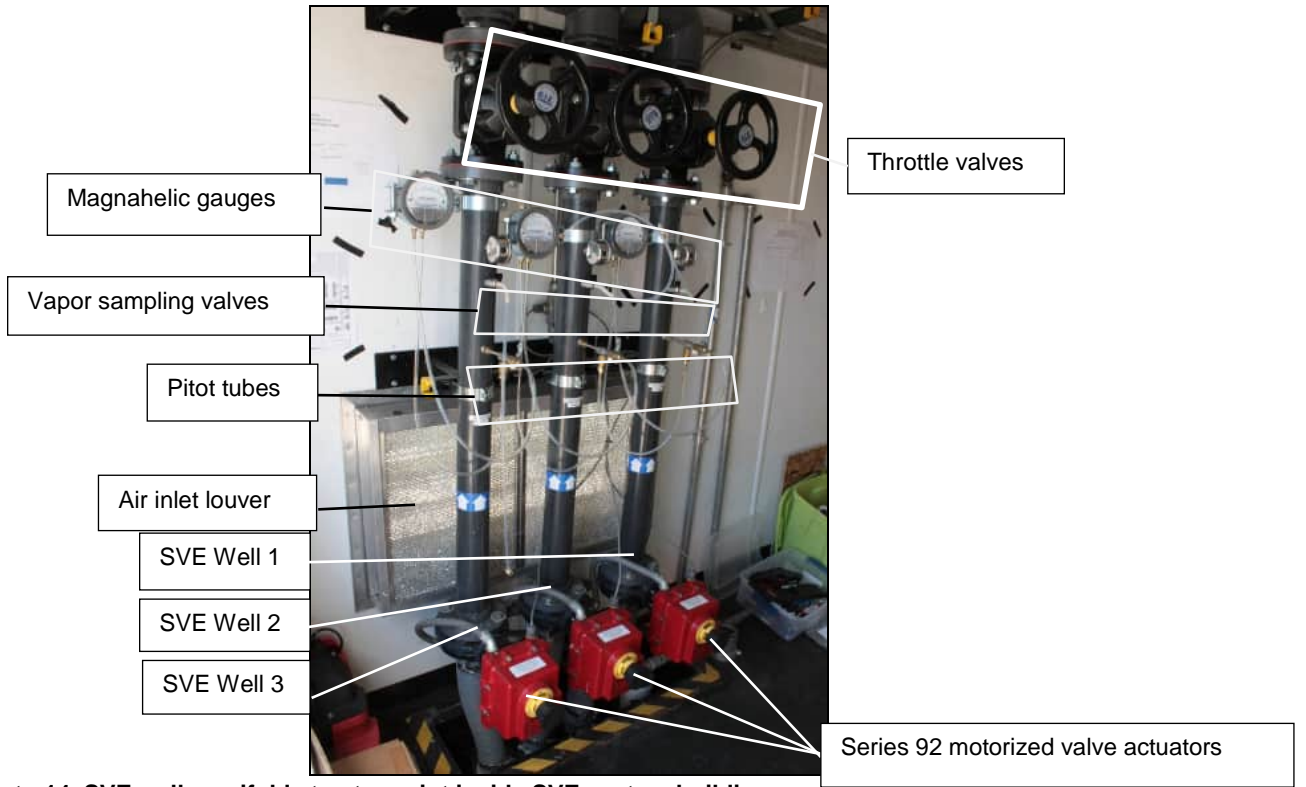


Photo 14. SVE well manifold at entry point inside SVE system building

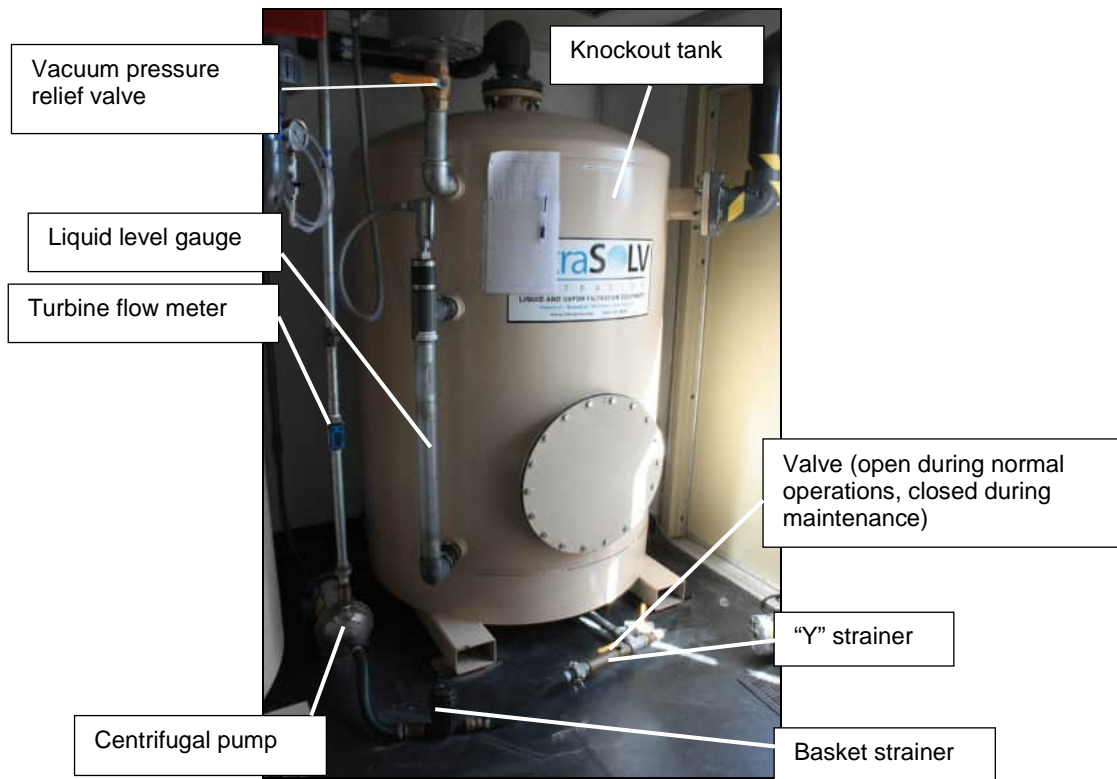


Photo 15. Liquid separation and discharge system

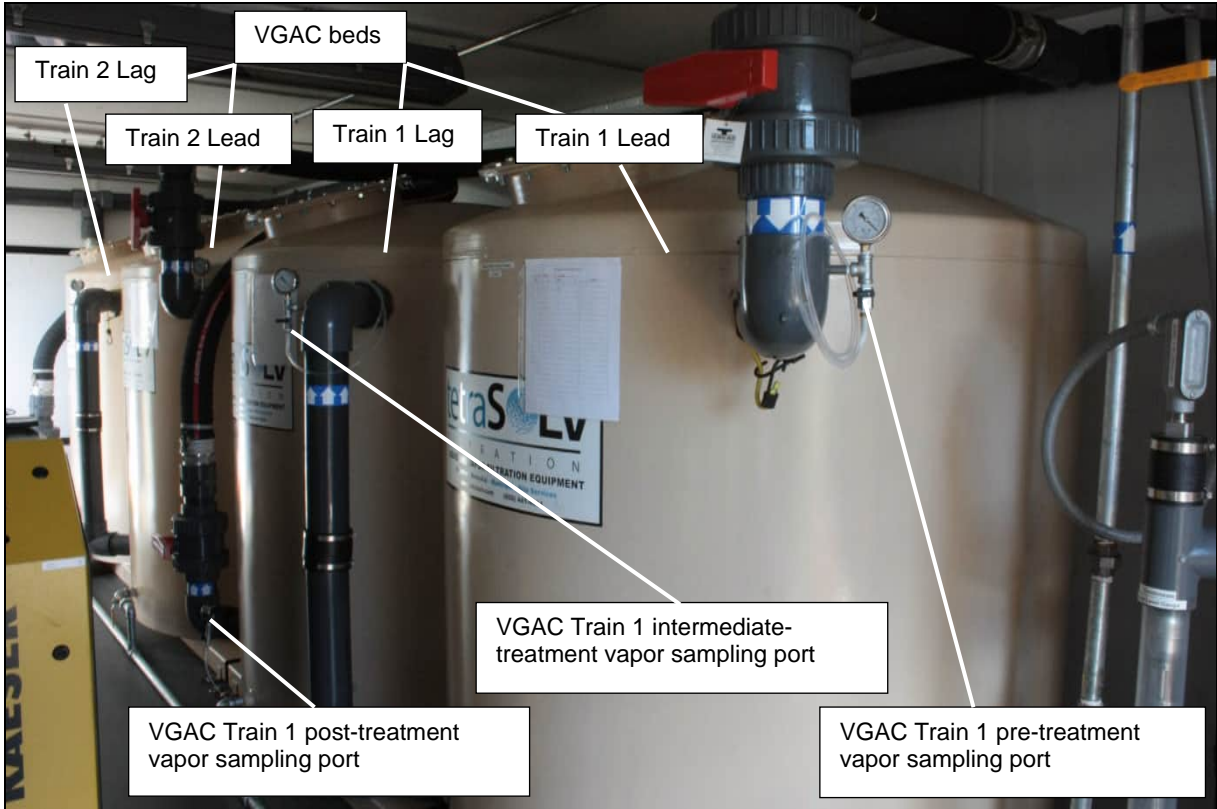


Photo 16. VGAC beds and vapor sampling ports



Photo 17. Exhaust stack on exterior of SVE system building with silencer

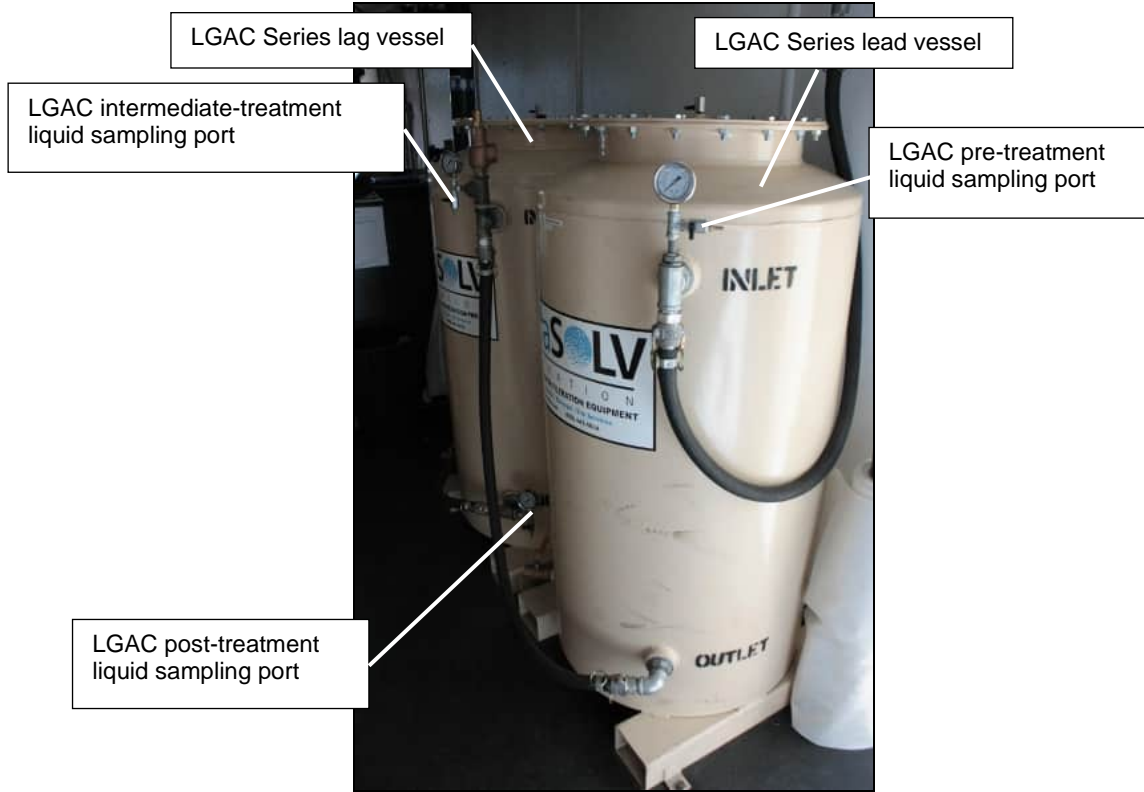


Photo 18. LGAC beds and liquid sampling ports

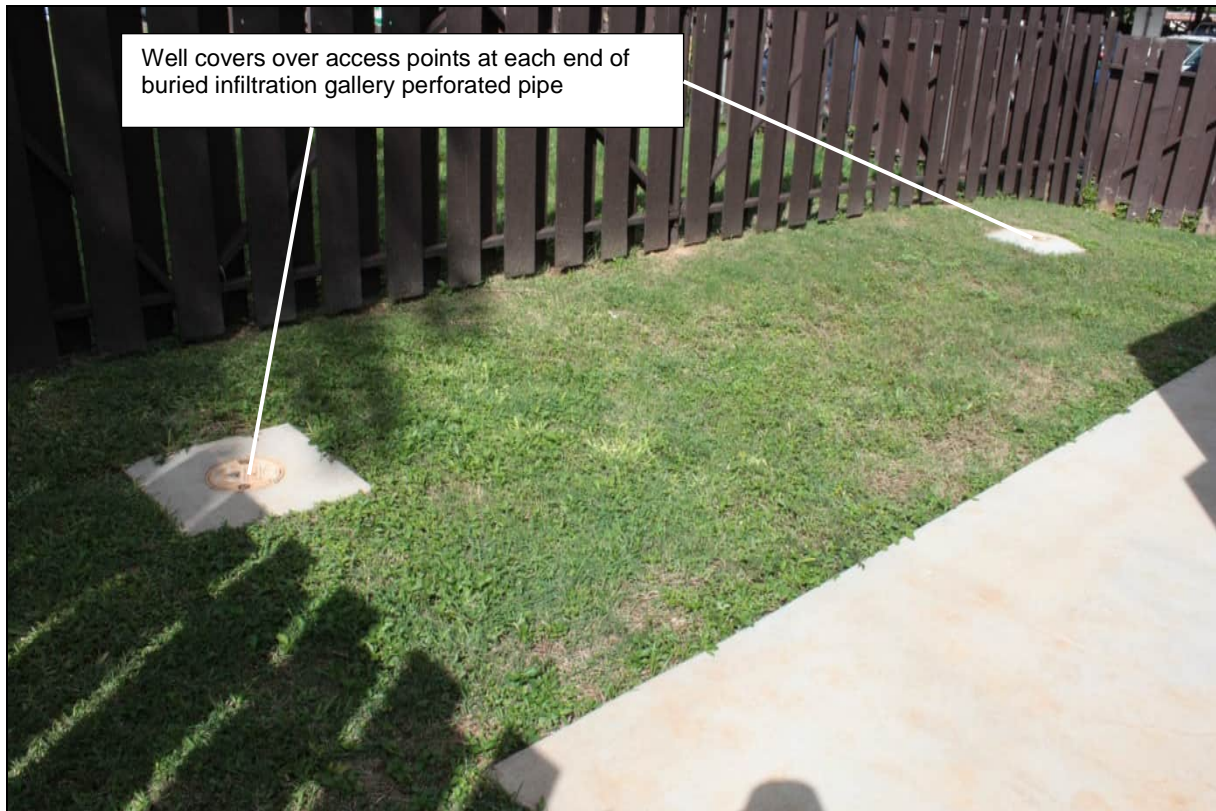


Photo 19. Infiltration gallery access points at the two well covers

2.3 Monitoring Locations

2.3.1 Vapor Monitoring Points and Pressure Monitoring Points

VMPs and pressure monitoring points (PMPs) are installed inside Onizuka Village to allow for monitoring of the SVE system performance. VMPs were constructed for soil vapor sampling. PMPs were constructed for the purpose of attaching a digital manometer to measure for the presence and magnitude of a negative pressure (vacuum) in soil. While the VMPs and PMPs were initially intended to be used for different monitoring purposes, they are actually constructed the same way using the same materials. Thirteen VMPs/PMPs are currently installed in proximity to SVE-1. Three VMPs/PMPs are currently installed in proximity to SVE-2. Six VMPs/PMPs are currently installed in proximity to SVE-3. The 22 VMP/PMP locations in relation to the SVE wells are shown in **Figure 2-1**. Boring logs for the VMP/PMP locations are presented on the compact disc (CD) in Appendix E.

VMPs and PMPs were constructed by installing a 6-inch-long screen implant in the middle of a 1.5-foot-thick interval of #3 Monterey sand in an open borehole. The screen implants are connected to sample tubing (3/16-inch inner diameter by 1/4-inch outer diameter) with a barbed connection. Hydrated granular bentonite placed on top of the sand seals the screen implant and sanded interval from short circuiting to ambient air. The effective permeable zone for monitoring is the entire sanded interval. In general, the sanded interval of the VMPs and PMPs installed in Onizuka Village are approximately 1.5 foot thick and extend from approximately 4.5 to 6 feet bgs. Exceptions to this profile of sanded interval include the following:

- VMP3-06A is sanded from 3.5 to 6 feet bgs with screen implant from 4 to 4.5 feet bgs.
- SVE3-PMP01 is sanded from 3 to 5 feet bgs with screen implant from 3.25 to 3.75 feet bgs.
- SVE1-PMP08 is sanded from 6.5 to 8 feet bgs with screen implant from 7 to 7.5 feet bgs.

The VMPs and PMPs are completed at the ground surface with flush-mount traffic-rated well covers set in place with a small concrete pad.

Seven four-plex residential buildings (28 individual residences) located near the areas where TPH hotspots in soil gas were previously found also have sub-slab sampling ports in their garages. However, these ports are generally used for soil vapor sampling and not for SVE system O&M.

2.3.2 Groundwater Wells

At the onset of operation, the SVE-1 well was found to have a propensity for producing groundwater into the SVE well and into the SVE system knockout tank, especially following periods of prolonged heavy rains. In an effort to assess the nature of groundwater intrusion into well SVE-1, five temporary microwells were installed along portions of SVE-1 to allow for gauging the depth to groundwater with the SVE system powered on. The five temporary wells are identified as TW05 through TW09 in **Figure 2-1**. Boring logs for these wells are presented on the CD in Appendix E. These wells can be used to monitor the potential for groundwater updraw caused by vacuum in well SVE-1.

2.4 Listing of Supporting Firms and Personnel

Table 2-1 lists the firms and personnel involved in system installation.

TABLE 2-1

Listing of Firms and Personnel involved in System Installation

Supporting Firms/Contacts	Role	Contact Number
Applied Science Laboratory (Kathy McKinley)	Analytical Lab for vapor and condensate samples	541.768.3144
Lendlease Corporation (Grant Arnold)	Assistant Environmental Manager (Environmental point of contact for Hickam Communities; responsible for coordinating environmental issues, including pesticide-impacted soil awareness training, for work within Onizuka village)	808.343.2134
Coconut Coast Electric (Gary Seals)	Electrical Modifications	808.651.7732
PCS (Jingbo Chang)	Investigation Derived Waste and GAC management and vacuum truck services	808.545.4599
Outback Power(Mark Mays)	Off-grid Design Engineer	425.232.1649
Kyle Combs	PLC Programmer (coordinate through Coconut Coast Electric)	765.748.1919
Speed Space	Fabricator of the building	800.418.2666
Tetrasolv (Doug Dallmer)	Installer of SVE Building Internals and oversaw onsite installation	713.703.6516
Ohana Nui (Michelle Aguinaldo)	Grounds maintenance inside fenced area of SVE Building	808.422.8383

3.0 Operation and Maintenance

3.1 Equipment Maintenance

This section discusses major pieces of equipment including the blower, PV array, AGM batteries, liquid separation discharge system, GAC changeout, and exterior building maintenance. Monthly maintenance checklists for these items are provided in Appendix A-6 and Appendix B-6. Detailed information regarding installation and O&M for all equipment is discussed in Section 3.2 for both the SVE system (Section 3.2.1) and off-grid components (Section 3.2.2). The following details additional information relative to O&M provided in Appendixes A and B.

Soil Vapor Extraction System

- Appendix A-1, O&M Manual (Onion Equipment Company)
- Appendix A-2, Building Layout, P&ID, and Electrical Schematics
- Appendix A-3, Fabrication and Installation Drawings
- Appendix A-4, GAC Changeout Procedure
- Appendix A-5, Factory Acceptance Testing Checklist
- Appendix A-6, Checklist for Monthly Inspection for SVE Process, Wells, and Ancillary Equipment [Note that the inspection frequency in the checklist may be increased if operational issues manifest or troubleshooting is required.]

Off-grid System

- Appendix B-1, O&M Manual for Off-grid System
- Appendix B-2, Electrical Drawings (PV and Control Room)
- Appendix B-3, Re-start Inverter/Load Center Rewiring One-line Diagram
- Appendix B-4, Inspection Form and Warranty
- Appendix B-5, Emergency Shutdown Procedure
- Appendix B-6, Checklist for AGM Quarterly Battery Inspection

3.1.1 Blower

The KAESER DB 166 C blower requires routine maintenance. Refer to the KAESER Assembly and Operating Manual (Appendix E) for maintenance instructions and associated safety precautions (a copy of the manual will be kept in the SVE Building).

SAFETY NOTE: It is important to switch off and lock out the power supply to the blower, and to verify the absence of voltage before working on live components, the vacuum system, or the drive system. Also, touching the fan wheel or the belt drive while the machine is running can result in serious injury.

Tables 3-1 and 3-2 summarize the maintenance schedule in the KAESER Assembly and Operating Manual. A maintenance log is kept with the blower to keep track of all maintenance activities performed. Tables 3-3 and 3-4 present recommended blower spare parts and the type of blower lubricant, respectively.

TABLE 3-1
Regular Blower Maintenance Tasks

Interval	Maintenance Task	See Chapter in Operating Manual for Task Instructions
24 hours after initial commissioning	Check belt tension	10.4
50 hours after initial commissioning	Check all screwed electrical connections and tighten if necessary	--
500 hours after initial commissioning	Change the lubricating oil	10.7
Up to 500 hours Or monthly	Check the oil level	10.5
	Check belt tension	10.4
	Check the air filter	10.8
Up to 2,000 hours At least annually	Drive motor bearings with re-greasing facility: Regrease the motor bearings	10.9.1
Up to 3,000 hours* At least annually	Change the SF220 lubricating oil (An adhesive label identifying the used lubricant is attached to the blower block)	10.7
Up to 3,000 hours At least annually	Change the air filter	10.8
Up to 6,000 hours* At least annually	Change the SF220 lubricating oil (An adhesive label identifying the used lubricant is attached to the blower block)	10.7
Annually	Check the safety relief valve	10.10
	Check all screwed electrical connection and tighten if necessary	--
Up to 12,000 hours At the latest every 3 years	Replace the drive belt	10.4
As needed	Check rotors for contamination	10.4

Notes:

hours = operating hours

*The intervals for lubricating oil changes at high thermal stresses much be reduced and can be determined upon analyses of the oil.

TABLE 3-2
Regular Blower Service Tasks – only an authorized KAESER service representative should carry out service work

Interval	Service Task
Up to 12,000 hours At the latest every 3 years.	Permanently greased drive motor bearings: Have motor bearings checked
Up to 12,000 hours At the latest every 3 years.	Fan motor (sound enclosure): Have motor bearings checked
Every 20,000 hours or At the latest every 5 years	Drive motor bearings with regreasing fittings: Have motor bearings checked

TABLE 3-3
Recommended Blower Spare Parts

Name	Quantity	Number
Air Filter	1	1250
Sealing Ring	1	1252
Drive Belts (set)	1	1800

TABLE 3-4
Blower Lubricating Oils

Name	Quantity (quarts)	Material Number
OMEGA FLUID SB-220	1	831057.00010
	5	831057.0
OMEGA FLUID FGB-220	1	892702.00020
	5	892702.00010

3.1.2 Photovoltaic Array

The PV Array should be inspected monthly for the following items:

- Check PV racking and associated bonding hardware for corrosion, damage, or deformation (repair or replace if observed).
- Check visible portions of PV conductors to look for compromises in the wire insulation (such as nicks or cuts). Note: do not touch any exposed portion of wire.
- Inspect the top side of the PV panels to look for cracks, excessive debris, and similar.
- Inspect the bottom side off the PV panels to look for cracks or significant scratches in the white backing of the panels.

The top of the PV panels should be cleaned quarterly for efficient solar power generation. When cleaning the panels, use a gentle stream of water and mild soaps such as automotive detergents. If there are any questions on the selection of soaps, contact the PV supplier. Panels should be cleaned in the early morning or late afternoon when it is cooler and there is no direct sun, as **applying cold water to the surface of hot panels may crack the glass of the panels and must be avoided.** A soft brush or sponge on a long extension pole can be used to access the panels. Do not use abrasive scrubbers or aggressive chemicals to clean the panels. **Do not use any soaps that contain bleach.** The following is a general sequence for cleaning the surface of the PV array:

- Wet the panels and rinse off any loose debris that has accumulated. Avoid contacting the PV panels with the hose and nozzle or any metal parts of the cleaning instruments used.
- Mix the soap solution per the manufactures or PV vendor recommendations in a clean bucket or pail.
- Re-wet the section of panel to be cleaned.
- Clean the panel with a soft sponge or brush, moving from high to low.
- Rinse the section that was cleaned.
- Repeat sequence for the remaining sections of the PV array.
- After the PV array is cleaned, rinse the entire surface again.
- Please note the following:
 - If the water being used to clean the array becomes dirty or contains grit or loose debris (that could scratch the array) prepare a clean bucket of solution.
 - Do not use any bleach containing soap.

The nearest source of potable water is at the gas station, 250 feet from the PV array. This area can be reached with a series of 5/8- or 3/4-inch inside diameter hoses (the larger diameter hose is preferred to maintain adequate water pressure). Wet the array before cleaning and rinse the panels moving from high to low.

3.1.3 Absorbed Glass Mat Battery System

A licensed electrician experienced with the specific equipment and battery system used will conduct quarterly electrical inspections of the off-grid PV system. The inspections will focus on the battery rack and the balance of the electrical system as defined herein. An example checklist for documenting the required information during the inspection is provided in Appendix B-6.

Following the inspection and before the conduct of subsequent inspections, the past inspection checklist and any ongoing observations (if any), should be noted and the example checklist revised as appropriate. Each inspection will be concluded with a brief summary including the completed checklist, data sheets, pictures, and other supporting information. The inspections are currently contracted to be conducted by Coconut Coast Electric (see Section 2.4 for contact information).

The procedure for conducting the inspection and testing of the AGM batteries is a requirement for maintaining the battery warranty, as stated in Section 11.3, Maintenance Records, of the 2008 EnerSys document *PowerSafe Safety, Storage, Operating and Maintenance Manual for VRL Battery Systems mSeries, DDm, DDS, DDV, and SC* (provided on the Appendix E CD). The minimum inspection frequency required to maintain the warranty is quarterly. Additional inspections may be necessary if there is excessive depth of discharge, if corrosion or leaks are observed on the batteries or interconnection strapping, and if there are problems starting or shutting down or degradation in run time. The following sections of the EnerSys document provide further information regarding the AGM battery inspection:

- Section 11.1, Battery Cleaning (pages 22 and 23): Clean batteries as specified in the procedure if there is evidence of dust accumulation or mild corrosion. Because the system is new, heavy post corrosion is not anticipated.
- Section 11.3, Update Maintenance Records (page 26): Use current RE-2000 install sheet (page 28) as a comparative baseline to track the following:
 - Individual cell voltages
 - Cell to cell connection resistance (ohms)
 - Terminal connection resistance (ohms)
 - Equipment room ambient temperature
- Battery Capacity Test, as described in Section 11.2.1: Should only be performed if the “State of Charge” (SOC) shown on the MATE3 drops below 40 percent on a daily basis.

Additional areas for inspection are included on the checklist in Appendix B-6.

3.1.4 Liquid Separation and Discharge System

Inspection of the liquid separation and discharge system should be conducted monthly, with maintenance performed as needed. During normal system operations, the valve handle at the base of the knockout tank in between the tank outlet and the centrifugal liquid pump needs to remain open so that liquid collected in the knockout tank can drain through the pump, into the LGAC vessels, and out to the infiltration gallery. If any maintenance of the liquid discharge system is needed, this valve will need to be closed first.

MAINTENANCE NOTE: The “Y” strainer and basket strainer in-line between the knockout tank and centrifugal pump should be inspected and cleaned monthly to prevent clogging of the line. These strainers can be cleaned by simply disassembling them, flushing with clean water, and reassembling.

The centrifugal pump and the Omega Engineering turbine flow meter should be verified to be working properly. Consult the equipment manuals (on the CD in Appendix E) if maintenance is needed. For the pump to turn on automatically, the liquid level gauge on the outside of the knockout tank needs to remain clean. Particulates entrained in the water inside the liquid level gauge clear tube may settle and cause a coating to build up. Monthly inspections should verify that the components inside the liquid level gauge are clean enough to allow the floating mechanism to freely float and sink with the water level. If

needed, the components inside the float tube and the inside walls of the clear tube can be cleaned by first draining the water in the knockout tank to a level at least below the bottom of the gauge. The gauge can then be disassembled and cleaned before being reassembled.

After treatment in the LGAC vessels, liquid effluent is drained by gravity from the LGAC vessels to the infiltration gallery. The two 8-inch-diameter well covers from the northern end of the building should be inspected monthly by opening the covers and inspecting the visible portions of the infiltration gallery piping to ensure water is properly infiltrating into the ground and not pooling.

3.1.5 Granular Activated Carbon Changeout

The SVE process has two VGAC trains and one LGAC train. Each VGAC train includes two 2,000-pound vessels of VGAC for a total of 4,000 pounds per train, or 8,000 pounds for both. The LGAC train is comprised of two 500-pound beds for a total of 1,000 pounds. VGAC changeout is determined when breakthrough occurs based on ongoing monitoring (see Section 3.3.3). When one of the two trains has breakthrough, the exhaust gas flow is valved over to the remaining train. When the second train approaches breakthrough, then both trains are changed out. Alternatively, the trains can be changed out as breakthrough occurs. Similarly, LGAC is changed out as dictated by sampling results (see Section 3.3.3) or a minimum changeout of once per year. Spare VGAC and LGAC is inventoried at the former John Rodgers Tank Farm (JRTF) or other NAVFAC-designated location. Refer to the GAC Changeout Procedure in Appendix A-4 and the AHA for O&M (which includes GAC changeout) in Appendix F-2.

The carbon changeout and transport and disposal process includes the following work, which will be provided by a yet-to-be-determined subcontractor (see Section 2.4 for contact information):

- Mobilize and demobilize equipment necessary to support changeouts, including the vacuum extraction and refill unit, flatbed truck, and forklift. The GAC vessels are located inside a building with no roof access. There is approximately 18 inches between the interior roof and the VGAC access lids (Photo 9). Vacuum extraction of the carbon will require using an extended length of hose (at least 30 feet) to reach from the building to the vacuum equipment. Work around the SVE Building requires the use of an all-terrain, extended-reach forklift. A rough terrain, extended reach forklift is required to place and remove supersacks from the fenced area.
- Use a Hurricane 500 (or equivalent) (see Appendix A-4) diesel-powered and trailer-mounted suction unit to remove and refill the vessels (Industrial Vacuum). The unit includes a cyclonic separator, baghouse, and blower safety filter. Fugitive emissions will be controlled during the GAC changeout process so there is no visible emission. The equipment is available for rent locally. While removing the GAC, look for and document the location of any evidence of channeling within the bed.
- Place spent GAC in supersacks on wooden pallets outside the SVE Building, ready to be loaded, secured, transported, and off-loaded at the JRTF (or other on-Base designated location) for staging before disposal.

- Before securing the spent GAC in the supersacks, collect analytical samples to support disposal (see Section 3.3.3). While staged on-Base, the GAC will be analyzed and profiled for subsequent disposal.
- Load, secure, transport, and off-load fresh GAC from the JRTF to the SVE Building to refill the GAC vessels.
- Before refilling with fresh GAC, inspect each vessel for any mechanical issues including the grates, supports, and for any signs of corrosion.
- Refill the appropriate vessels with fresh GAC using suction to convey carbon from the supersacks to the vessels while minimizing dust generation.
- Level and smooth the top of the carbon vessels to mitigate channeling. Replace and secure the vessel manway and perform clean-up activities.

Reactivated **coconut-shell** VGAC and LGAC is supplied from the Continental United States and shipped by barge to Oahu for off-loading and subsequent inspection, loading, securing, transport, and off-loading at the JRTF location or other NAVFAC-designated location. GAC will be provided in lined, waterproof supersacks (1,000 pounds per sack), on wooded pallets. Once off-loaded at the JRTF, the GAC will be covered with 10-mil black plastic and secured.

3.1.6 Fire Extinguishers and Safety Equipment

The electrical room and the process rooms in the SVE Building each have a 10-pound ABC dry chemical fire extinguisher mounted on the wall inside the doorway to each room. The fire extinguishers should be inspected monthly, and shaken and inverted to prevent the powder from settling and packing. The fire extinguishers should be serviced and recertified every year. If a fire extinguisher is used, regardless of quantity, it should be serviced and completely recharged. During this monthly inspection, also inspect the balance of the site safety equipment and signage.

3.1.7 General Exterior Maintenance

The exterior of the SVE Building, wood fence surrounding the SVE system building, and PV array will be inspected monthly to monitor their condition. Fence inspection should also include the gate, to monitor the functionality of the hinges and locking mechanisms. Any deficiencies should be repaired as soon as possible.

Grass and weeds cannot be allowed to grow to heights where they would create shade on the PV panels. Vegetation can be maintained by cutting, pulling from the roots, or lightly applying commercially available, household-type grass and weed killer. The use of any herbicide must be approved by the Base and a material safety data sheet made available onsite.

The Hickam landscaping contractor (**Ohana Nui**) has agreed to cut the grass inside the fenced area on a regular basis. Ohana Nui was provided the combination to the lock on the access gate. In the event that the current lock combination is no longer accurate, or if the lock type is changed, Ohana Nui should be notified. The primary point of contact at Ohana Nui is Michelle Aguinaldo at (808) 422-8383 or michelle@ohana-nui.com.

3.2 Soil Vapor Extraction Facility Supporting Information

This section summarizes available installation and O&M manuals, cutsheets, and other information applicable to both the SVE and off-grid systems. This information is stored in the SVE Building and presented on CD as Appendix E.

3.2.1 Soil Vapor Extraction System Supporting Information

A standalone O&M manual for the process portion of the SVE Building is provided in Appendix A-1. The following bullets list installation and O&M manuals and cutsheets of vendor-provided equipment for the process portion of the SVE Building. The listed items are provided on the CD in Appendix E; a hard copy of each is maintained onsite in the SVE Building.

- Rotary Blower Assembly and Operating Manual (KAESER)
- Blower Installation Data Sheet (KAESER)
- Rotary Phase Converter Operation and Installation Manual (GENTEC)
- M2A Transmitter (Catalytic LEL Detector) Operator's Manual (RKI INSTRUMENTS)
- Liquid Transfer Pump Model NPE/NPE-F Instruction Manual (GOULDS)
- NPE 316L SS cutsheet (GOULDS)
- Explosion-Proof Exhaust Fan Cutsheet (CCI THERMAL TECHNOLOGIES)
- 3200 See-Flo Indicator (ERDCO)
- Float Switches (FPI SENSORS INTERNATIONAL)
- Diaphragm Valves and Actuators (GIE, INC)
- Lateral Drain Pipe (MW MATTSON/WITT)
- Bottom Load Multi-Jet Meters (MASTER METER)
- Pressure and Vacuum Relief (NATIONAL VACUUM EQUIPMENT, INC)
- 93 NPT Full Port Hot Forged Brass Ball Valves (RUBINETTERIE UTENSILIERIE)
- ST51 Mass Flow Meters Installation and Operation Guide (FCI FLUID COMPONENTS)
- In-Line Flow Conditioning Plates Cutsheet (SIERRA)
- Immersible Thermal Gas Mass Flow Meter Cutsheet (SIERRA)
- Explosion-Proof Smoke Detector Instructions (PYROTECTOR)
- Compact Filter Silencers Cutsheet (SOLBERG)
- Check Valves Cutsheet (STRATAFLO)
- Electric Actuators (Series 92) (ASAHI/AMERICA)
- Temperature Switches (AUTOMATION DIRECT, PROSENSE)
- D-Ring Lifting Lugs (TANDEMLOC)
- LGAC Vessel Elevation and Plan (TETRASOLV)
- Moisture Separator Elevation and Plan (TETRASOLV)
- VGAC Vessel Elevation and Plan (TETRASOLV)

3.2.2 Off-grid Photovoltaic System

A standalone O&M manual for the off-grid portion of the SVE Building (including the PV Array) is provided in Appendix B-1. The following bullets list installation and O&M manuals and cutsheets of vendor-provided equipment for the PV Array and electrical room. The listed items are provided on the CD in Appendix E; a hard copy of each is maintained onsite in the SVE Building.

- Flex Max Charge Controller (OUTBACK)
- Flex Max Quick Start Manual (OUTBACK)
- Flex Net DC User's Guide (OUTBACK)
- GS Load Center Installation Manual (OUTBACK)
- MATE3 Owner's Manual Addendum (OUTBACK)
- VRLA Battery Systems, Safety, Storage, Operating and Maintenance Manual (ENERSYS)
- EnergyCell RE High Capacity Battery Installation Guide and Owner's Manual (OUTBACK)
- Radian Series Inverter/Charger Installation Manual (OUTBACK)
- Radian Series Quick Start Guide, Setup and Programming (OUTBACK)
- Radian Mate3 Startup Guide (OUTBACK)
- AXS Port SunSpec Modbus Interface Owner's Manual (OUTBACK)
- HUB Communication Manager User's Manual (OUTBACK)
- Exhaust Fan (16 inch, 115 Volt) (Purchased GRAINGER and DAYTON Product)
- PV Cell Cutsheet (SUNIVA)
- PV Installation Manual (SUNIVA)
- Combiner Boxes Heavy Duty Switches (SIEMENS)
- Power Supply Cable (X-FLEX)
- •Direct Current (DC) Disconnect (EATON)
- Voltage Drop Calculation

3.3 Sampling

3.3.1 Flow Rate Monitoring and Targets

Flow rate monitoring is conducted to evaluate operation of the blower and performance of the horizontal wells. Flow rate data can be collected from the appropriate SVE well manifold leg inside the building (Photo 14).

The flow rate should be checked using the Dwyer DS-300 averaging pitot tubes, combined flow at the mass flowmeter, blower motor amperage, and battery voltage (charge) status from the HMI.

Flow at individual header legs must be calculated based on differential pressure measurements at the three Dwyer DS-300 pitot tubes (one for each manifold leg). The temperature of the extracted vapor should also be recorded. The DS-300 instruction sheet is available online and can be downloaded from the following location: http://www.dwyer-inst.com/PDF_files/DS-300_iom.pdf. The startup team should download this instruction sheet.

The flow equation, solving for flow ("Q"), uses measured input parameters static line pressure (low pressure), differential pressure (difference between static and dynamic

pressure), and temperature. Additional information may be found online at http://www.engineeringtoolbox.com/pitot-tubes-d_612.html).

Any Gas

$$Q \text{ (SCFM)} = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

Where

K = flow coefficient of 0.67 for 3-inch pipe (as measured at the manifold)

D = pipe inside diameter (2.9 inches)

P = static line pressure is measured in pounds per square inch atmospheric (psia) on the gauges (psia = gauge pressure + 14.7). Delta P is the difference between static (low) pressure and dynamic pressure across the pitot tube (refer to engineering toolbox link above).

S_s = specific gravity of Air at 60 F = 1

T = temperature in degrees Fahrenheit + 460 (degrees Rankine [R])

The above flow equation can also be downloaded in spreadsheet form from the Dwyer website at http://www.dwyer-inst.com/Products/DS_Calculator.cfm

The main line (header where all three manifold legs are connected) mass flowmeter has a direct-read (local) display in scfm, and can also be read remotely and from the HMI/touchscreen. Flow velocity measurements and calculated flow will be recorded on the weekly performance monitoring form in Appendix D-1.

3.3.1.1 Flow and Vacuum Targets

The target SVE flow is 0.5 scfm per foot (scfm/ft) of screen. Flow targets for each SVE well are shown in Table 3-5.

TABLE 3-5
Target Flow Rates

SVE Well	Screen Length (feet)	Target Flow Rate (scfm)
SVE-1	500	250
SVE-2	200	100
SVE-3	360	180

The practical flow limit of the blower at 100 percent motor speed setting using the variable frequency drive (VFD) is approximately 275 scfm. Expected vacuum level, as measured at the SVE manifold legs, is 6 to 8 inches Hg (80 to 110 inches water column [w.c.]). (Note: the

dynamic pressure measured across the pitot tube is not the same as the vacuum pressure in the line.)

If the blower needs to be operated at less than 100 percent motor speed to reduce blower motor amperage (so not to exceed the 23-ampere [A] upper limit) and extend the service time of the batteries, flow can be rotated between all three wells at approximately 0.3 to 0.4 scfm/ft. Note that blower motor amperage is strongly influenced by vacuum pressure (load) on the blower, and less influenced by flow and motor revolutions per minute. For example, during the FAT, the sample-measured amperages shown in Table 3-6 were recorded as a function of vacuum.

TABLE 3-6
 Factory Acceptance Testing Results

Motor Speed (%)	Vacuum (inches Hg)	Flow Rate (scfm)	Amperage (A)
50	7	135	19
50	10	135	23
75	5.5	248	15
75	7.5	228	19
100	5	315	18
100	5	300	24

Note:

23 A is the maximum motor amperage recommended for sustained, long-term operation.

% = percent

3.3.2 Exhaust Sampling

Inlet-gas and off-gas samples from the SVE system can be collected from the following locations:

- At each inlet riser from SVE 1, SVE 2, and SVE 3 intake pipes (before being combined for treatment by VGAC)
- Between the lead and lag vessels of the VGAC trains
- At the outlet of the VGAC train being used (or inlet to the exhaust stack)

These samples can be used to track VGAC performance, monitor and determine VGAC breakthrough, evaluate mass removal rates, and perform Title V permit requirement comparisons.¹ Note that only two of the four VGAC vessels (one train) will be operated at any given time; the other train will be used once breakthrough occurs on the first. Samples will be collected in 1-liter Summa canisters. Flow controllers will be set to 200 milliliters per minute.

¹ As described in Section 4.3.1.1 of the SAP, uncovered sources emitting less than 1 ton per year of each air pollutant and less than 0.1 ton per year of each hazardous air pollutant are exempt from modification of the JBPHH Title V permitting requirements (Hawaii Administrative Rules 60.1-62(d)(1)). Also, no modifications to the current JBPHH Title V permit are anticipated to be necessary. The applicable action levels for post-treatment off-gas samples are the JBPHH Title V permit limits. HDOH permit requirements will be used to assess permit exemption applicability and air emission treatment options.

SVE off-gas samples will be analyzed in an offsite laboratory for the following:

- Volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (USEPA) Method TO-15
- TPH, gasoline-range organics by USEPA Method TO-3
- Fixed gases (oxygen, nitrogen, carbon monoxide, carbon dioxide, and methane) by ASTM International (ASTM) Method D-1946

Mass removal rates will be estimated by using the concentration data from the analytical samples and the exhaust flow rate from the mass flowmeter. The fixed gas data can be used in combination with published biodegradation rate constants to estimate the rate of biodegradation in the subsurface.

Sample collection procedures and analytical methods are described in Worksheet #14 of the Sampling and Analysis Plan (SAP) (DON, 2014a). An Analytical Reference Limits and Evaluation table is provided in Worksheet #15 of the SAP. Worksheet #19 of the SAP identifies field sampling requirements, including analytical methodology, container type and volume, preservation and holding times. Worksheet #27 outlines sample custody procedures, sample nomenclature, and sample shipping procedures. Worksheet #30 lists analytical laboratories that have been used for site sample analyses.

3.3.3 Granular Activated Carbon Related Sampling

The results of the off-gas samples will be used to determine breakthrough and the changeout of a particular VGAC train. Based on the results of the startup monitoring, GAC consumption is estimated at one train per month. Once one train is expended, the second train will be valved into service. When the new train approaches breakthrough, both trains will be changed out; alternatively, the VGAC can be changed out as each train is expended. The results of the off-gas samples can also be used to determine whether the off-gas requires treatment through the VGAC trains in order to achieve the Title V permit limits.

Following removal of the VGAC or LGAC, a composite sample from each will be collected from the supersacks and the samples submitted to a laboratory for analysis in accordance with Navy and waste disposal facility requirements. It is anticipated that GAC analytical testing will be required for benzene, toluene, ethylbenzene, and xylenes (BTEX), TPH, polycyclic aromatic hydrocarbon (PAH), toxicity characteristic leaching procedure (TCLP) – As (arsenic), TCLP-Cd (cadmium), TCLP-Cr (chromium), TCLP-Pb (lead), and chlorinated pesticides, though it is recommended to consult PVT landfill waste acceptance requirements of the disposal facility prior to waste characterization sampling. The worksheets from the SAP identified in the previous section that outline sample collection, analysis, and handling requirements also apply to GAC sampling.

Once the analytical data is returned, coordinate with the JBPHH Environmental Engineer at the Hickam Environmental Storefront to develop the waste profiles, manifests, and documentation for transport and disposal (T&D) at the PVT Landfill. It is anticipated that GAC analytical testing will be required to confirm that the spent GAC conforms to the waste profile. Documentation must be submitted and reviewed by the system

environmental manager before T&D. A NAVFAC representative will sign documentation requiring generator signature.

3.3.4 Field Documentation and Sample Management

3.3.4.1 Field Logbooks

Field logbooks will be used to document where, when, how, and from whom any vital project information was obtained. Logbook entries will be complete and accurate enough to permit reconstruction of field activities. Field logbooks will be maintained with pertinent information. Field logbooks will be bound with consecutively numbered pages. Each page will be dated and the time of entry noted in military time. All entries will be legible, written in black or blue ink, and signed by the individual making the entries. Language will be factual, objective, and free of personal opinions or other terminology that might prove inappropriate.

At a minimum, the following information will be recorded during the collection of each environmental sample:

- Sample location and description
- Sampler name(s)
- Date and time of sample collection
- Designation of sample as composite or grab
- Type of sample (i.e., matrix)
- Type of sampling and equipment used
- Field observations and details important to analysis or integrity of samples (e.g., heavy rains, odors, colors)
- All field instrument readings
- Lot numbers of the sample containers, sample tag numbers, chain-of-custody form numbers, and chain-of-custody seal numbers
- Shipping arrangements (overnight air bill number)
- Recipient laboratory name

In addition to the sampling information, the following specifics will also be recorded in field logbooks for each day of sampling:

- Names of team members and their responsibilities
- Time of site arrival/entry onsite and time of departure from site
- Names of other personnel or visitors onsite
- A summary of any meetings or discussions with any potentially responsible parties, their representatives, or federal, state, or other regulatory agencies

- Deviations from sampling and analysis plans and procedures and a summary of the approval process for the deviation
- Changes in personnel and responsibilities, as well as reasons for the changes
- Levels of safety protection
- Calibration readings for any equipment used and equipment model and serial number

3.3.4.2 Chain-of-Custody Records

Chain-of-custody records are used to document sample collection and shipment to a laboratory for analysis. All sample shipments will be accompanied by a chain-of-custody record. Forms will be completed and sent with the samples for each laboratory and each shipment (i.e., each day). If multiple containers are sent to a single laboratory on a single day, forms will be completed and sent with the samples for each container. Information on all samples collected for analysis must be included on the forms.

The chain-of-custody record will identify the contents of each shipment and maintain the custodial integrity of the samples. In general, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, in a locked container, or kept in a secured area that is restricted to authorized personnel. The field team leader or designee will sign chain-of-custody records. The field team leader or designee will sign the "relinquished by" box and note the date, time, and air bill number.

3.3.4.3 Reporting

Sampling results will be presented in quarterly and yearly reporting as required.

3.4 Performance Monitoring

Performance monitoring is focused on the off-grid system, individual SVE well risers, and the overall remediation process including the following:

- Battery pack SOC and voltage (read as percent SOC on MATE3 display)
- Battery room temperature (use standard thermometer)
- VFD setting (read as percent blower speed from HMI touchscreen display)
- Current (in A) and wattage (in W) (read from HMI touchscreen display)
- Charge controller output (kW) (read from HMI touchscreen display)
- Totalizer on the effluent pump from the knockout tank (read from liquid flowmeter located just downstream of the liquid centrifugal pump near the knockout tank)
- Blower flow rate in cfm (read from HMI touchscreen display)
- Blower temperature (read from front dial display on the blower)
- Blower run time (from hour meter) (read from HMI touchscreen display)
- PID sampling of train in use (pre-VGAC, intermediate-VGAC, and post-VGAC)

- PID breathing zone

The performance monitoring form is presented in Appendix D-1. Initially, after startup, performance monitoring was conducted weekly, but the requirement has been reduced to biweekly as of January 2016. Further reductions in frequency may be appropriate depending on continued uniformity of system performance. Alternatively, an increase in frequency may be required for specialized troubleshooting.

3.5 System Inspections

The following inspections will be conducted on the SVE system:

- Quarterly inspection of AGM battery rack, inverter load center, and ancillary equipment associated with the off-grid PV system (see Appendix B-6)
- Performance monitoring (see Appendix D-1)
- Pressure monitoring (see Appendix D-2)
- Monthly inspection of the overall systems, including the following: effluent discharge system, GAC treatment system (including process piping), general building inspections, and SVE vault inspections as presented in the Checklist in Appendix A-6

Details of the inspections are included on the individual inspection checklists referenced above.

3.6 Pressure Monitoring Form

Eleven permanent vadose zone monitoring points have been installed to monitor the SVE capture zone (**Figure 2-1**). The probes are installed at depths of approximately 5 to 7 feet bgs, dependent on the depth to groundwater. The vadose zone monitoring points are completed with a steel flush mount cover set in concrete. If either a shallow water table or the presence of clay in the screened interval is encountered during installation, sample locations may be modified in the field.

Short-term differential pressure monitoring data can be collected using a digital manometer at each of the VMPs. The pressure differential monitoring will be conducted to evaluate the lateral extent of the pressure field. The field form for pressure monitoring is included in Appendix D-2. O&M personnel will consider issuance of status reports, investigation of well field performance, and other such requirements, to determine the frequency of pressure monitoring and its recording on this form.

This page intentionally left blank.

4.0 Health and Safety

An APP that includes a Site Safety and Health Plan (SSHP) (DON, 2014c) has been prepared in accordance with 29 *Code of Federal Regulations* 1910 and 1926. The APP addresses the potential hazards associated with the field activities. Subcontractors are responsible for health and safety procedures specific to their particular work components and are required to develop and submit an AHA to the system operator for review before the start of field work.

A safety notification describing the overall hazards and precaution of working in and around AGM batteries, the O&M AHA, and the GAC and blower oil material safety data sheet are presented in Appendixes F-1, F-2, and F-3, respectively.

This page intentionally left blank.

5.0 References

State of Hawaii Department of Health (HDOH). 2011. *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater*. Fall 2011, revised January 2012.

U.S. Department of the Navy (DON). 2016. *Treatability Study Report for Subsite ST32 Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii*.

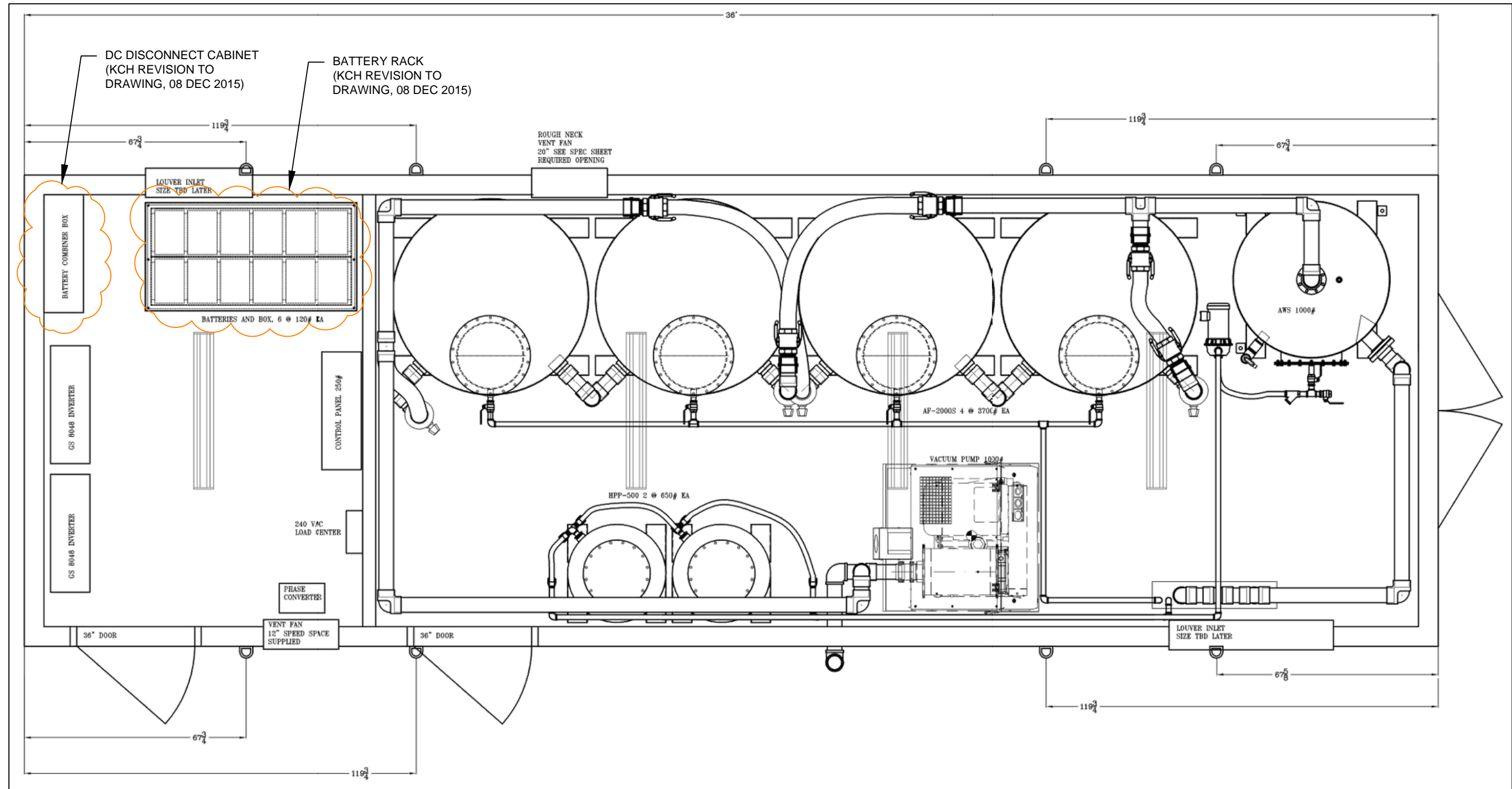
U.S. Department of the Navy (DON). 2014a. *Sampling and Analysis Plan, Treatability Study for Subsite ST32 Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii*. January.

U.S. Department of the Navy (DON). 2014b. *Treatability Study Implementation Plan for Subsite ST32 Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii*. April.

U.S. Department of the Navy (DON). 2014c. *Accident Prevention Plan, Treatability Study for Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii*. June.

This page intentionally left blank.

Figures



SOURCE:
 AS BUILT DRAWING ENTITLED BUILDING LAYOUT, DRAWING # M-1 / R3, BY TETRASOLV FILTRATION, DATED MARCH 30, 2014.

Equipment Building Plan Layout

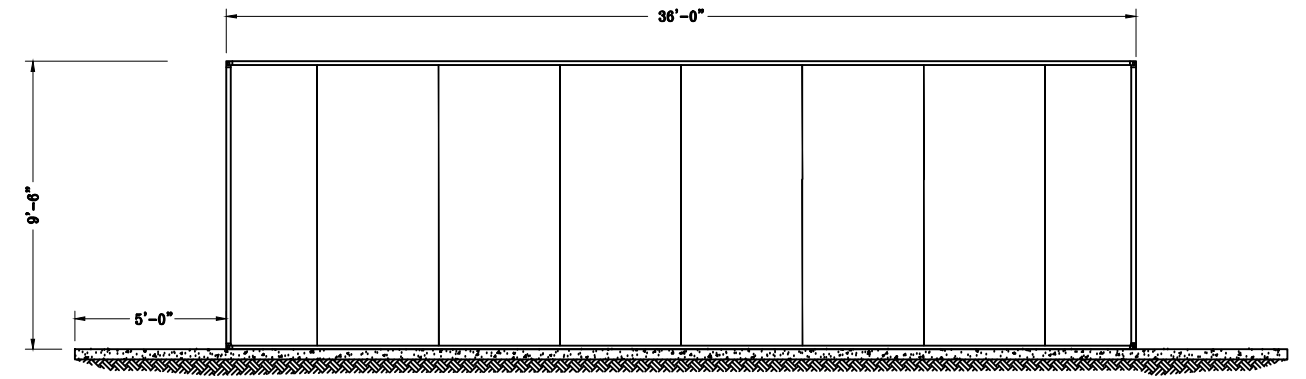
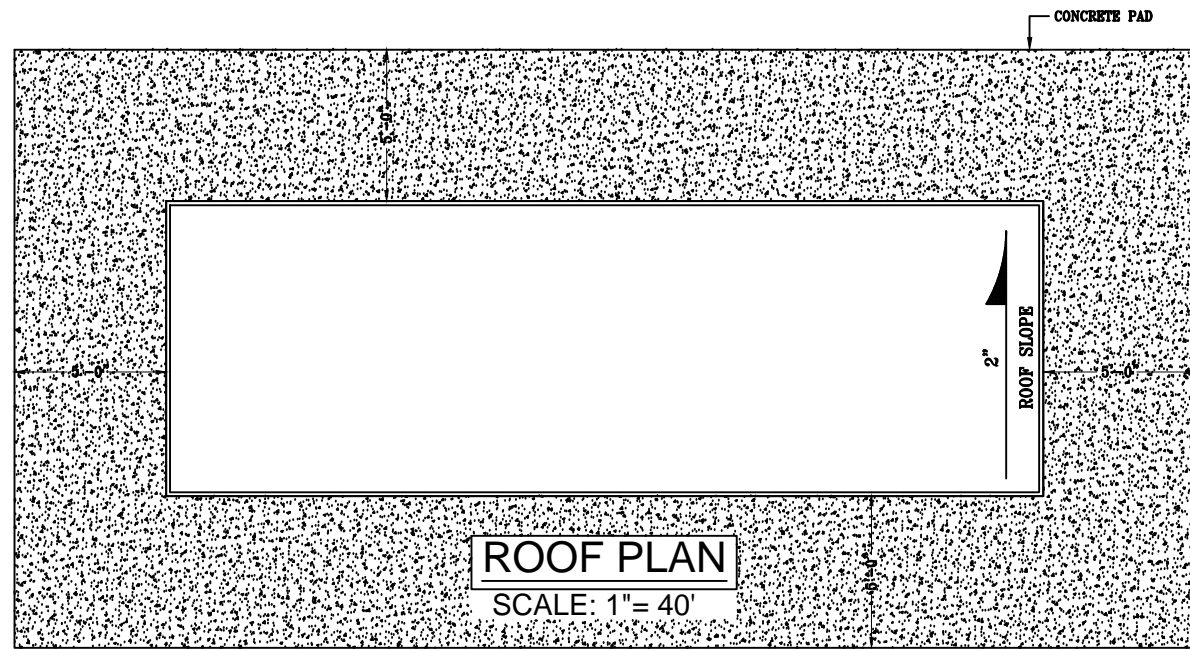
O&M Plan for Subsite ST32 Onizuka Village
 Joint Base Pearl Harbor-Hickam, Hawaii



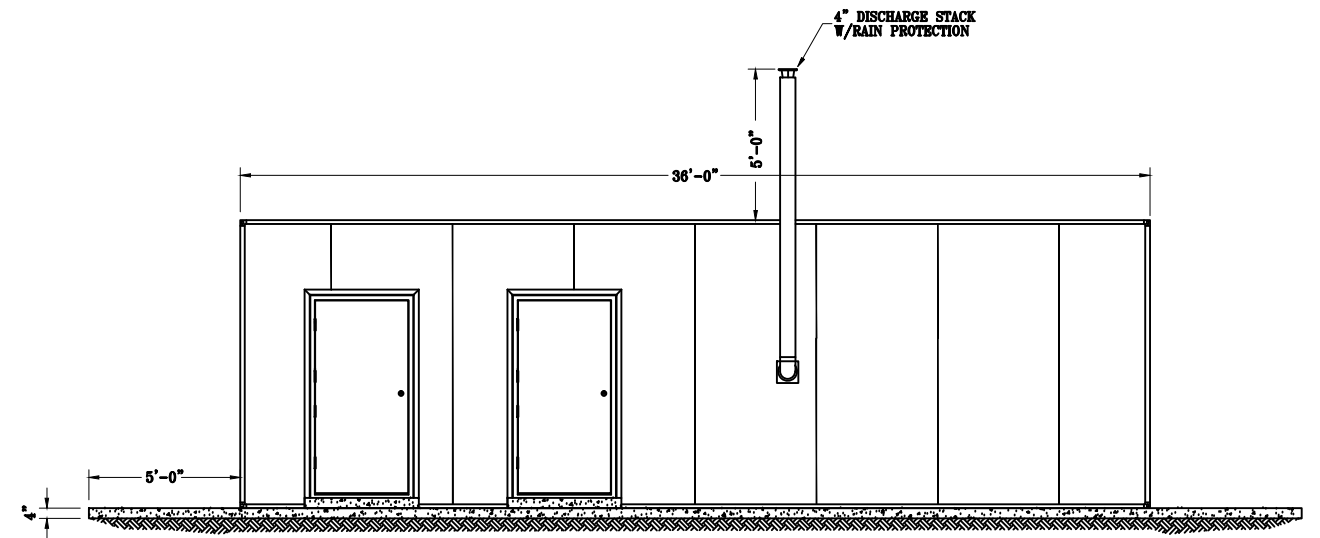
FIGURE

2-7

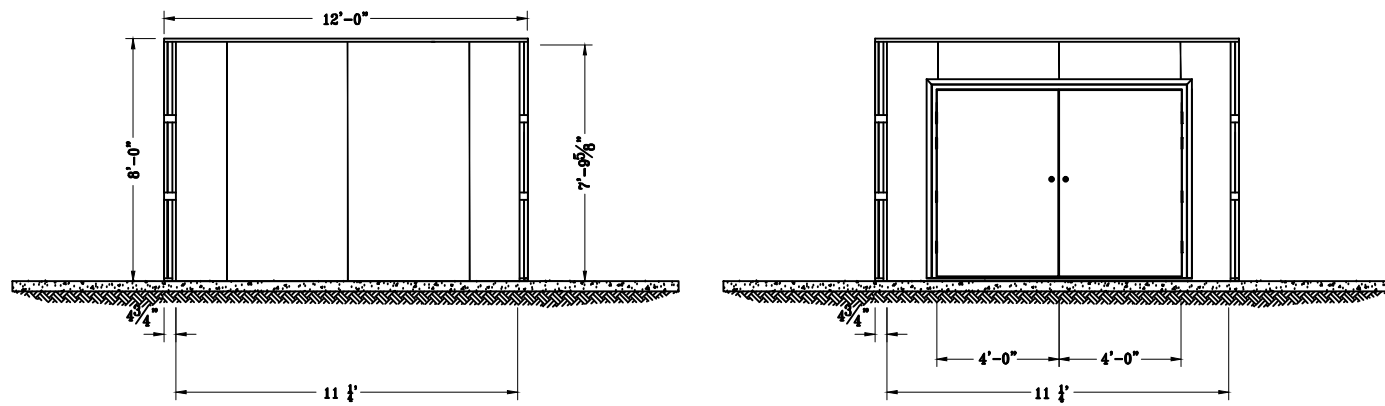
This page intentionally left blank.



EAST WALL FRAMING
SCALE: 1" = 40'




WEST WALL FRAMING
SCALE: 1" = 40'



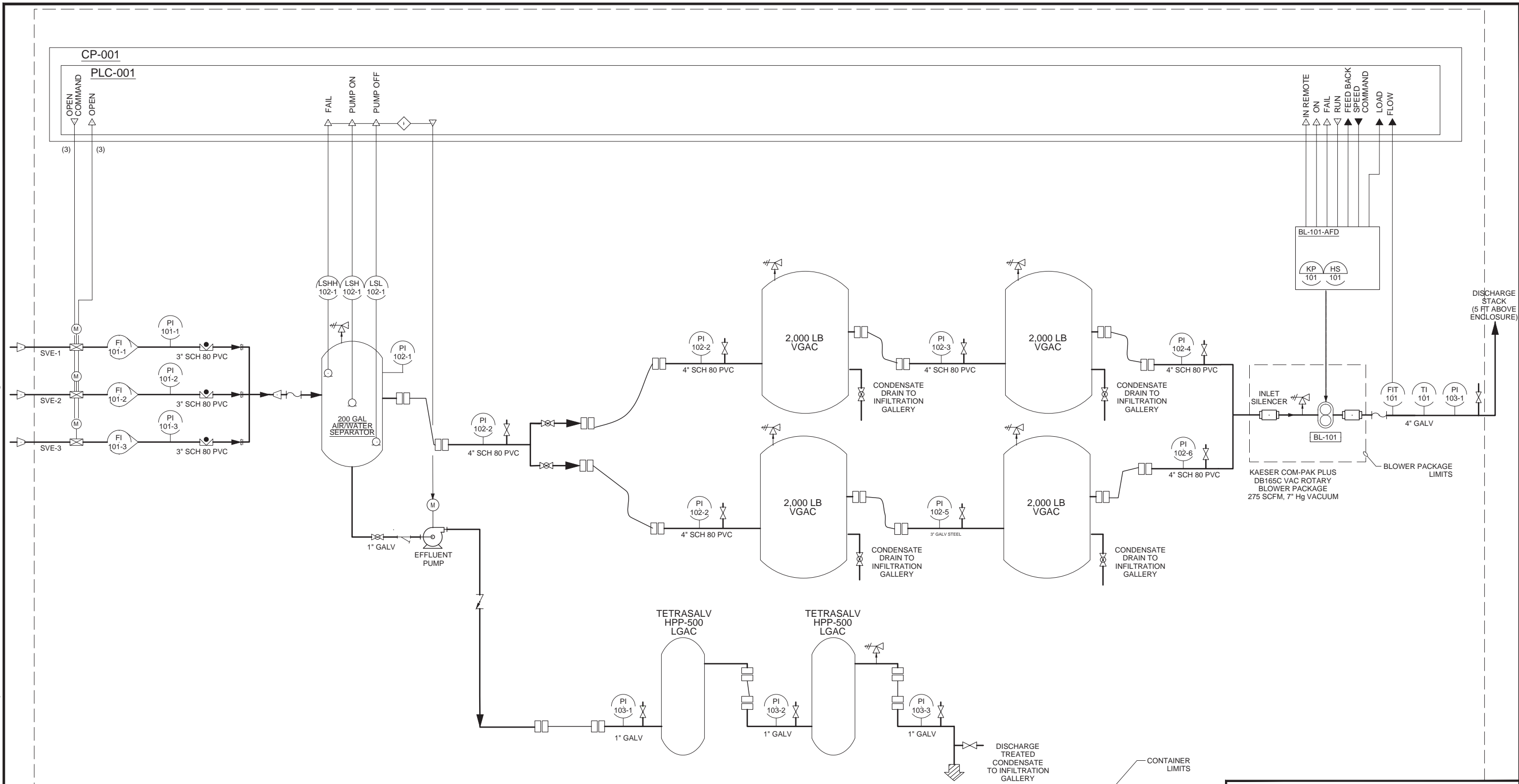
NORTH WALL

SOUTH WALL

NORTH/SOUTH WALL FRAMING
SCALE: 1" = 40'

Equipment Building Sections and Details	
O&M Plan for Subsite ST32 Onizuka Village Joint Base Pearl Harbor-Hickam, Hawaii	
	FIGURE 2-8

This page intentionally left blank.



LEGEND

	UNION	⊗	BALL VALVE	PI 101	PRESSURE INDICATOR	FI 101	FLOW INDICATOR (AVERAGING PITOT TUBE)	▷	REDUCER COUPLING	↘	CHECK VALVE
⊗	DIAPHRAGM VALVE	⊥	PRESSURE/VACUUM RELIEF VALVE	TI 101	TEMPERATURE INDICATOR	□	QUICK - CONNECT / CAMLOCK FITTING	M	MOTORIZED VALVE		
⊥	SAMPLE PORT	Y	Y-STRAINER	FIT 101	FLOW INDICATOR/TRANSMITTER	—	HIGH TEMP PRESSURE / VACUUM RATED HOSECAM-AND-GROOVE FITTINGS	S	SELENOID VALVE		

NOTE:
REFER TO THE APPENDICIES FOR A
PROCESS AND INSTRUMENTATION
DRAWINGS PREPARED BY THE
FABRICATOR.

SVE Piping and Instrumentation Diagram

O&M Plan for Subsite ST32 Onizuka Village
Joint Base Pearl Harbor-Hickam, Hawaii



FIGURE
2-9

This page intentionally left blank.

Appendix A SVE System

This page intentionally left blank.

Appendix A-1
O&M Manual (Onion Equipment Company)

This page intentionally left blank.

**ERRATA SHEET FOR
SOIL VAPOR EXTRACTION SYSTEM
OPERATION & MAINTENANCE MANUAL
JOINT BASE PEARL HARBOR HICKAM, HAWAII**

The attached Operations & Maintenance (O&M) Plan for the Soil Vapor Extraction System (SVE) at Joint Base Pearl Harbor Hickam, Hawaii, was prepared by Onion Equipment Company (OEC). This standalone document is contained in the overall O&M Plan for the SVE System, SVE Wells, and Off-Grid PV System. The errata items to the subject report are considered minor (refer to table below).

Location	Revision	Reason for Change
Cover Sheet	Section B, C, and D are not applicable	Information referenced is contained in other locations
Section 3.4, Step 3, 5th sentence	Delete and replace with "Take amperage readings, as necessary, for each component, and record on a checklist to compare to manufactures information. Table 3-1 can be used to record amperage readings for the blower as a function of SVE well vacuums."	Clarification of Text
Section 4.4, 1st Paragraph, last sentence	Delete and replace with "When the level in the tank activates the pump will turn on."	Clarification of Text

This page intentionally left blank.



Operation & Maintenance Manual

**SVE System
Joint Base Pearl Harbor
Hickam, Hawaii
Job# 14-01A**

CONTENTS

Section A – General O&M

- 1.0 General Description
- 2.0 Health and Safety
- 3.0 Installation & Startup
- 4.0 SVE System Operation
- 5.0 Not used
- 6.0 Control Panel Operation
- 7.0 Maintenance

Section B – Drawings

System P&ID Drawing
Electrical Schematics

Section C – Supplied Components Data Sheets

Section D – Supplied Components O&M Sheets

This page intentionally left blank.

1.0 GENERAL DESCRIPTION

Table 1.1
System Specifications

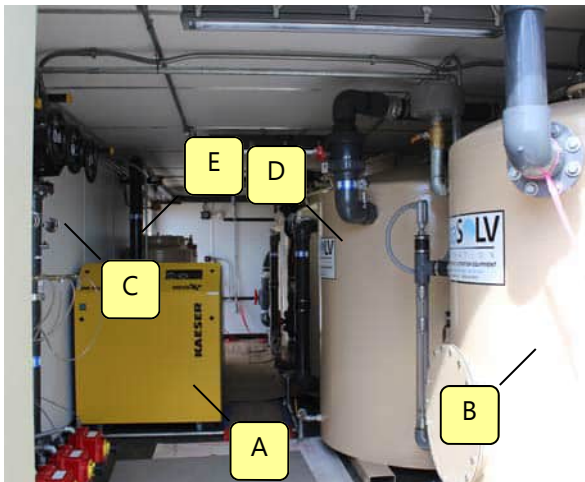
Description	Specification
Footprint	12' x 36' x 9' H
SVE Design	275 SCFM @ 7"Hg
Shipping Weight	28,750 lbs
Operating Weight	31,500 lbs
Power Requirement	230V/3PH/60HZ
Amperage Requirement	100

1.1 SVE System

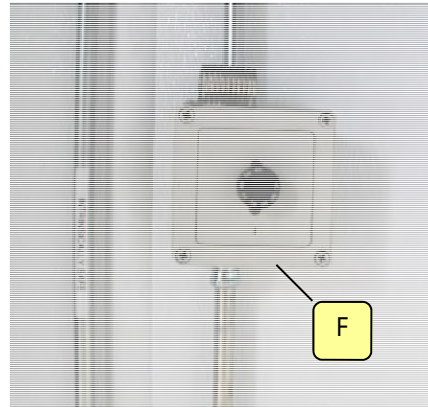
The Soil Vapor Extraction System (SVE) consists of multiple integrated components designed to pull vacuum on a common manifold in order to extract vapors and liquid out of ground wells. The system utilizes a Positive Displacement Blower (PDB) to create vacuum.

Component

- A - Vacuum Blower (PDB)
- B - Moisture Separator
- C - SVE Manifold
- D - Vapor Carbon Filters
- E - Liquid Carbon Filters
- F - Exhaust Fan TStat
- G - E-Stop
- H - Inlet Louver / Filter Wall
- I - Exhaust Fan
- J - Bypass Louver
- K - SVE Room Heater



(equipment room)



During normal operation extracted vapors upon exiting the soil extraction wells pass through a moisture knockout followed by an inline air filter into the suction side of the PDB. When the fluid level in the Air Water Separator (AWS) reaches the pump activation set point the system starts the transfer operation until the pump deactivation point is reached.

1.2 Building HVAC

It is important that the building climate be monitored and adjusted for seasonal variations.

- **IMPORTANT: HVAC ducting and inlets, louvers, etc. should be regularly inspected to insure no restriction or debris would impede the free flow of air.**

On the equipment room divider wall (1) thermostats control the SVE Room Ventilation Fan.

Located on the left side of the blower is the inlet louvers. The inlet louvers have removable filter panels which will require replacement at periodic intervals depending upon the site conditions. The filter panel fabric is available from a wide variety of sources. OEC typically uses a 1" thick polyester filter media roll we obtain from Grainger (P/N 2W186). This material comes in rolls of varying lengths and should be cut to the required length.

1.3 Building Disconnect

The building disconnect is located on the end of the building.

In case of emergency the disconnect can be used to disconnect the entire structure from the electrical power supply.

- ◆ ***WARNING: In case of manual disconnect system re-start should only be attempted after verification of safe operation. This includes elimination of explosive and electrical hazards.***

2.0 HEALTH AND SAFETY

It is important that the entire O&M manual be read prior to set up and operation of the system. If you have any questions please contact OEC at the number listed below.

- Always adhere to "lockout/tagout" procedures when servicing the system.
- Wear appropriate safety equipment when operating system. OEC recommends hearing and eye protection be utilized while the system is operating.
- ◆ **WARNING: Certain components of the compressor and vacuum blower may hot during operation and immediately after shutdown. Even after shutdown system may cause burns upon contact for extended period of time.**

Fire Extinguishers are located inside the building below the light switch and outside adjacent to the entry door. First Aid Kit is located above the fire extinguisher.

Emergency Stop Buttons are located in each room of the structure and on the front of the Control Panel inside the structure. An additional ESB is located on the compressor.

- ◆ **WARNING: The compressor ESB ONLY functions for the air compressor and has no interlink to the system controls.**



(Control Panel)

This page intentionally left blank.

3.0 INSTALLATION & STARTUP

3.1 Shipment & Unloading

Upon arrival at the site the system should be thoroughly checked for any damage that may have occurred during shipment. Any damage should be noted with the carrier and OEC immediately.

3.2 Positioning

- ◆ **WARNING: Failure to follow the procedures outlined below can result in damage to the system.**

The building should be positioned on a firm level surface capable of supporting the entire system at full operational weight. The building should be leveled and firmly supported and anchored.

Any loose components should be connected to the system at this time.

3.3 Inspection

Perform the following inspections after un-loading the system. Note any discrepancies and contact OEC immediately.

- Check the system exterior for damage which may have occurred during shipment. Inspect the support structures and piping support for damage.
- Inspect the piping system for damage. Insure the valves operate properly. Check installed instruments and instrument installation points for damage.

3.4 Set Up

- Prior to completing the remaining steps, Section 6 (Control Panel Operation) should be read.

Step 1: A qualified electrical contractor with experience in industrial wiring systems shall make electrical connections. Connect the Control Panel to the fused primary feed. (see table 1.1 for electrical requirements).

- **IMPORTANT: At the time of installation local code requirements may necessitate changes to the wiring of the system. Any changes should be discussed with OEC prior to completion.**

Step 2: Check rotation of 3 Phase motors. All motors were tested at the factory to have the same rotation,

- ◆ **WARNING: Do not operate any other components until this test has been completed. Some components may be severely damaged if run in reverse direction.**

Step 3: Individually test each component in manual mode. Review the manual for the component to be tested. Scroll to the component screen on the control panel and place the component in hand mode. Listen to the component. Take amperage readings on each line and compare to those in table 3.1. Discontinue operation and contact OEC immediately if discrepancies exceed 20% or unusual sounds, vibration or smells are present.

- **IMPORTANT: These tests should be completed prior to connection the system to exterior piping. If piping has been connected we recommend temporary disconnection during this test.**

Step 4: Test all system faults and interlocks.

Step 5: Connect the site piping to the system process piping.

- **IMPORTANT: All piping connected to the process piping rack should be self supported. We also recommend the use of flexible joints wherever system piping connects to the site piping.**

Table 3.1
Operational System Amperage Readings @ _____ VAC

Device	Serial Number	Pressure / Vacuum	Line 1	Line 2	Line 3
Blower / Kaeser DB166C VAC	4946				

4.0 SVE SYSTEM OVERVIEW & OPERATION

4.1 Positive Displacement Blower (PDB)

The system uses a vacuum pump to extract vapor and liquid from the subsurface.

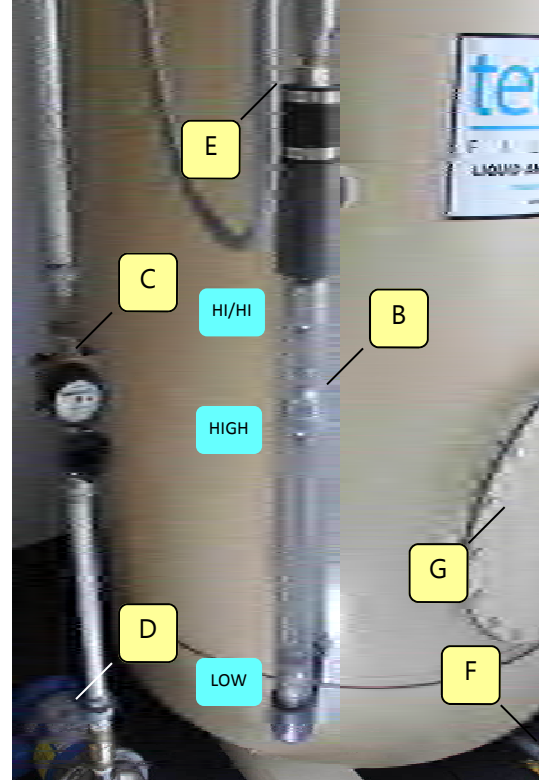
General operation of the PDB consist of monitoring the oil level, temperature and belt condition. Specific O&M Instructions should be obtained in the PDB blower manual.

- ♦ **CAUTION:** Prior to operating the PDB read all start-up instructions.

Component

- A - Check Valve
- B - Site Tube
- C - Liquid Flow Meter
- D - Transfer Pump
- E - Level Switch
- F - Maintenance Drain
- G - Inspection Manway

♦ **WARNING:** Operation of the PDB manually should be done with extreme caution. If liquid levels go beyond the 'EMERGENCY HIGH' point they may cause damage to the pump or be discharged out the discharge line.



Air Water Separator and Transfer System

4.2 AWS Separator & Transfer System

The AWS system separates entrained liquid from the air stream.

The AWS system should be cleaned and inspected on a regular basis as site conditions warrant. Prior to servicing manually pump the AWS system until the lower pump set level clears. Next open the drain valve to fully drain the AWS tank. The side inspection manway can then be removed. Inspected the interior of the tank for corrosion and or lining failure. Be sure to carefully clean the area around the suction pump and drain pickup. It may be necessary to disconnect the pump suction tube. Remove accumulated solids and reclose the inspection manway after cleaning the gasket surface and carefully cleaning the gasket. It is also recommended at this time that the level detection sensor be removed and cleaned.

- ♦ **CAUTION:** Take care not to lodge debris in the



Positive Displacement Blower

suction port assembly which may impair or clog the pump.

4.3 Level Detection

The AWS system detects level using a 3 point level switch. The switch consists of 3 floats connected to a single rod. The float operates a magnetic switch contained in the rod. When the float is down the switch is open and closed when the float is up. This configuration is referred to as NORMALLY OPEN. The floats are referred to as HI/ HI, HI and LOW. The HI/HI level indicates a critical failure of the transfer system such as pump failure, closed valve, etc. The HI level indicates to the control panel to operate the associated transfer pump. The LOW level indicates to the control panel to shut off the associated pump.

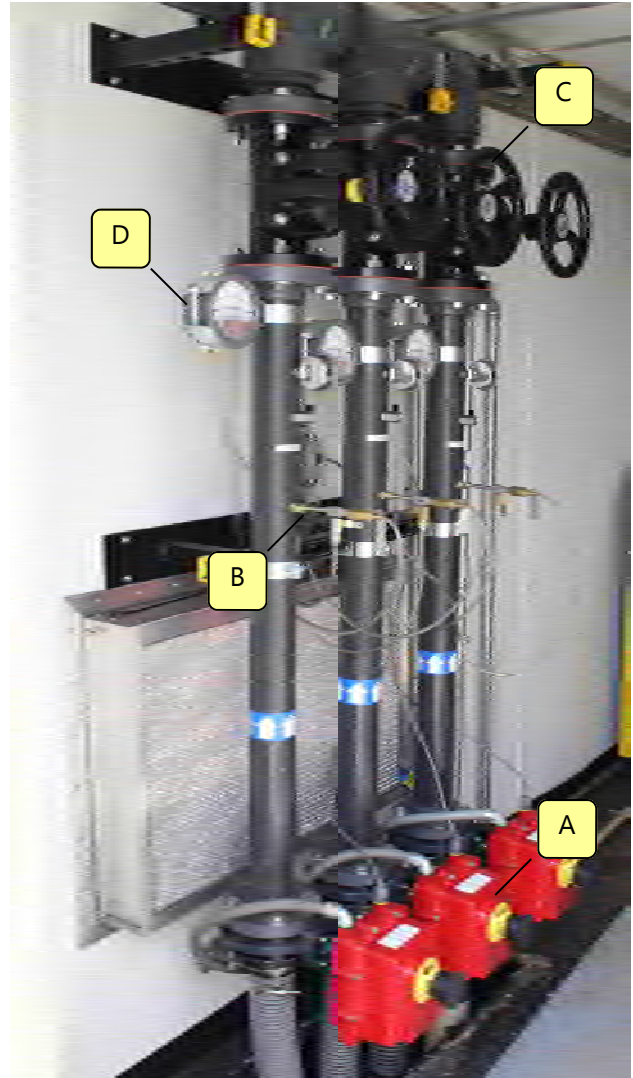
The site tube should be cleaned or replaced whenever the liquid level cannot be easily observed. The site tube is easily removed by loosening the hose clamps where the tube connects to the tank. A mild solution of muriatic acid works well for cleaning the tube.

4.4 AWS Transfer Pump

The AWS transfer pump operates to transfer liquids from the AWS tank. In the AUTO position this pump will start and stop automatically by the control panel. When the level in the tank activates the pump the to operate.



Vacuum Bleed Valve



SVE Manifold

Component

- A - Isolation Valve
- B - Flow Measuring Tube
- C - Diaphragm Valve
- D - Flow Meter

♦ **WARNING: Operation of the AWS transfer pump manually should be done with extreme caution. Dry running of the pump for even short periods can cause damage.**

4.5 SVE Manifold

The SVE manifold consists of 3" SVE Legs. Periodic cleaning of the flow meters, transmitters and gauges is recommended to insure accurate operation. Refer to each component O&M Manual for recommended cleaning procedure.

4.5 Activated Carbon System

Vapors from the extraction wells after passing through the moisture separator pass through vapor phase activated carbon filters. The vapor carbon removes trace organic contaminants from the vapor stream. The activated carbon system needs to be monitored for organic breakthrough and periodically replacement of the media.

Separated liquid from the moisture separator likewise is treated with liquid phase activated carbon filters. Refer to the carbon filter O&M Instructions for specific information pertaining to carbon filter operation.



Liquid Carbon



Vapor Carbon

This page intentionally left blank.

6.0 CONTROL PANEL OPERATION

6.1 Control Panel Overview

The control panel enclosure houses the Process Logic Controller (PLC). The PLC and Operator Interface Screen (OIS) provide operational and control of the sparge system. All OIS screens have a common OIS date and time.

Date and Time can be changed by pressing the field and entering the new value.

The Event Banner lists operator actions in the order completed.

6.2 Emergency Stop Button

The ESB is activated by pushing the button in. Once pushed the button will remain down until pulled upward which cancels the ESB mode. Always wait at least 15 seconds before turning the system back on to give the PLC time to reset.

Activating the ESB also activates the Shunt Trip System which disconnects all power from the system.

After ESB activation follow the procedures in Section 6.3 (Shunt Trip System Restart).

- ◆ **WARNING: Only use the ESB in case of emergency shutdown.**

- ◆ **WARNING: Use extreme caution when working in the interior panel area. If voltage is present there are many surfaces which may cause electrocution.**

6.3 Operator Interface Screens OIS

The operator interface screens allow configuration and display of system information and variables. The OIS is a touch screen. User configured values are changed by touching the display where the information desired to be changed is displayed.

Alarm Status Display - Active alarms displayed in illuminated RED. Refer to System Faults/Alarms table 6.1 for description of alarms.

System Variables - System variables can be configured by pressing the corresponding SETPOINT value and inputting the desired value.

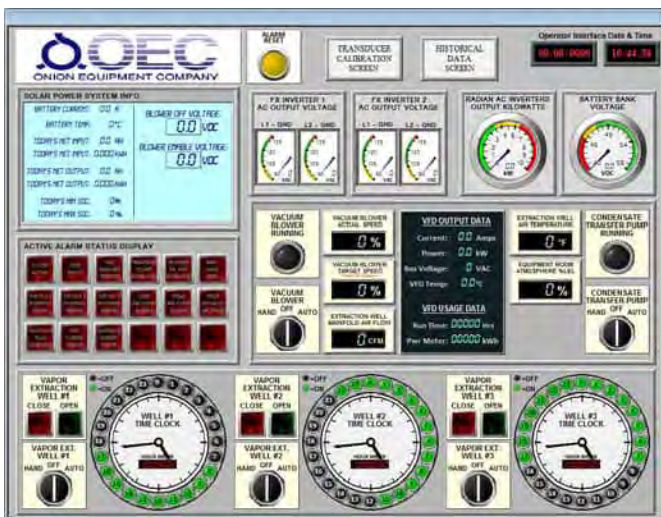
Refer to Table 6.2 - System Variables Table for a list of variables with their associated input screen and description.

- ◆ **CAUTION: Carefully consider input variables and the consequences of overall system operation before changing values.**

Certain motorized and actuated have Hand/Off/Auto selection. "OFF" selection disables the device from operation. "HAND" places the device into manual mode and all operational controls are by-passed.

- ◆ **CAUTION: HAND operation of the devices will by-pass all or many SAFETY controls is only recommended for certain situations and only for limited duration. Damage to equipment and or personnel is possible in HAND mode. HAND operation requires careful consideration of consequences during manual operation.**

"AUTO" places the device in standard operating mode.



(operator interface screen)

Table 6.1 - System Faults / Alarms

Fault	Description	Action
Transfer Pump Overload	Transfer Pump Overload Detected	
SVE room LEL High Limit	LEL Warning Level above set point	
Blower Exhaust Fan Overload	Overload Detected	
SVE Valve Position Error	Corresponding Valve Positioner Error (Quan. 3)	
Low Air Flow Alarm	Air Flow Below Setpoint	
High Air Flow Alarm	Air Flow Below Setpoint	
E-Stop Active	E-Stop activated or in continuity in alarm circuit	
SVE Blower VFD Fault	VFD Malfunction	
VFD Breaker Tripped	Circuit Breaker Tripped	
High Exhaust Air Temp	Exhaust high temp setpoint reached	
AWS Level High	Hi/Hi Level Float in Moisture Separator Activated	
VFD Communication Failure	Failure of VFD Communication	
Outback Communication Error	Failure of Outback Charging Communication	

Table 6.2 - System Variables

Screen	Variable	Description
SVE CONTROL	SVE WELL VACUUM READINGS / LOW VAC SETPOINT (Quantity 6)	Low level vacuum alarm setpoint for low vacuum alarm on corresponding well.
SVE CONTROL	SVE WELL VACUUM READINGS / HIGH VAC SETPOINT (Quantity 6)	High level vacuum alarm setpoint for low vacuum alarm on corresponding well.
SVE CONTROL	HVE RECOVERY MANIFOLD / LOW VAC SETPOINT	Low level vacuum alarm setpoint for low vacuum alarm on HVE manifold.
SVE CONTROL	HVE RECOVERY MANIFOLD / HIGH VAC SETPOINT	High level vacuum alarm setpoint for low vacuum alarm on HVE manifold.
SVE CONTROL	HVE RECOVERY MANIFOLD / LOW FLOW SETPOINT	Low level flow alarm setpoint for low flow alarm on HVE manifold.
SVE CONTROL	HVE RECOVERY MANIFOLD / HIGH FLOW SETPOINT	High level flow alarm setpoint for high flow alarm on HVE manifold.
VAPOR EXTRACTION WELL TIMERS	Biosparge Well Timer Function (Available for each Biosparge Well)	Select individual hours of operation for selected Biosparge Well.
HORIZONTAL BIOSPARGE SETTINGS	LOW AIR FLOW ALARM SET POINT	Low level flow alarm setpoint for low flow alarm on Biosparge manifold.
HORIZONTAL BIOSPARGE SETTINGS	HIGH AIR FLOW ALARM SET POINT	High level flow alarm setpoint for high flow alarm on Biosparge manifold.
HORIZONTAL BIOSPARGE SETTINGS	Horizontal Well Timer Function (Available for each Horizontal Well)	Select days of week and individual hours of operation for selected Horizontal Well.

This page intentionally left blank.

7.0 MAINTENANCE

7.1 Preventative Maintenance

Table 7.1 contains a summary of normal maintenance items and intervals. This list is not intended to replace the manual for the installed components. We do not guarantee its accuracy or completeness.

7.2 Extended Shut Down

If the system will be shutdown for extended periods certain procedures should be taken to protect the system.

Remove instrumentation and store in a protected manner.

Completely drain and clean AWS tank, compressed

air storage tank, compressed air filters, suction strainers, wye strainers. Remove compressed air heat exchanger exhaust hood and replace with weather tight cover. Seal all air inlets. Place desiccant pads as recommended by desiccant manufacturer for local climate and replace as recommended. Additional desiccant pads should be placed in all control panel and interior of machinery.

**Table 7.1
Preventative Maintenance**

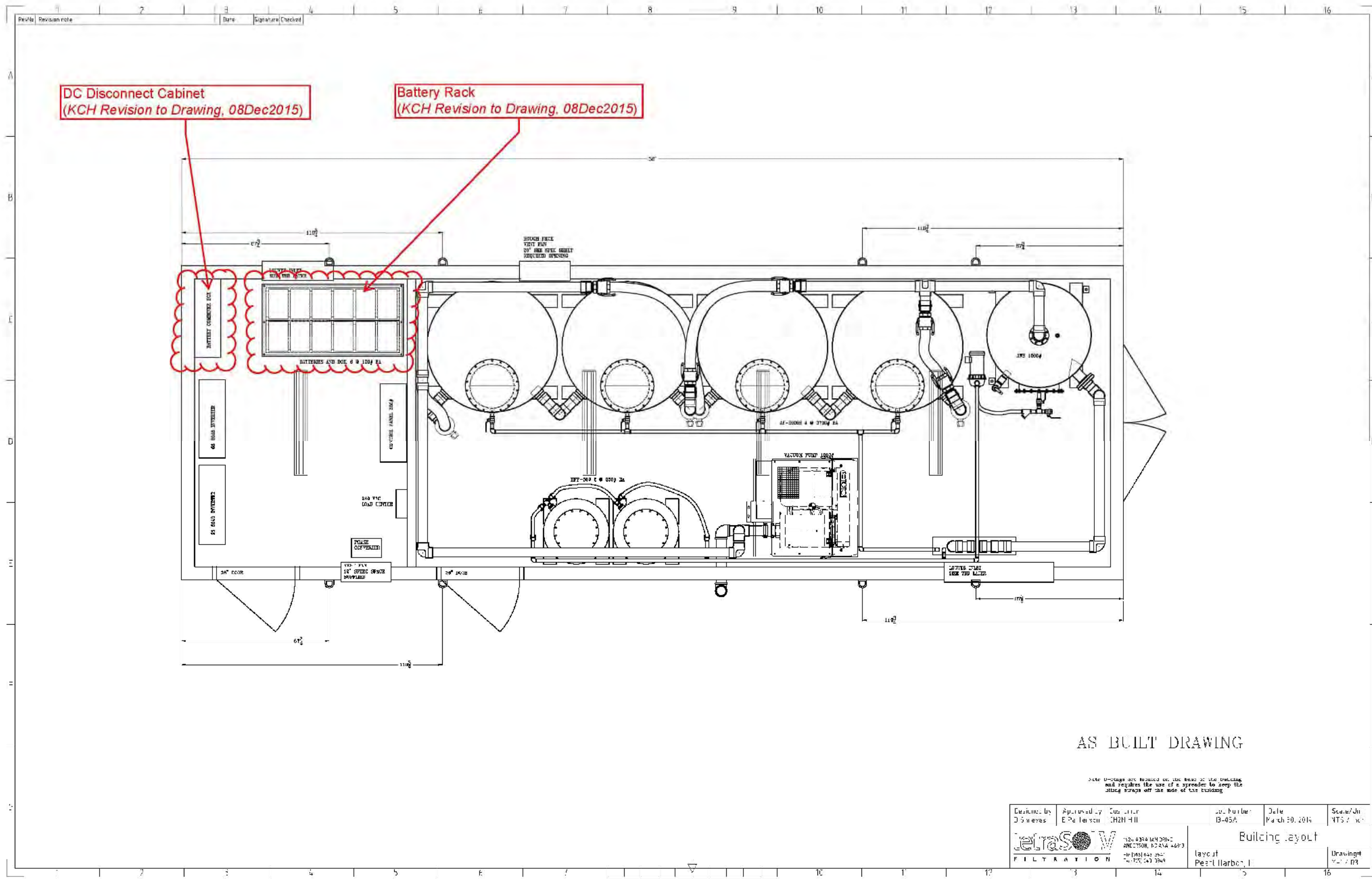
Component	Action	Frequency
Painted surfaces	Inspect and repair painted surfaces	6 months
Building Exterior	Inspect Roof, caulking on installed devices. Verify louver operation. Clean and lubricate louvers.	6 Months
RSAC and PDB	See service intervals in manual	-
HVAC System	Clean heater coils, clean louvers, clean fan blades.	6 Months
Air Filters	Clean and inspect, verify auto drain function	Weekly
All	Check for proper relief points on PRV's and VRV's. Verify accuracy of instrumentation.	Monthly
Receiver Tank	Clean and inspect, verify auto drain function, test level switch	90 Days
Control Panel	Test all system interlocks and faults	90 Days
AWS Tank	Clean and Inspect Tank Interior, Verify Backup Level Switch, Verify Level Transmitter Accuracy	90 Days
LEL Detector	As per site HSP and Manufacturer Recommendation	TBD
ESB	Verify shunt trip and ESB's	Annually
Air Flow Meters	Remove and clean and inspect FCI meters. Remove clean and inspect CDI meters.	90 Days
Liquid Flow Meter	Remove clean and inspect liquid flow meter	90 Days

This page intentionally left blank.

Appendix A-2

Building Layout, P&ID, and Electrical Schematics

This page intentionally left blank.



This page intentionally left blank.

ITEM	QTY	DESCRIPTION
120	1	VACUUM PUMP, PASCY COMPACT PLUS, MODEL DB1960, 10 HP 230/5/50 1/4" INLET/OUTLET, 250 CFM @ 27" HG WITH SOUND ENCLOSURE
123	4	ACTON THERMOCARBON 1.5L 11 GAZEY FILTRATION MODEL MV-7000 4" HT, 2000 LITRE HEAD GAS 1A
124	1	ACTON THERMOCARBON 1.5L 11 GAZEY FILTRATION MODEL MV-7000 4" HT, 2000 LITRE HEAD GAS 1A
125	1	CENTRIFUGAL PUMP GOULD'S NPE MODEL 3.45 1.25 x 1.5 x 0.75 HP 6000RPM 10-15 GPM, 35H TCH
126	2	LIQUID PHASE CARBON FILTER, TETRASOL FILTRATION MODEL-FP-500 1" FPT 1/3, 500 LB REACT CAC EA
201	1	AIR FILTER - SOBERG FS 100 1" FPT
202	1	

MASTER BILL OF MATERIAL

ITEM	QTY	DESCRIPTION
401	3	ORP-Room Valve, OE Model, SP022303, 3" NPT
402	7	Ball Valve, KLS 304 1" SP0121, SS BALL, EPDM SEAT
403	1	Spring Loaded Check Valve
404	13	Ball Valve, KLS 304 1/4" SP0121, SS BALL, EPDM SEAT
405	3	3" Butterfly Valve, NEMA/ANSI Type 27 w/Electric Actuator Series 80
406	1	1" Single Wye Strainer
407	4	1" PVC Ball Valve, KLS 304
500	1	Flow Meter/Totalizer Master Meter Model, JMW 0200
501	1	
502	1	Vacuum Gauge Model, PUL, 1" FPT, RANGE 0-20" HG
503	1	Pressure Relief Valve, National Vacuum Model, 4709
504	1	In-line Flow Meter, S Model 6405, 1" ID, 12 PSI, 0.00-0.4 SCFH, A OUTLET
505	1	
506	4	In-line Flow Meter, S Model 6405, 1" ID, 12 PSI, 0.00-0.4 SCFH, A OUTLET
507	3	Pressure Gauge, PG Model, 201L, 1/2" NPT, 0-100-0-100 PS
508	1	100T-8, S Model 6405, FLO4

ITEM	QTY	DESCRIPTION
509	1	Level Switch - P Sensors (Part) Level 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80

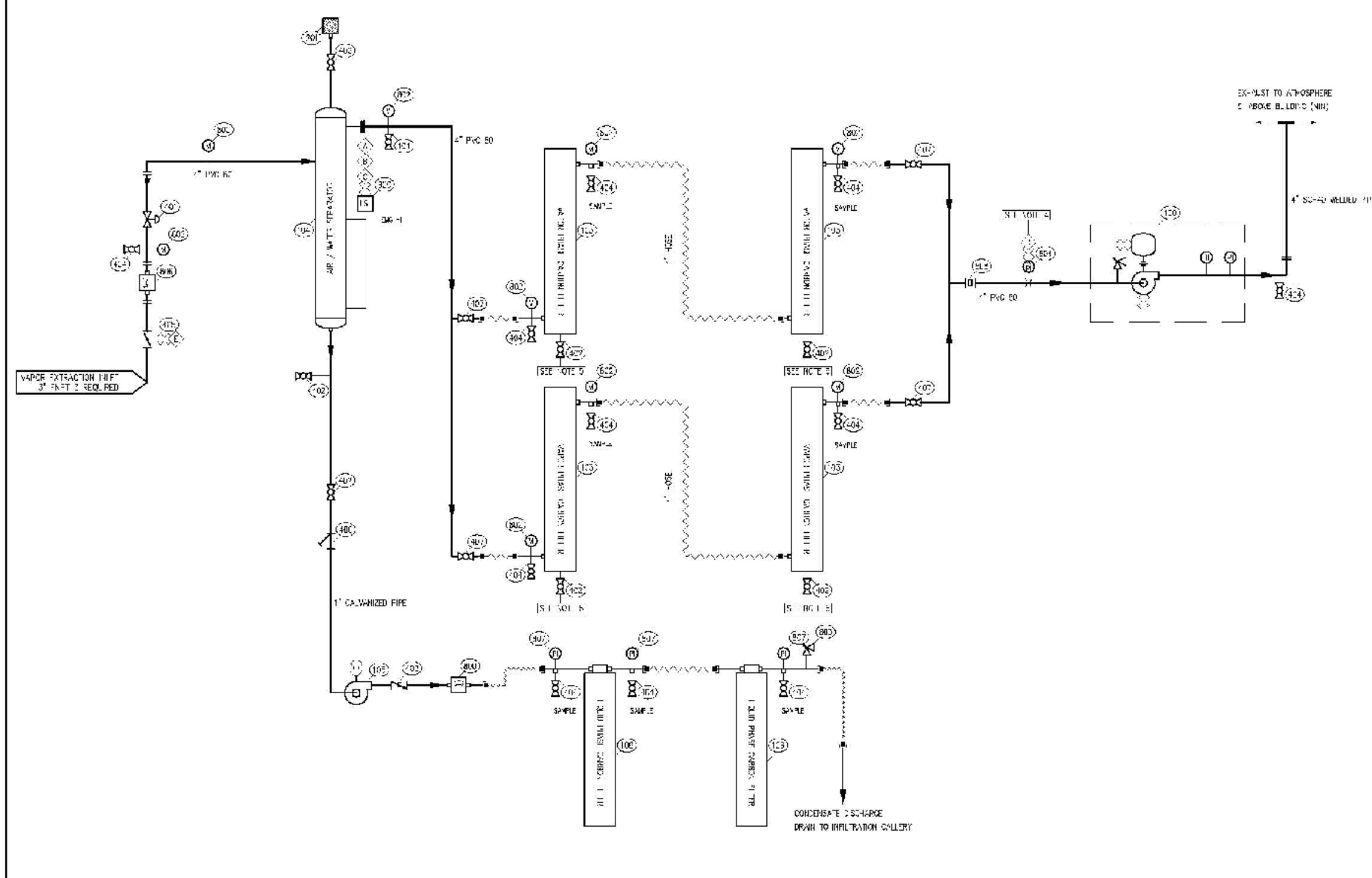
NOTES

- ALL QUICK CONNECT FITTINGS ALUMINUM WITH BALL-BEAN GASKETS
- ALL HOSE CONNECTED TO PUMP, ALL 1/2" PNEUMATIC FILTERS
- PRIMARY SYSTEM VOLTAGE 230V 3 PHASE 60 HZ SOLAR POWERED
- USE NOTAS RECOMMENDED PIPE LENGTHS
- DIRMS TO GRAVITY DRAIN TO-GROUND FLOOR TO INFLTRATION GALLERY

SYSTEM INTERLOCKS	
ALARM	ACTION
ALL	SYSTEM SHUTDOWN

BILL OF MATERIAL TAG LEGEND	
10X - SPECIALIZED PROCESS EQUIPMENT	60X - HEATING AND VENTILATION
20X - STANDARD PROCESS EQUIPMENT	70X - NOT LISTED
30X - CONTROL PANELS	80X - INSTRUMENTATION
40X - VALVES	90X - OTHER
50X - LIGHTING	00X - NOT USED

PROCESS



ELECTRICAL TERMINATIONS	PNEUMATIC TERMINATIONS
<ul style="list-style-type: none"> 01 LIQUID LEVEL - SHUTDOWN - AMS - HD 02 LIQUID LEVEL - PUMP START 03 LIQUID LEVEL - PUMP STOP 04 FLOW INDICATION, 4 SCFH OUT PUT 05 FLOW CONTROL VALVE 	<ul style="list-style-type: none"> 15 LIQUID LEVEL SWITCH 16 LEVEL SENSOR - HIGH 17 LEVEL SENSOR - LOW 18 PRESSURE SENSOR - DIFFERENTIAL 19 PRESSURE SENSOR - LOW 20 PRESSURE SENSOR - HIGH 21 TEMPERATURE SENSOR - HIGH 22 TEMPERATURE SENSOR - LOW 23 TEMPERATURE SENSOR - DIFFERENTIAL 24 TEMPERATURE SENSOR - HIGH 25 TEMPERATURE SENSOR - LOW

<ul style="list-style-type: none"> 06 DIFF. PRESS. GAUGE 07 THERMOMETER 08 GAUGE IN LINE 09 SWITCH TO GROUND 10 BALL VALVE 11 GATE VALVE 12 NEEDLE VALVE 13 BALL VALVE 	<ul style="list-style-type: none"> 26 SPRING CHECK VALVE 27 PISTON CHECK VALVE 28 BALL VALVE 29 BUTTERFLY VALVE 30 CONTROL VALVE 31 REGULATOR VALVE 32 ISOLATION/4" VALVE 33 IN LINE FILTER 34 STRAINER 35 FLOW METER 36 OR OF PNEUMATIC SENSORS 37 PRESSURE/VACUUM TRANSDUCER 38 FLOW SWITCH 	<ul style="list-style-type: none"> 39 FLOW METER 40 FLOW METER 41 FLOW METER 42 FLOW METER 43 FLOW METER 44 FLOW METER 45 FLOW METER 46 FLOW METER 47 FLOW METER 48 FLOW METER 49 FLOW METER 50 FLOW METER
--	--	--

PROPERTY OF **OEC**

THIS DRAWING IS LOANED SUBJECT TO RETURN ON DEMAND AND IS NOT TO BE REPRODUCED NOR USED IN ANY WAY DETRIMENTAL TO OUR INTERESTS

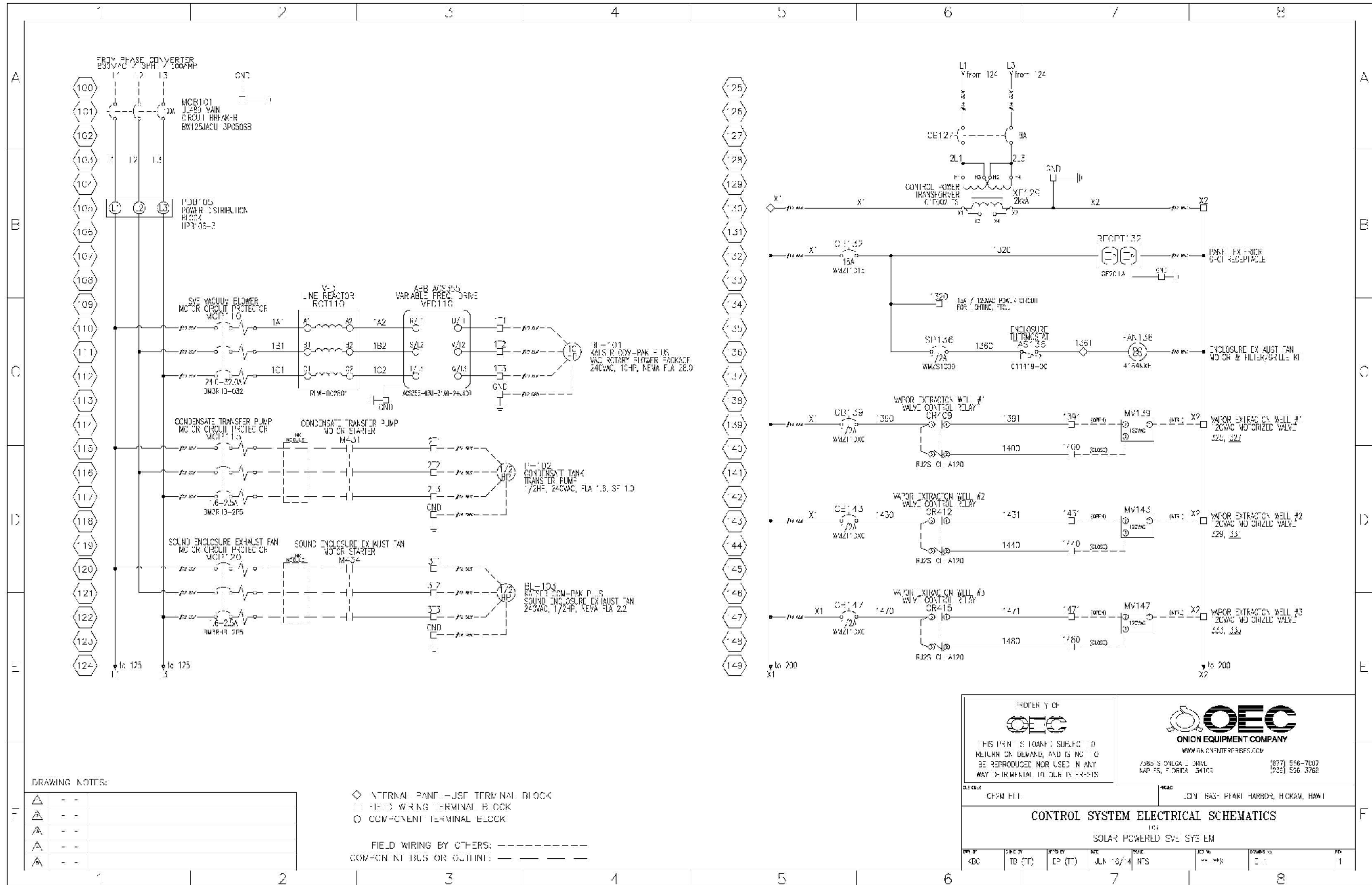
OEC
UNION EQUIPMENT COMPANY
WWW.OEC-ENTERPRISES.COM

7085 SILVER LAKE DRIVE
WALTON, FLORIDA 32786
Ph: (813) 228-1007
Fax: (813) 228-0728

DATE: 01/11/14
DRAWN BY: JON HASE
CHECKED BY: JON HASE
APPROVED BY: JON HASE

PROCESS AND INSTRUMENTATION FLOW DIAGRAM							
SOLAR POWERED SVE SYSTEM							
DATE: 01/11/14	DESIGN: JON HASE	REV: 01	SCALE: NTS	TITLE: PROCESS AND INSTRUMENTATION FLOW DIAGRAM	PROJECT: SOLAR POWERED SVE SYSTEM	DRAWN BY: JON HASE	2

This page intentionally left blank.




DRAWING NOTES:

△	- -
▲	- -
△	- -
▲	- -
△	- -
▲	- -

- ◇ INTERNAL PANEL - USE TERMINAL BLOCK
 - FIELD WIRING TERMINAL BLOCK
 - COMPONENT TERMINAL BLOCK
- FIELD WIRING BY OTHERS: - - - - -
- COMMON BUS OR GROUND: - - - - -

PROPERTY OF



ONION EQUIPMENT COMPANY
WWW.ONIONEQUIPMENT.COM

7385 S. ONION AVE. JUNEAU, ALASKA 99801 (907) 586-7007 FAX (907) 586-3768

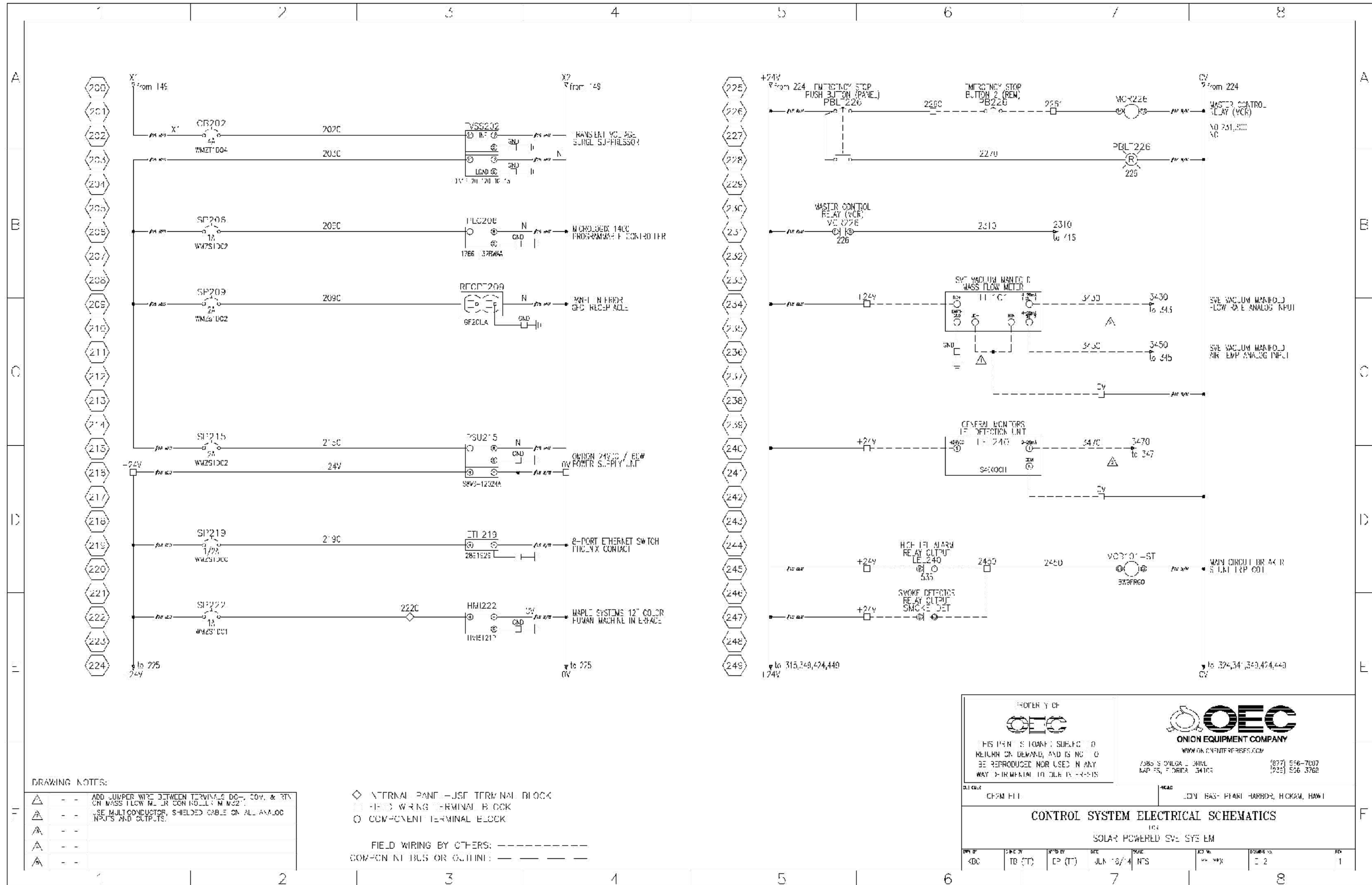
PROJECT: CHYM FILL LOCATION: CHYM BASIN PIKANI HARBOR, HONOLULU, HAWAII

CONTROL SYSTEM ELECTRICAL SCHEMATICS

SOLAR POWERED SVL SYS EM

DATE: <DC	DATE: TB (T)	DATE: EP (T)	DATE: JUN 13/4	DATE: NTS	DATE: 11/13/4	DATE: 11/13/4	DATE: 11/13/4
-----------	--------------	--------------	----------------	-----------	---------------	---------------	---------------

This page intentionally left blank.



DRAWING NOTES:

- △ - - ADD JUMPER WIRE BETWEEN TERMINALS DC- COV. & RTN ON MASS FLOW METER CONNECTION IN M221
- △ - - USE MULTICONDUCTOR, SHIELDED CABLE ON ALL ANALOG INPUTS AND OUTPUTS
- △ - -
- △ - -

- ◇ INTERNAL PANEL - USE TERMINAL BLOCK
 - FIELD WIRING TERMINAL BLOCK
 - COMPONENT TERMINAL BLOCK
- FIELD WIRING BY OTHERS: - - - - -
- COMPONENT BUS OR OUTLINE: - - - - -

PROPERTY OF

OEC

ONION EQUIPMENT COMPANY
WWW.ONIONEQUIPMENT.COM

7385 S. OLOA DRIVE (877) 556-7007
WAIKIKO, HAWAII 96741 (808) 556-3762

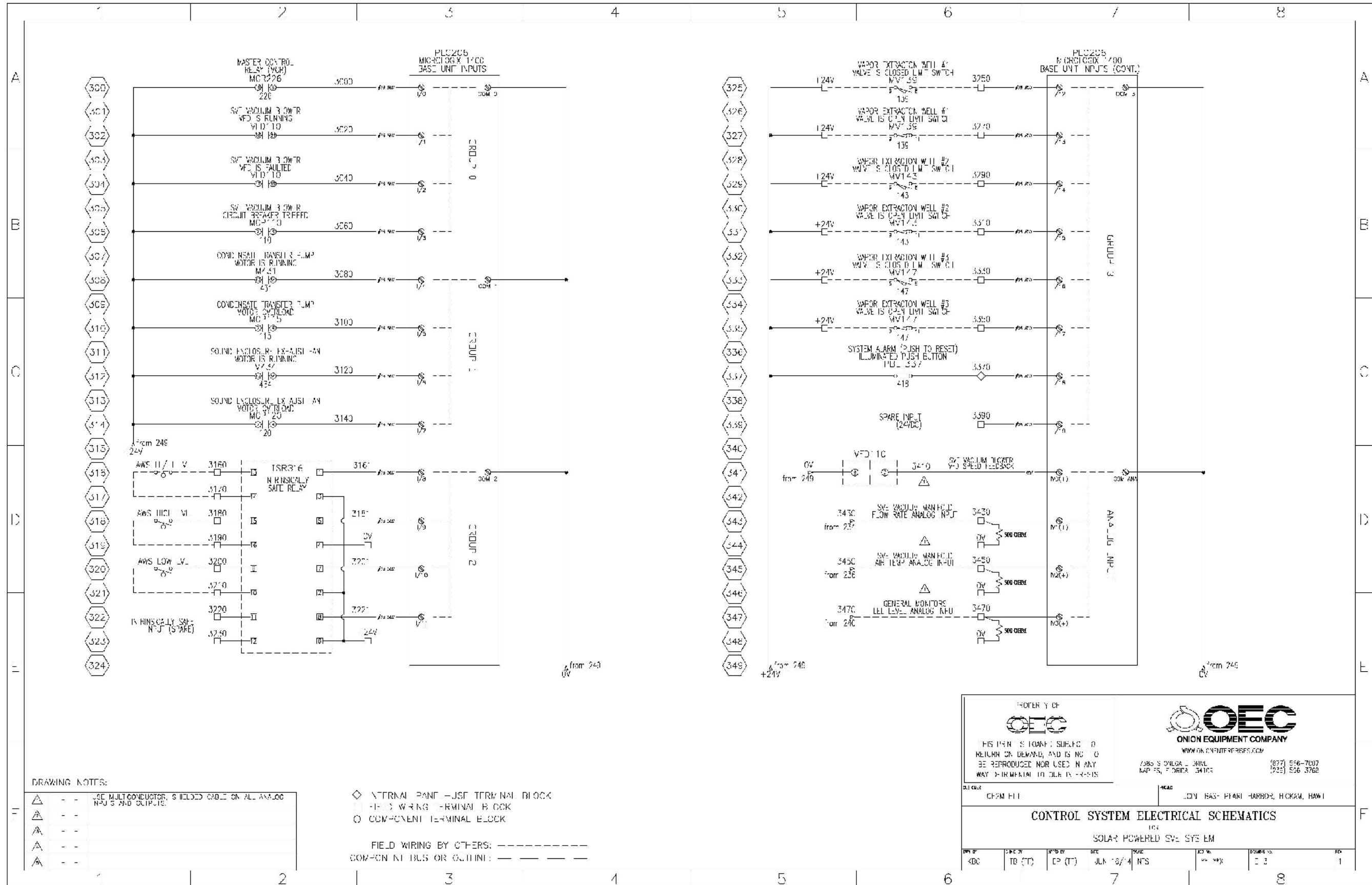
PROJECT: CHYM F11 HEAD: LCVN 163-PIHARI HARBOR, HOKKAIDU, HAWAII

CONTROL SYSTEM ELECTRICAL SCHEMATICS

104
SOLAR POWERED SVL SYS EM

DATE: <DC	DATE BY: TB (T)	APP'D BY: EP (T)	DATE: JUN 18/14	SCALE: NTS	REV: 00	REV: 02	REV: 01
-----------	-----------------	------------------	-----------------	------------	---------	---------	---------

This page intentionally left blank.



DRAWING NOTES:

- △ - - USE MULTICONDUCTOR, SHIELDED CABLE ON ALL ANALOG INPUTS AND OUTPUTS
- △ - -
- △ - -
- △ - -
- △ - -

- ◇ INTERNAL PANEL - USE TERMINAL BLOCK
 - FIELD WIRING TERMINAL BLOCK
 - COMPONENT TERMINAL BLOCK
- FIELD WIRING BY OTHERS: - - - - -
- COMMON RAIL BUS OR GROUND: - - - - -

PROPERTY OF

OEC ONION EQUIPMENT COMPANY
WWW.ONIONEQUIPMENT.COM

7385 S. OHLON AVE. JOLIET, IL 61781 (815) 596-7007 FAX: (815) 596-3762

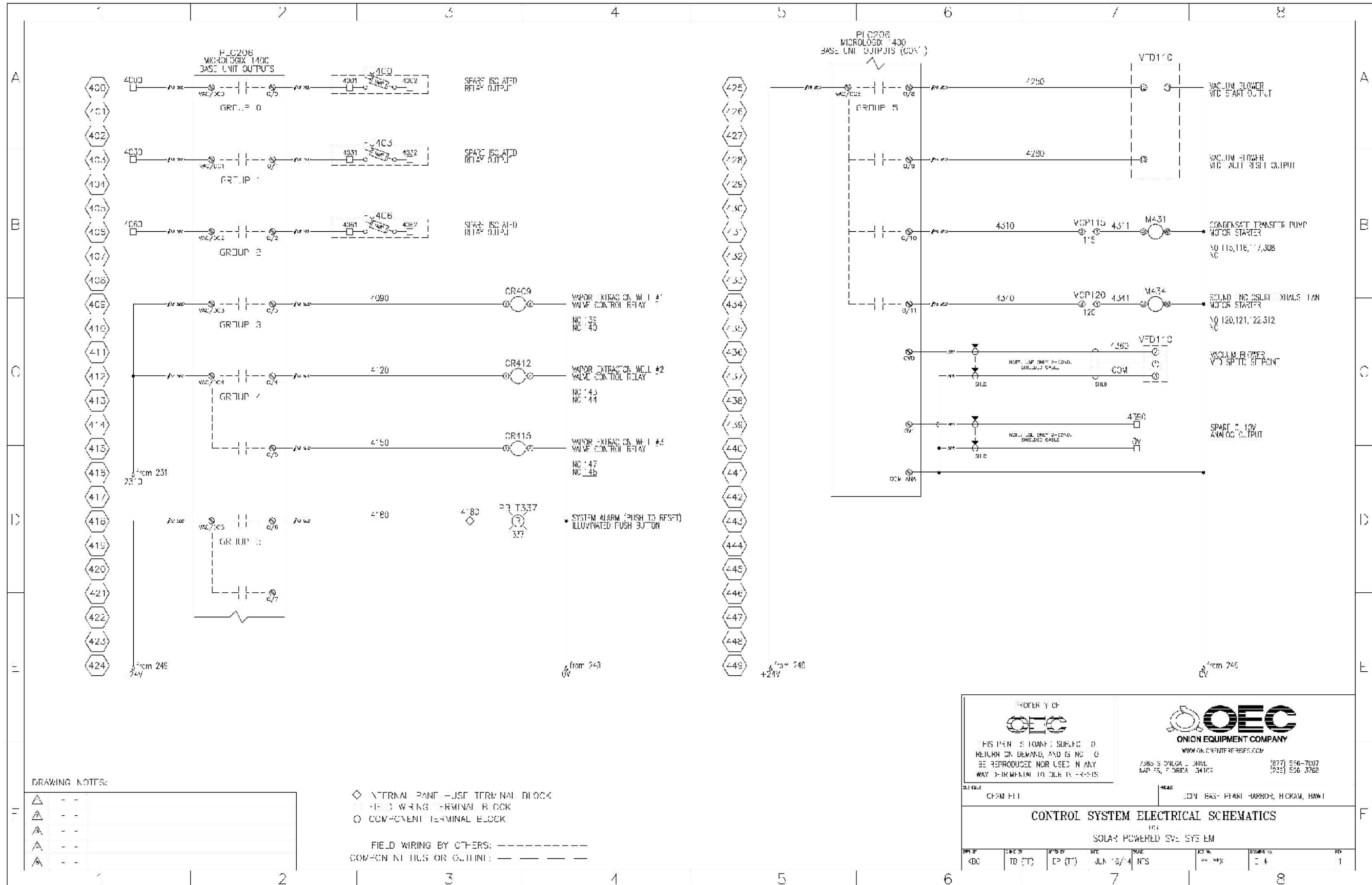
PROJECT: CHYM F11 HEAD: LCVN BAS-PIARI HARBOR, HOKSAM, HAWAII

CONTROL SYSTEM ELECTRICAL SCHEMATICS

SOLAR POWERED SV: SYS EM

DATE: <DC	DATE: TB (T)	DATE: EP (T)	DATE: JUN 13/4	SCALE: NTS	REV: 1
-----------	--------------	--------------	----------------	------------	--------

This page intentionally left blank.



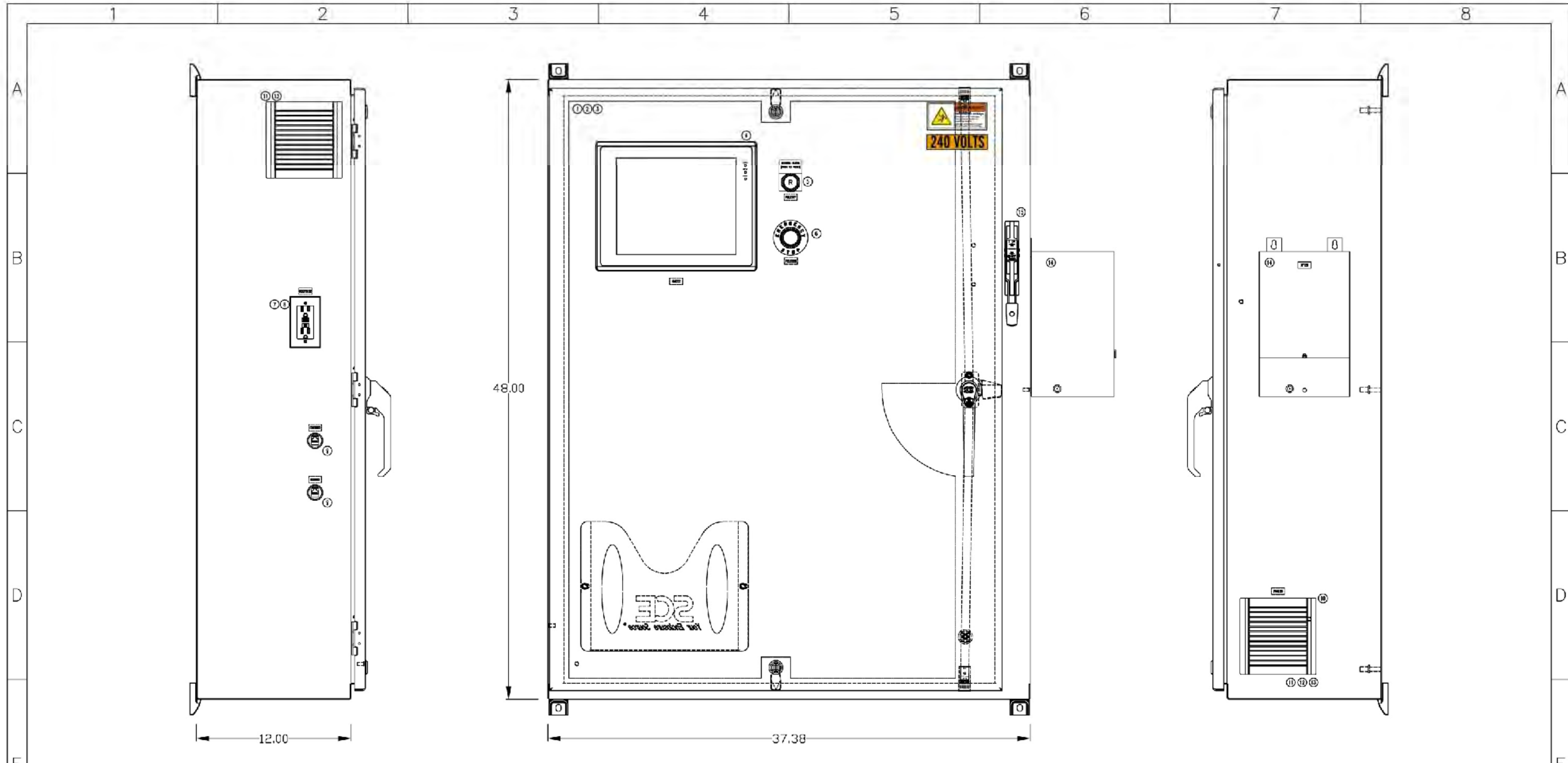
DRAWING NOTES:

△	--	
△	--	
△	--	
△	--	
△	--	

- ◇ INTERNAL PANEL - JUST TERMINAL BLOCK
 - FIELD WIRING TERMINAL BLOCK
 - COMPONENT TERMINAL BLOCK
- FIELD WIRING BY OTHERS: - - - - -
- COMMON BUS OR GROUND: - - - - -

PROPERTY OF OEC THIS DRAWING IS LOANED TO YOU FOR YOUR USE ONLY. IT IS NOT TO BE REPRODUCED NOR USED IN ANY WAY INFRINGING THE RIGHTS OF OEC.		OEC ONION EQUIPMENT COMPANY WWW.ONIONEQUIPMENT.COM 7385 S. ONIOLA DR. JOLIET, IL 61781 (815) 746-7007 MAPLE BLVD. FORT MONROE, VA 22031 (703) 556-3762	
PROJECT: CHYM F11		HEADQUARTERS: 1545 PIKANI HARBOUR, HONGKONG, HAWAII	
CONTROL SYSTEM ELECTRICAL SCHEMATICS 104 SOLAR POWERED SYSTEMS			
DATE: 10/20/07	BY: JTB	DATE: 10/20/07	BY: JTB
DATE: 10/20/07	BY: JTB	DATE: 10/20/07	BY: JTB
DATE: 10/20/07	BY: JTB	DATE: 10/20/07	BY: JTB

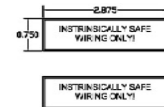
This page intentionally left blank.



BILL OF MATERIAL

ITEM #	QTY	CATALOG	MANUFACTURER	DESCRIPTION
1	1	SCS-48XEL272LP	SAGINAW C&E	NEMA 4/12 DISCONNECT ENCLOSURE 48" x 36" x 12"
2	1	SCF-48PM	SAGINAW C&E	48" x 36" RUB PAINT - WHITE PAINTED STEEL
3	1	SCF-ELMPK	SAGINAW C&E	ENCLOSURE FOOT MOUNTING KIT
4	1	HMS120P	MAPLE SYSTEMS	12" COLOR OPERATOR INTERFACE TOUCH SCREEN
5	1	ALD2591CON-R-24V	IDEC	30mm ILLUMINATED PUSH BUTTON, 24V LED, RED LENS
6	1	XV1E-4V411Q4M-R	IDEC	22mm ILLUM. RED E-STOP PUSH BUTTON, MAINT.
7	1	GF22-1A	HUBBELL	20A GFCI RECEPTACLE - IVORY
8	1	SS23	HUBBELL	STAINLESS STEEL GFCI COVER PLATE
9	6	M22-RJ45-SA	EATON	ETHERNET, CAT5e, IN-LINE COUPLER, STR. FOR RJ-45
10	1	4603N	EBM-PAPST	EX. FAN, 120VAC, 120x120x38mm, 135.5 CFM, 18W
11	2	LZ40N	EBM-PAPST	EXHAUST GRILLE & FILTER KIT
12	1	LZ126	EBM-PAPST	1M MOLDED 2-PRONG PLUG FOR EX. FAN
13	4	LZ4C-1	EBM-PAPST	FILTER SCREEN MOUNTING BRACKET KIT
14	1	C1FC2LES	HAMMOND	2KVA 1-PH. TRANSFORMER, 480/240 PRI x 120/240 SEC
15	1	BW9FOGA-15A	FUJI ELECTRIC	MAIN CIRCUIT BREAKER DISCONNECT HANDLE

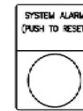
BLUE BACKGROUND / WHITE TEXT
ADHESIVE-BACKED



22.5mm HOLE - YELLOW
BACKGROUND, RED TEXT



30mm HOLE - ALUMINUM
JUMBO LEGEND PLATE



PROPERTY OF
OEC
THIS PRINT IS LOANED SUBJECT TO
RETURN ON DEMAND, AND IS NOT TO
BE REPRODUCED NOR USED IN ANY
WAY DETRIMENTAL TO OUR INTERESTS



ONION EQUIPMENT COMPANY
WWW.ONIONENTERPRISES.COM
7385 STONEGATE DRIVE
NAPLES, FLORIDA 34109 (877) 566-7007
(239) 596-3768

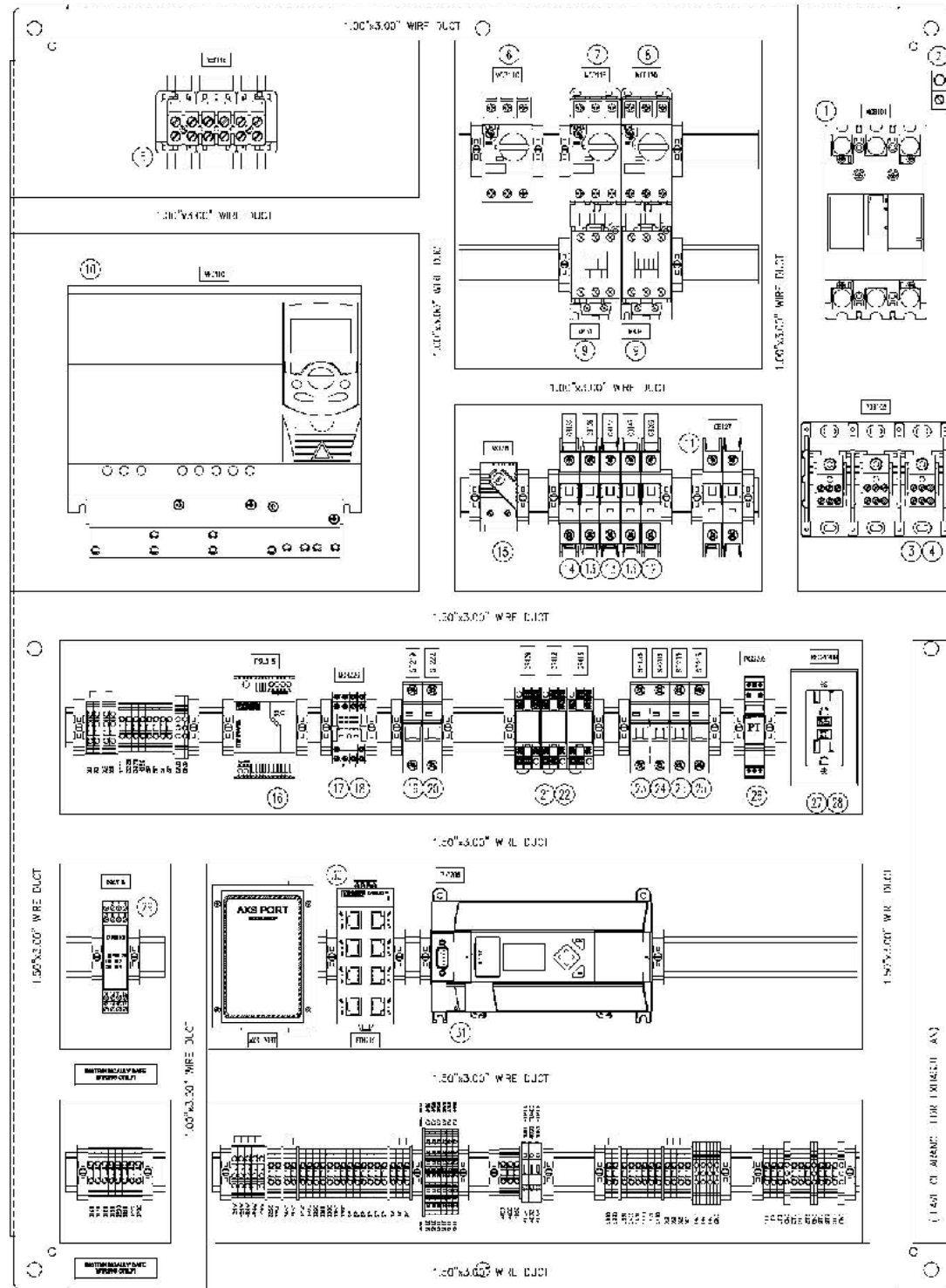
CUSTOMER: CH2M HILL PROJECT: JOINT BASE PEARL HARBOR, HICKAM, HAWAII

CONTROL SYSTEM ELECTRICAL SCHEMATICS
FOR
SOLAR POWERED SVE SYSTEM

DRW BY: KBC	CHKD BY: TB (TF)	APP'D BY: EP (TF)	DATE: JUN 16/14	SCALE: NTS	JOB No: **_**X	DRAWING No: E-5	REV: 1
-------------	------------------	-------------------	-----------------	------------	----------------	-----------------	--------

This page intentionally left blank.

CONTROL PANEL INTERIOR LAYOUT



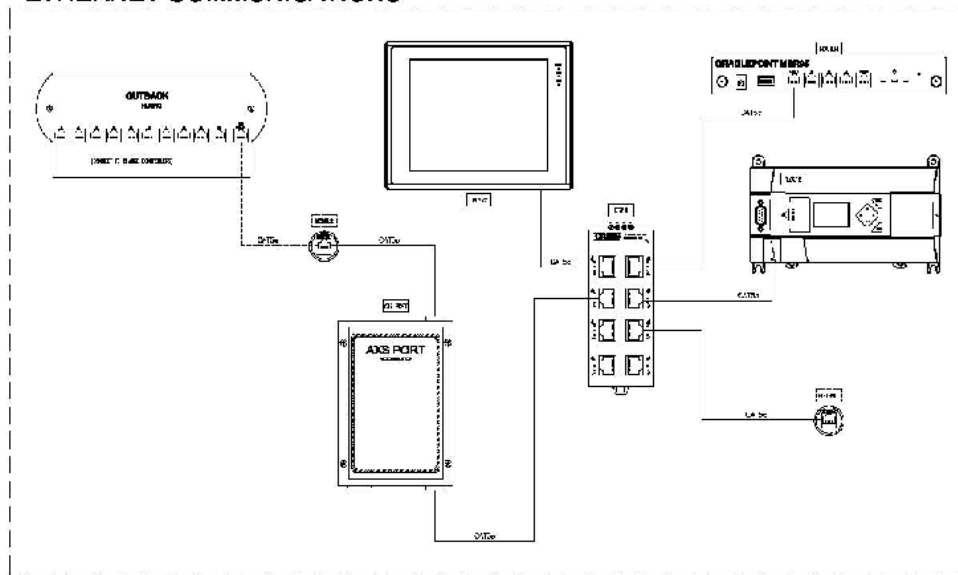
VFD110 MODIFIED PARAMETERS

PARAM #	DESCRIPTION	VALUE
1106	MIN. FREQ	0.500 Hz
1301	MINIMUM AM	4.0%
1401	RELAY OUTPUT 1	FAULT
1601	ADJ CONTENT SEL	OUTPUT FREQ.
1604	MINIMUM AOM	4.0 mA
1806	DO SIGNAL	RUN
2001	MINIMUM SPEED	500 RPM
2002	MAXIMUM SPEED	3600 RPM
2007	MINIMUM FREQ	0.0 Hz
2202	ACCELER TIME 1	0.3 s
2203	DECELER TIME 1	0.0 s
2301	PROP GAIN	0.08
2302	INTEGRATION TIME	1.24 s
2304	AGG. DEPR. TIME	0.23 s
3401	DO 1 PARAM	OUTPUT FREQ.
3408	SIGNAL PARAM	PID 1 SETPT
3415	SIGNAL PARAM	PID 1 FBK
4005	10% VALUE INV	YES
4008	UNITS	INVC
4009	10% VALUE	50.0 INVC
4011	INTERNAL SETPT	0.0 INVC
9902	APPLIC MACRO	PID CONTROL
9906	MOTOR NOM CURR	8.9A
9908	MOTOR NOM SPEED	3600 RPM

BILL OF MATERIAL

ITEM #	QTY	DRAWING	MFG	DESCRIPTION
1	1	BWH 26148143P00000	FLUJ ELECTRIC	UL489 60AMP RIGID CASE CIRCUIT BREAKER
2	1	CD7D-44-07	PANOUT	3/4\"/>

ETHERNET COMMUNICATIONS



PROPERTY OF
OEC
 ONION EQUIPMENT COMPANY
 WWW.ONIONEQUIPMENT.COM

7385 S OYLER DR, JOLIET, IL 61781 (815) 746-7007
 MAPLE BLVD, FORT MONROE, VA 22031 (703) 556-3762

CONTROL SYSTEM ELECTRICAL SCHEMATICS
 104
 SOLAR POWERED SVL SYS EM

DATE: JUN 18/4
 SCALE: 1:1
 SHEET: 6 OF 6

This page intentionally left blank.

Appendix A-3 Fabrication and Installation Drawings

This page intentionally left blank.

SPEED SPACE

BUILDING LOCATION: ANDERSON, INDIANA

OCCUPANCY GROUP: B

CONSTRUCTION TYPE: VB

DESIGN CODES

2008 INDIANA BUILDING CODE (2006 IBC/UFC W/IN AMEND)
 2008 INDIANA MECHANICAL CODE (2006 IMC W/IN AMEND)
 2010 INDIANA ENERGY CONSERVATION CODE
 2009 INDIANA ELECTRIC CODE (2008 NFPA 70)
 THIS UNIT IS TO MEET ALL UFC STANDARDS

MODEL	SIZE	SQ. FOOTAGE
SS1236	11'-9" X 36'-0"	423

INDEX	
0	COVER SHEET
0a	GENERAL NOTES
1	FLOOR PLAN
2	NOT USED
3	NOT USED
4	EXTERIOR ELEVATIONS
4a	EXTERIOR ELEVATIONS
5	CROSS SECTION
6	FRAME DETAILS



DESIGN LOADS

ROOF LIVE LOAD: 30 PSF
 WIND: SPEED: 120 MPH EXP. C
 SEISMIC DESIGN CAT.: E
 FLOOR LIVE LOAD: 50 PSF

Kevin M. Finn, P.E., Inc.
 1716 Elkhart Rd., Suite 1
 Goshen, IN 46526
 IN Lic. # PE19600032

SPEED SPACE		65213 CR 31 GOSHEN, IN 46528	
CUSTOMER:		REVISIONS	
DEALER: ONION EQUIPMENT		NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14	
COVER SHEET	DWG #: 0	SERIAL #: A-8618	QUOTE# S022414GR4

This page intentionally left blank.

BUILDING CODE

- 1) BUILDER/DEALER SHALL BE RESPONSIBLE FOR ON SITE BARRIER FREE PROVISIONS; STEPS, RAMPS/ PARKING SIGNS, ETC. AND SHALL COMPLY TO THE AMERICANS WITH DISABILITIES ACT AND ALL STATE & LOCAL CODES OR REQUIREMENTS.
- 2) DOORS SHALL BE READILY OPENABLE FROM THE EGRESS SIDE WITHOUT THE USE OF A KEY.
- 3) CORROSIVE RESISTANT FLASHING AT TOP & SIDES OF DOORS, WINDOWS AND AT ROOF PENETRATIONS.
- 4) CLOTHES RODS AND HAT SHELVES SHALL BE MOUNTED NO HIGHER THAN 54 INCHES.
- 5) THE LOWER 12 INCHES OF ALL DOORS SHALL HAVE A SMOOTH UNINTERRUPTED SURFACE.
- 6) POTABLE WATER TO BE SUPPLIED @ SITE BY OTHERS.
- 7) ADEQUATE TOILET FACILITIES SHALL BE LOCATED IN AN ADJACENT BUILDING UNDER SAME OWNERSHIP. WITHIN 500' OF THIS UNIT
- 8) THIS BUILDING IS NOT INTENDED TO BE OCCUPIED EXCEPT FOR SERVICE AND MAINTENANCE PERSONNEL.
- 9) THIS BUILDING SHALL MEET ALL IBC/UFC STANDARDS.

STRUCTURAL

- 1) TRUSSES TO BE CERTIFIED FOR LOAD AND APPLICATION USED.
- 2) INTERIOR PARTITIONS TO BE CONSTRUCTED TO WITHSTAND A 5 PSF HORIZONTAL FORCE.
- 3) INTERIOR WALL BOARD SHALL BE 1/4 INCH MINIMUM THICKNESS OR CONFORM TO SECTION 1422.5 (TESTED WITH MATERIALS SUSPENDED FROM THE NON-COMBUSTIBLE BACKING).
- 4) ALL LUMBER TO BE GRADED AND MARKED.
- 5) COMPRESSION PLATED REQUIRED TO ENSURE WOOD TO WOOD CONTACT AT BEARING WALL TO ROOF JOINTS.
- 6) DADOS AND NOTCHING NOT TO OCCUR IN CENTER 1/3rd OF THE LENGTH OF THE WALL STUDS.
- 7) EXTERIOR BRACING MAY BE PROVIDED WITH T1-11 WOOD SIDING, 7/16 INCH HARDBOARD SIDING, "STORMBRACE" EXTERIOR SHEATHING OR 3/8 INCH CDX PLYWOOD.

//////SPEED SPACE//////

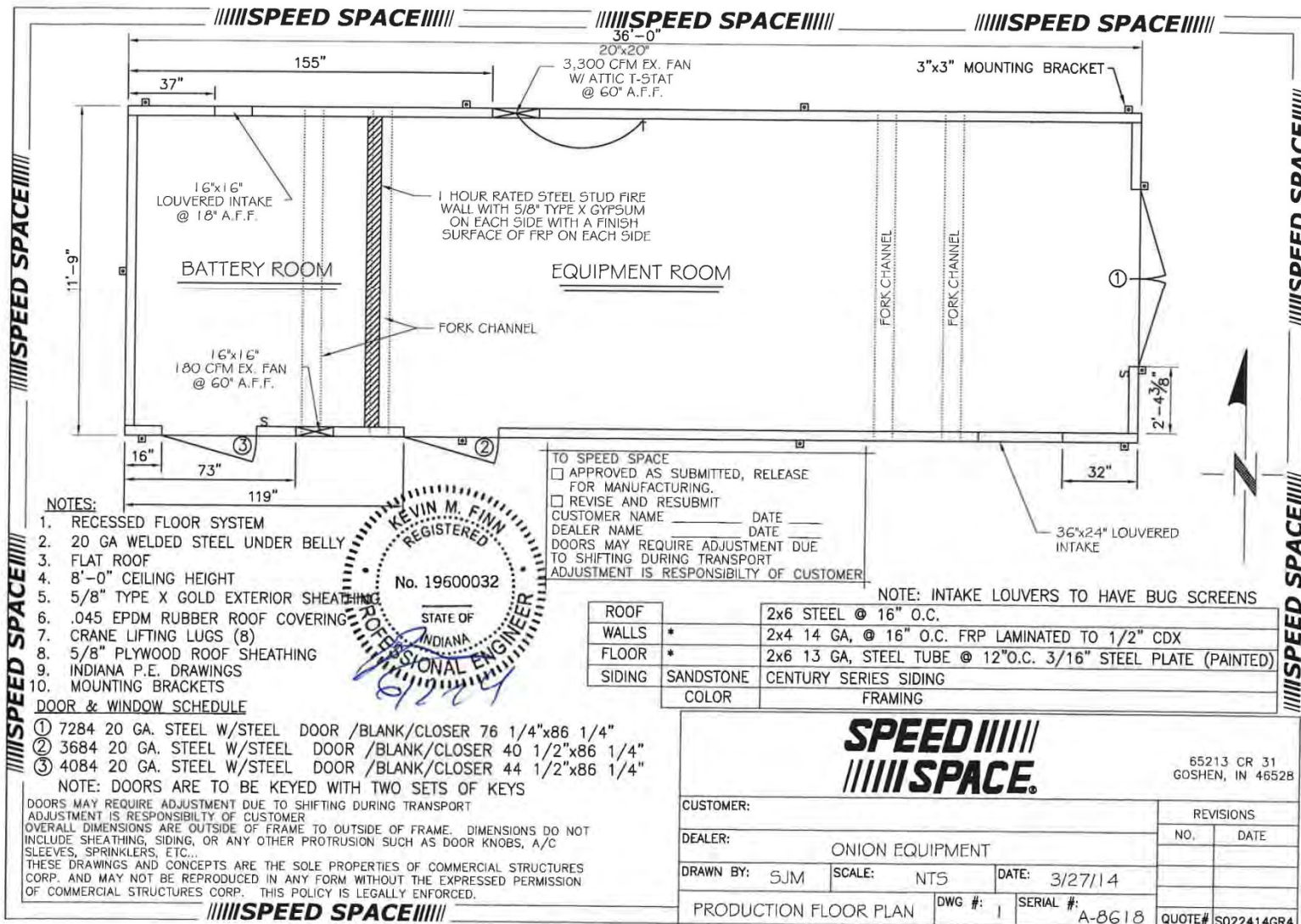
//////SPEED SPACE//////



SPEED			65213 CR 31 GOSHEN, IN 46528	
SPACE				
CUSTOMER:			REVISIONS	
DEALER: ONION EQUIPMENT			NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14		
GENERAL NOTES		DWG #: 0a	SERIAL #: A-8618	QUOTE# S022414GR4

//////SPEED SPACE//////

This page intentionally left blank.



NOTES:

1. RECESSED FLOOR SYSTEM
2. 20 GA WELDED STEEL UNDER BELLY
3. FLAT ROOF
4. 8'-0" CEILING HEIGHT
5. 5/8" TYPE X GOLD EXTERIOR SHEATHING
6. .045 EPDM RUBBER ROOF COVERING
7. CRANE LIFTING LUGS (8)
8. 5/8" PLYWOOD ROOF SHEATHING
9. INDIANA P.E. DRAWINGS
10. MOUNTING BRACKETS

DOOR & WINDOW SCHEDULE

- ① 7284 20 GA. STEEL W/STEEL DOOR /BLANK/CLOSER 76 1/4"x86 1/4"
- ② 3684 20 GA. STEEL W/STEEL DOOR /BLANK/CLOSER 40 1/2"x86 1/4"
- ③ 4084 20 GA. STEEL W/STEEL DOOR /BLANK/CLOSER 44 1/2"x86 1/4"

NOTE: DOORS ARE TO BE KEYED WITH TWO SETS OF KEYS
 DOORS MAY REQUIRE ADJUSTMENT DUE TO SHIFTING DURING TRANSPORT
 ADJUSTMENT IS RESPONSIBILITY OF CUSTOMER
 OVERALL DIMENSIONS ARE OUTSIDE OF FRAME TO OUTSIDE OF FRAME. DIMENSIONS DO NOT INCLUDE SHEATHING, SIDING, OR ANY OTHER PROTRUSION SUCH AS DOOR KNOBS, A/C SLEEVES, SPRINKLERS, ETC...
 THESE DRAWINGS AND CONCEPTS ARE THE SOLE PROPERTIES OF COMMERCIAL STRUCTURES CORP. AND MAY NOT BE REPRODUCED IN ANY FORM WITHOUT THE EXPRESSED PERMISSION OF COMMERCIAL STRUCTURES CORP. THIS POLICY IS LEGALLY ENFORCED.



TO SPEED SPACE
 APPROVED AS SUBMITTED, RELEASE FOR MANUFACTURING.
 REVISE AND RESUBMIT
 CUSTOMER NAME _____ DATE _____
 DEALER NAME _____ DATE _____
 DOORS MAY REQUIRE ADJUSTMENT DUE TO SHIFTING DURING TRANSPORT
 ADJUSTMENT IS RESPONSIBILITY OF CUSTOMER

NOTE: INTAKE LOUVERS TO HAVE BUG SCREENS

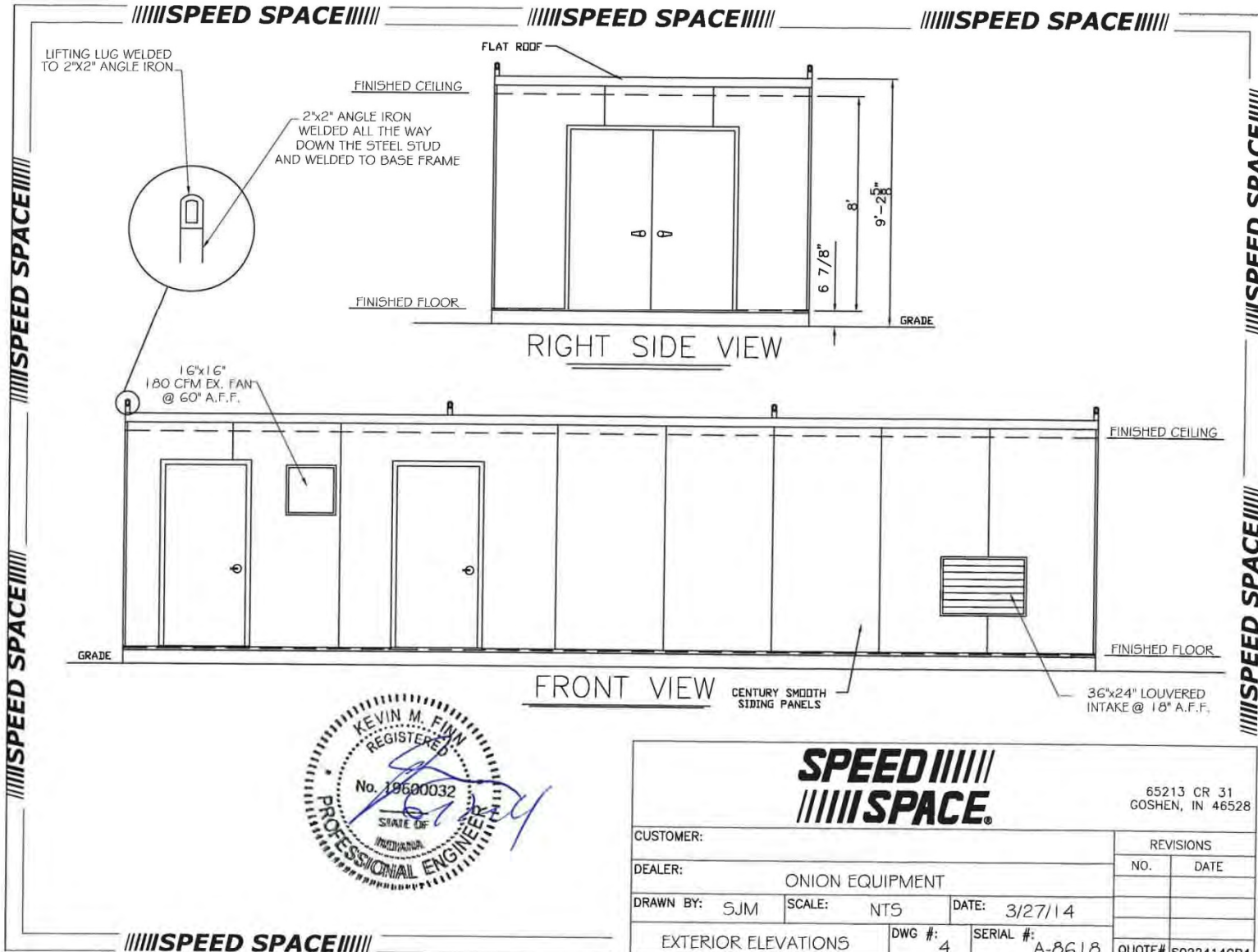
ROOF	2x6 STEEL @ 16" O.C.
WALLS *	2x4 14 GA, @ 16" O.C. FRP LAMINATED TO 1/2" CDX
FLOOR *	2x6 13 GA, STEEL TUBE @ 12" O.C. 3/16" STEEL PLATE (PAINTED)
SIDING	SANDSTONE CENTURY SERIES SIDING
COLOR	FRAMING

SPEED SPACE

65213 CR 31
 GOSHEN, IN 46528

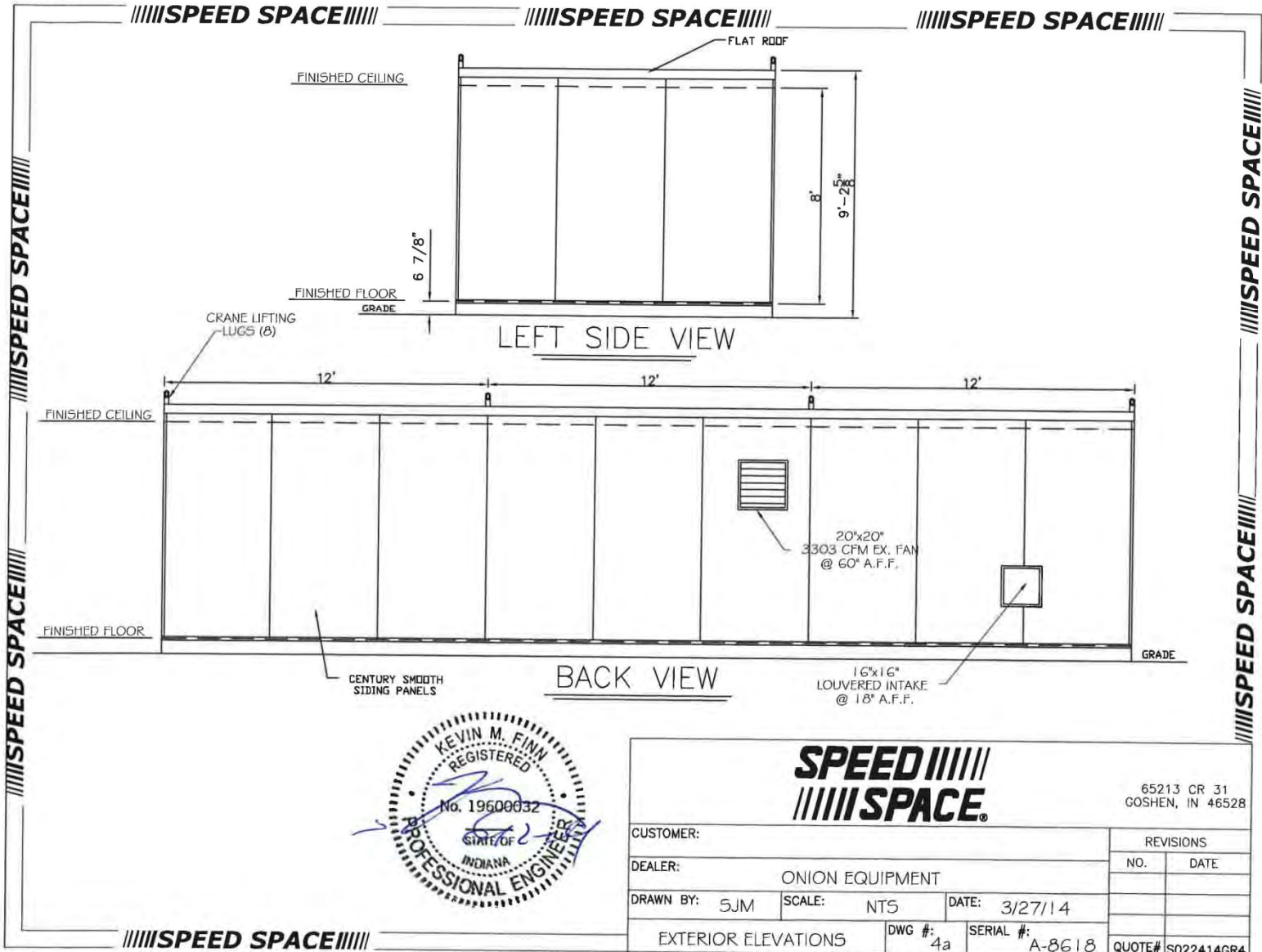
CUSTOMER:		REVISIONS	
DEALER: ONION EQUIPMENT		NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14	
PRODUCTION FLOOR PLAN		DWG #: 1	SERIAL #: A-8618
		QUOTE#	S022414GR4

This page intentionally left blank.



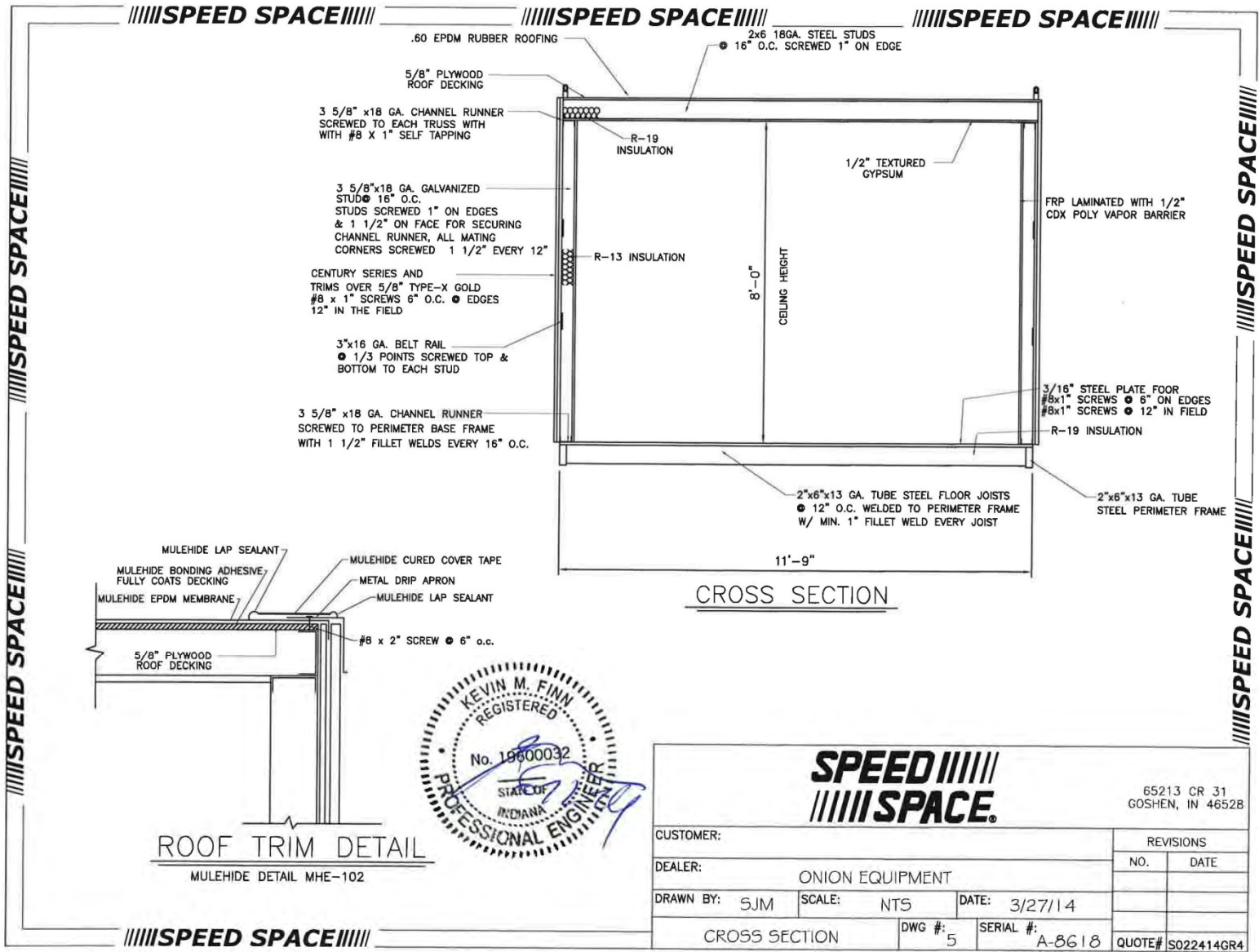
SPEED SPACE			65213 CR 31 GOSHEN, IN 46528	
CUSTOMER:			REVISIONS	
DEALER: ONION EQUIPMENT			NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14		
EXTERIOR ELEVATIONS		DWG #: 4	SERIAL #: A-8618	QUOTE# S022414GR4

This page intentionally left blank.



SPEED SPACE		65213 CR 31 GOSHEN, IN 46528	
CUSTOMER:		REVISIONS	
DEALER: ONION EQUIPMENT		NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14	
EXTERIOR ELEVATIONS		DWG #: 4a	SERIAL #: A-8618
		QUOTE# S022414GR4	

This page intentionally left blank.

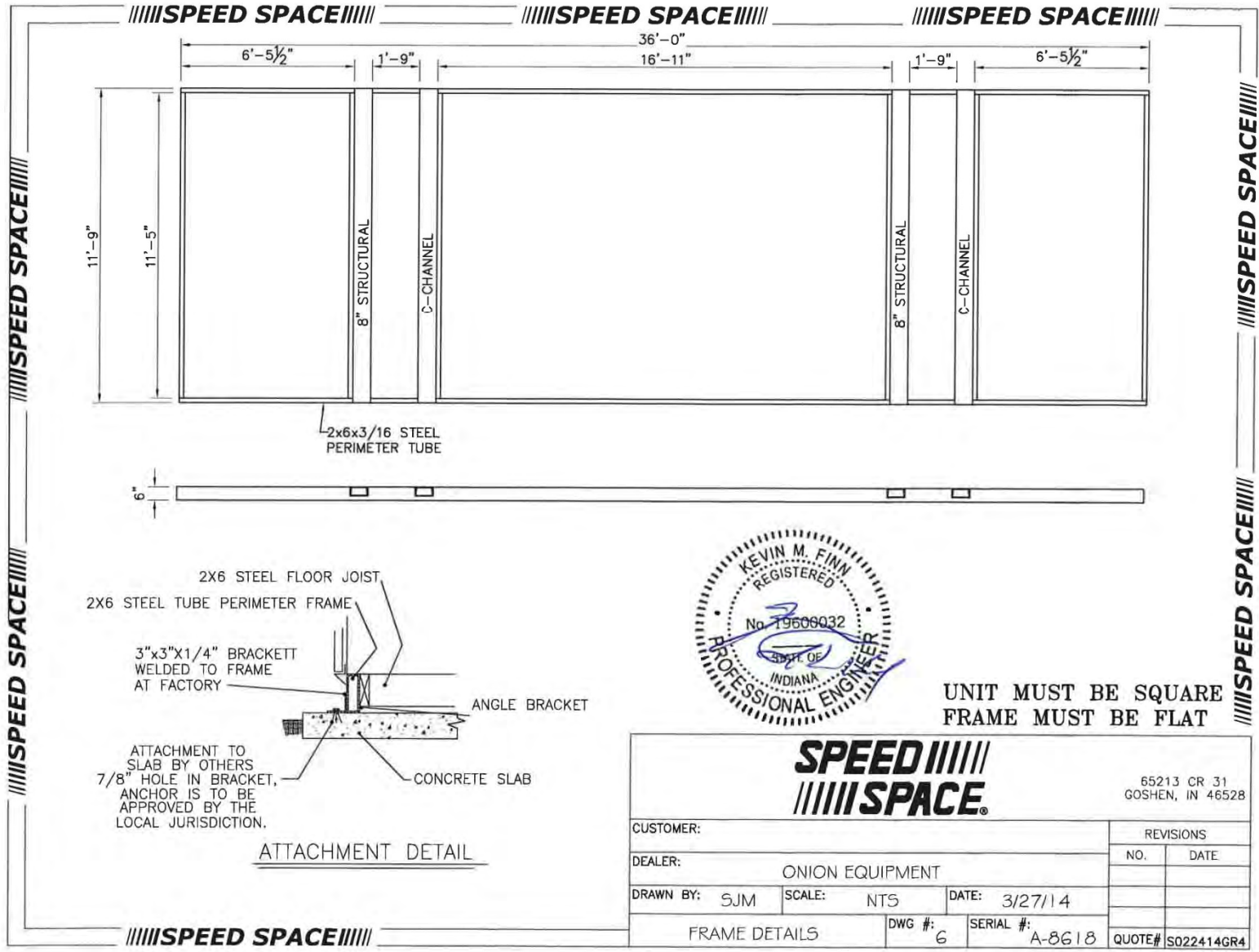


SPEED SPACE

65213 CR 31
GOSHEN, IN 46528

CUSTOMER:			REVISIONS	
DEALER: ONION EQUIPMENT			NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14		
CROSS SECTION		DWG #: 5	SERIAL #: A-8618	QUOTE# S022414GR4

This page intentionally left blank.



UNIT MUST BE SQUARE
FRAME MUST BE FLAT

CUSTOMER:		REVISIONS	
		NO.	DATE
DEALER:		ONION EQUIPMENT	
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14	
FRAME DETAILS		DWG #: 6	SERIAL #: A-8618
		QUOTE#	S022414GR4

This page intentionally left blank.

SPEED SPACE

SUBJECT: WALL STUD ANALYSIS

ENGR: KEVIN M. FINN, P.E., INC.
1716 ELKHART RD., STE. 1
GOSHEN, IN 46526

THIS CALCULATION CONSIDERS THE STEEL FLOOR JOIST.
AND ANALYZES THE DESIGN SUPPORTING THIS CONSIDERATION.

A-8618 WIND SPEED - 120 MPH, EXP. C 2006 IBC w 2008 IN AMEN
NOMINAL WIND LOAD = 27.104 PSF
IMPORTANCE FACTOR - 1
TOTAL Cp = 1

TOTAL WIND LOAD USED FOR LATERAL RESISTANCE DESIGN = 27.10 PSF

WALL TRIB. WIDTH = 1.33 FT O.C.

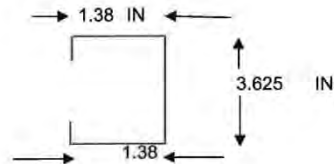
APPLIED UNIFORM LOAD AT WALL STUD = 36.05 PLF

EFFECTIVE LENGTH OF WALL STUD L = 8 FT

APPLIED BENDING MOMENT TO EACH END FRAME $W \times L^2 / 8 = 3460.6$ IN-LBS

WALL STUD = USE 3-5/8" x 18 GA. C-CHANNEL STUD

lo = 0.71 t = 0.0451 IN
Sx = 0.3920 d = 3.625 IN
A = 0.34 width = 1.38 IN
Fy = 33 ksi LDF = 1



RESULTANT BENDING STRESS = fb = M/Sx = 8828.16 psi

ALLOWABLE Fb = 19800 psi

CHECK DEFLECTION $\delta = 5WL^4/384EI = 0.1614$ IN

VS. ALLOWABLE DEFLECTION = L/240 = 0.4 IN - OK



This page intentionally left blank.

SPEED SPACE

SUBJECT: FLOOR JOIST ANALYSIS

ENGR: KEVIN M. FINN, P.E., INC.
1716 ELKHRART RD., STE. 1
GOSHEN, IN 46526

THIS CALCULATION CONSIDERS THE STEEL FLOOR JOIST
AND ANALYZES THE DESIGN SUPPORTING THIS CONSIDERATION.
SERIAL NO. A-8618

IMPORTANCE FACTOR - 1 FLR LIVE LOAD = 50 PSF
TOTAL Cp = 1 FLR DEAD LOAD = 10 PSF

TOTAL LOADS FOR FLOOR JOIST LOADING = 60.00 PSF

FLOOR TRIB. WIDTH 1 FT O.C.

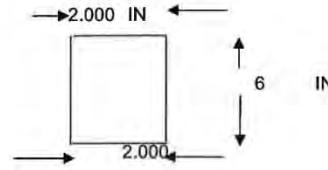
APPLIED UNIFORM LOAD AT FLOOR JOIST = 60.00 PLF

EFFECTIVE LENGTH OF FLOOR JOIST L = 11.3 FT

APPLIED BENDING MOMENT TO EACH JOIST $W \times L^2 / 8 = 11492.10$ IN-LBS

FLOOR JOIST = USE SINGLE 2" x 6" x 13 GA. STEEL TUBE

$I_o = 5.899273$ IN⁴ $t = 0.0897$ IN
 $S_x = 1.9664$ IN³ $d = 6$ IN
 $A = 1.361$ IN² width = 2.000 IN
 $F_y = 36$ ksi LDF = 1



RESULTANT BENDING STRESS = $f_b = M/S_x = 5844.16$ psi

ALLOWABLE $F_b = 21600$ psi

CHECK DEFLECTION $\delta = 5WL^4/384EI = 0.10722$ IN

VS. ALLOWABLE DEFLECTION = $L/360 = 0.376667$ IN - OK



This page intentionally left blank.

SPEED SPACE

SUBJECT: ROOF JOIST ANALYSIS

ENGR: KEVIN M. FINN, P.E., INC.
1716 ELKHART RD., STE. 1
GOSHEN, IN 46526

THIS CALCULATION CONSIDERS THE STEEL ROOF JOIST
AND ANALYZES THE DESIGN SUPPORTING THIS CONSIDERATION.

A-8618	WIND SPEED -	90 MPH
	NOMINAL WIND LOAD =	20.933 PSF
IMPORTANCE FACTOR -	1	ROOF LIVE LOAD = 30 PSF (ROOF LOAD CONTROLS)
TOTAL Cp =	1	ROOF DEAD LOAD = 10 PSF

TOTAL WORST CASE (WIND OR ROOF LOADS) USED FOR ROOF JOIST LOADING = 40.00 PSF

WALL TRIB. WIDTH = 1.33 FT O.C.

APPLIED UNIFORM LOAD AT ROOF JOIST = 53.20 PLF

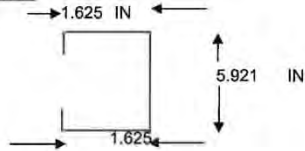
EFFECTIVE LENGTH OF ROOF JOIST L = 11.33 FT

APPLIED BENDING MOMENT TO EACH END FRAME $W \times L^2 / 8 = 10243.84$ IN-LBS

ONE STANDARD INSTALLATION AND ONE ANGLED

ROOF JOIST = USE SINGLE 6" x 18 GA. CSJ STEEL STUD - CONSERVATIVE

$I_o =$	2.316 IN ⁴	$t =$	0.0451 IN
$S_x =$	0.7720 IN ³	$d =$	5.921 IN
$A =$	0.447 IN ²	width =	1.625 IN
$F_y =$	33 ksi	LDF =	1



RESULTANT BENDING STRESS = $f_b = M/S_x = 13269.22$ psi

ALLOWABLE $F_b = 19800$ psi

CHECK DEFLECTION $\delta = 5W'L^4/384EI = 0.121$ IN

VS. ALLOWABLE DEFELCTION = $L/240 = 0.5665$ IN - OK

CHECK SHEAR - $(30 \text{ PSF} + 10 \text{ PSF}) \times 11.75'/2 \times 1.33' \text{ O.C.} / A = 699.22$ PSI - ok



This page intentionally left blank.

SPEED SPACE

SUBJECT: WIND -
LATERAL RESISTANCE ANALYSIS

ENGR: KEVIN M. FINN, P.E.
2700 W. WILDEN AVE. 4
GOSHEN, IN 46528

THIS CALCULATION CONSIDERS THE LATERAL ANALYSIS ON THE HORIZONTAL DIAPHRAGM OF WIND
AND ANALYZES THE DESIGN SUPPORTING THIS CONSIDERATION.

WIND SPEED - 120 MPH exp. C -3 SECT Factor CONVERT B TO C = 1.21
IMPORTANCE FACTOR - 1 2006 INTERNATIONAL BUILDING CODE / 2008 IN BC
WIND CONDITION EXCEEDS SEISMIC DESIGN CATEGORY B
qs = 20.98 PSF MODEL REFERENCE: A-8618

TOTAL WIND LOAD = $qs \times Ce \times x = 25.38$ PSF

TOTAL HORIZONTAL FORCE APPLIED AT TOP OF ROOF TO TOP PLATE CONNECTION -

ROOF PROJECTION = 0.75 FT - ACTUAL ROOF PROJECTION
WALL PROJECTION = 8 FT

FORCE (PLF) AT TOP OF WALL = 120.57 PLF

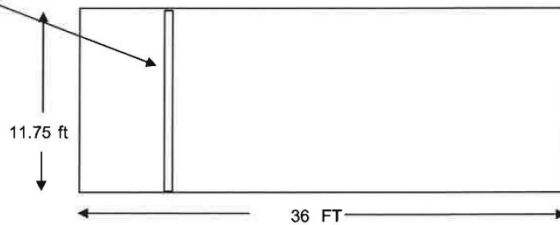
APPLIED FORCE AT RIGHT ENDWALL (27' SECTION) = 1627.69 LBS

RESULTANT APPLIED MAXIMUM DIAPHRAGM SHEAR LOAD = 138.53 PLF - 11' 9" Diaphragm Depth
5/8" APA RATED SHEATHING

EFFECTIVE SHEARWALL LENGTH EACH ENDWALL (WORST CASE) OF UNIT LENGTH =
4.66 FT - SHEARWALL

RESULTANT SHEARWALL LOAD = 349.29 PLF - OKAY FOR 1/2" APA RATED SHEATHING
TYPE X GOLD GYPSUM

184.70 PLF - 5/8" TYPE X GYP EACH SIDE



SHEARWALL TOTAL (ft) = 4.66

SHEARWALL HOLDDOWN REACTION - 11.25 FT DISTANCE FROM CENTER OF HOLDDOWN TO END OF
SHEARWALL - BASED ON RESULTANT SHEARWALL LOAD
 \times WALL HT. / (SHEARWALL LENGTH - DISTANCE END TO FASTENER L

= 1028.32 LBS < 1100 LBS - ACTUALLY USED



This page intentionally left blank.

SPEED SPACE
 65213 CR 31
 Goshen, IN 46528
 (574) 642-2666
 engineering@speedspace.org

Subject: Seismic Vs. Wind
 5/28/2014

Engr: Kevin M. Finn, P.E., Inc.
 1716 Elkhart Rd., Ste 1
 Goshen, IN 46526

LOCATION - ANDERSON, IN

2006 IBC w 2008 IN AMENDMENTS
 PROJECT: 11' 9" x 36' A-8618

30 PSF ROOF LIVE LOAD

TW (wt) = l x w x (25 psf + (30-30)0.25) = 4387.5 LBS

TOTAL LOAD = ROOF DL & 1/2 WALL DL & 25% OF (30-30)LL
 Cs IS THE MINIMUM Cs VALUE CALCULATED TO
 THE LEFT

Sds = 0.40
 S = 2.00
 Sd1 = 0.20 IE = 1
 R = 6

Vr = CsW = 292.5 LBS

Cs = Sds / (R/IE) = 0.0667

Cs = SD1/((R/IE)T) = 0.33 ← need not exceed
 Cs = 0.044SdsIE = 0.0176 (abs. Min)

V = 292.50 lbs T=0.1N= 0.1000 Fa = 1.1
 Fv = 2

ROOF, WALL, FLOOR HEIGHT = 8 FT
 WALL LENGTH = 36 FT

SITE CLASS - D SEISMIC DESIGN CATEGORY - D

SEISMIC VS. WIND

WIND BASED ON WIND - WALL LOAD CALC - 120 MPH, EXP. C

q = 20.09 B to C = 1.21 W = q(GCp) = 24.31 PSF
 TOTAL WIND FORCE ON LONGITUDINAL WALL = 3500.3 LBS - BASED ON WIND
 (WIND CONTROLS) UPPER 1/2 OF WALL

TOTAL FORCE ON END WALL = 1142.46 LBS - BASED ON WIND - UPPER 1/2
 VS. SEISMIC = 292.50 LBS - WIND CONTROLS
 ON THE ENDWALL



This page intentionally left blank.

Design Loads

Bldg_{dl} := 16000-lbf Maximum Building Dead Load applied to (8) Lug Config.

Bldg Information

wall_{ht} := 9-ft + 2.625-in wall height
 bldg_{length} := 36-ft + 0-in building length
 bldg_{width} := 11-ft + 9-in building width
 FS := 1.33

Lifting Element Information

N_{lugs} := 8
 Lug_{spacing} := 12-ft + 0-in lug spacing
 Lug_{capacity} := 3600-lbf lug capacity
 Angle_{leg} := 2-in angle leg ht.
 Angle_{thk} := 0.25-in angle thk
 Angle_{area} := 0.938-in² angle area

Weld Information

t_w := 0.125-in weld thickness
 F_{EXX} := 60-ksi weld tensile strength
 t_b := 0.25-in base metal thickness
 F_y := 36-ksi base metal yield strength

5/8" A307 Bolt Information

T_{bolt} := 5900-lbf bolt tensile capacity (see AISC-ASD Table 1-B)

$$PLF_{bldg} := \frac{(Bldg_{dl})}{2 \cdot bldg_{length}}$$

PLF_{bldg} = 222.2-plf

$$P_{lug} := FS \cdot [PLF_{bldg} \cdot (Lug_{spacing})]$$

maximum load per lug

P_{lug} = 3546.7 lbf

$$Lug_{capacity} = 3600.0 \text{ lbf} \geq P_{lug} = 3546.7 \text{ lbf}$$

CHECK_{lug} = "OK"

Weld Strength

$$t_e := 0.7071 \cdot t_w$$

t_e = 0.088-in

$$R_1 := t_e \cdot (0.30 \cdot F_{EXX})$$

fillet weld strength

$$t := \min(t_w, t_b)$$

$$R_2 := t \cdot (0.40 \cdot F_y)$$

base metal strength

$$R := \min(R_1, R_2)$$

$$R = \begin{pmatrix} 1.59 \\ 1.80 \end{pmatrix} \cdot k\text{li}$$

R = 1.59-kli

$$weld_{min.length} := \frac{P_{lug}}{R}$$

weld_{min.length} = 2.2-in

$$weld := \begin{bmatrix} 2(1.35\text{-in}) \\ \frac{(8\text{-ft})}{11} \\ 6\text{-in} \end{bmatrix}$$

$$weld = \begin{pmatrix} 2.7 \\ 8.7 \\ 6.0 \end{pmatrix} \text{in}$$

$$weld_{length} := \min(weld)$$

weld_{length} = 2.70-in

Connection Summary: C.G. Eye Nut threaded onto 5/8" A307 bolt. The A307 bolt is to be welded to the 2x2x1/4" thk. angle. 2x2x1/4" thk. angle stitch welded to the wall stud & fully welded (6" min.) to the base frame

CHECK_{weld} = "OK"

Angle Tensile Strength

$$T_{angle} := 0.60 \cdot F_y \cdot Angle_{area}$$

T_{angle} = 20260.8 lbf

$$T_{angle} = 20260.8 \text{ lbf} \geq P_{lug} = 3546.7 \text{ lbf}$$

CHECK_{angle} = "OK"

Bolt Strength

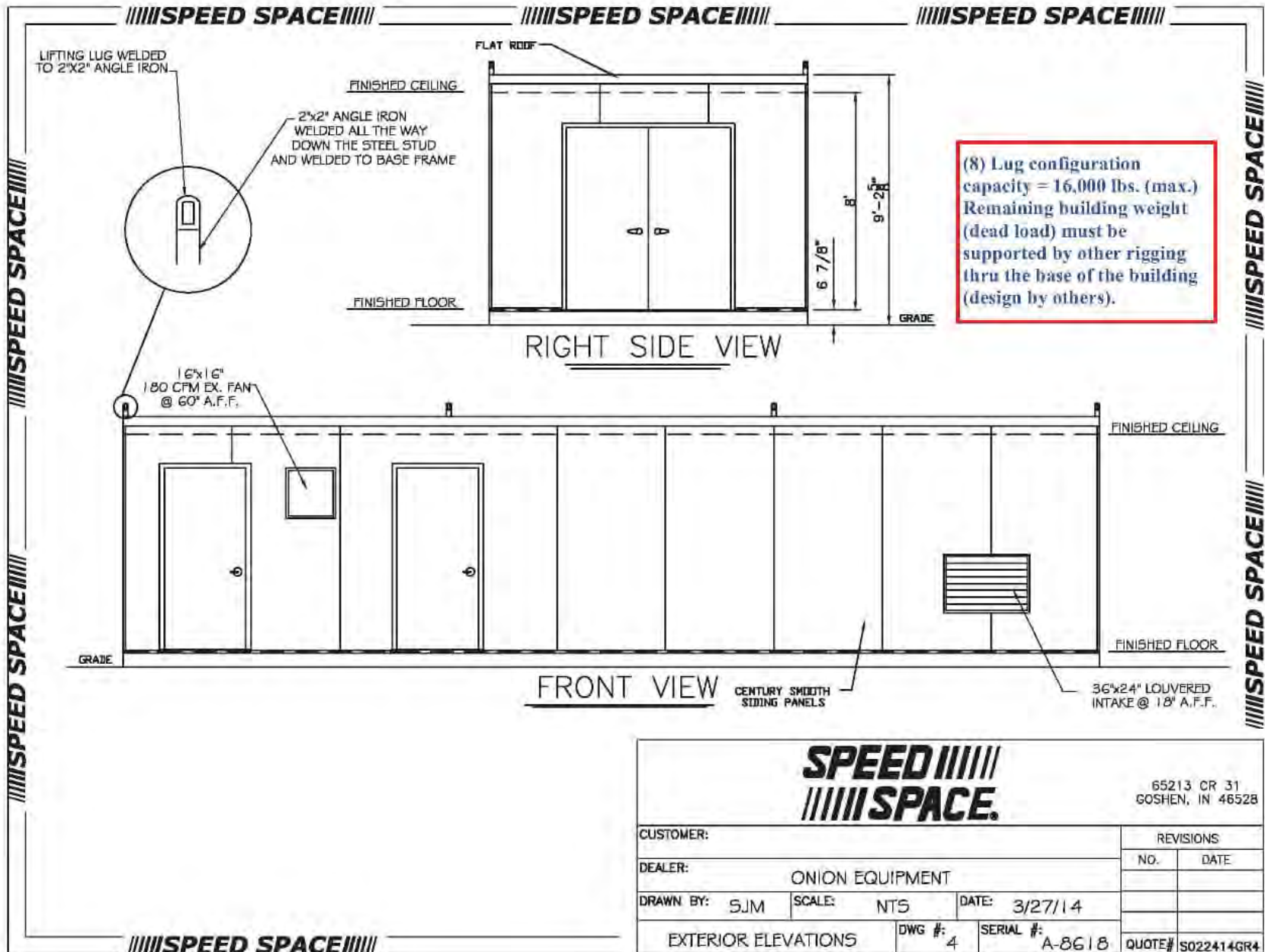
$$T_{bolt} = 5900.0 \text{ lbf} \geq P_{lug} = 3546.7 \text{ lbf}$$

CHECK_{bolt} = "OK"



Note: The building must be evenly lifted using rated spreader bars that span the width of the building attaching to (8) lugs. The spreader bar width must match the building width so as to maintain a direct axial (vertical) load on the lifting lugs. Lateral &/or impact loads must not be placed on the angle or lug attachment points. (Crosby Group "EyeNut" or equivalent, 3600 lb. min. working load)

This page intentionally left blank.



SPEED SPACE

65213 CR 31
GOSHEN, IN 46528

CUSTOMER:			REVISIONS	
DEALER: ONION EQUIPMENT			NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14		
EXTERIOR ELEVATIONS		DWG #: 4	SERIAL #: A-8G18	QUOTE# S022414GR4

This page intentionally left blank.

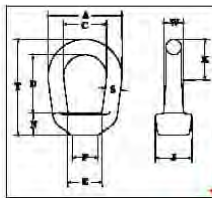
Forged Eye Nuts



G-400



- Forged Steel - Quenched and Tempered.
- Hot Dip galvanized.
- Tapped with standard UNC class 2 threads after galvanizing.
- Meets or exceeds all requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements. Importantly, these products meet other critical performance requirements including fatigue life, impact properties and material traceability, not addressed by ASME B30.26.
- Also available in blank (as forged) item (S-4028) or on request with metric threading (M-400).
- Recommended for In-Line pull.



G-400 Eye Nuts

Size No.	"S" Stock Size (in.)	G-400 Stock No.	Std. Tap Size	Working Load Limit (lbs.)*	Weight Per 100 (lbs.)	Dimensions (in.)										
						A	C	D	E	F	J	K	N	T	W	
1	.25	1090438	1/4	520	.09	1.25	.75	1.00	.75	.50	.69	.69	.98	1.72	.31	
2	.31	1090474	3/8	1250	.17	1.62	1.00	1.20	.93	.56	.81	.89	.50	2.09	.41	
3A	.38	1090517	1/2	2250	.28	2.00	1.25	1.44	1.08	.81	1.00	1.09	.62	2.55	.50	
4	.50	1090535	5/8	3600	.60	2.50	1.50	1.92	1.35	1.00	1.31	1.31	.69	3.25	.69	
5	.63	1090553	3/4	5200	1.00	3.00	1.75	2.38	1.59	1.12	1.50	1.57	.89	3.89	.84	
6	.75	1090571	7/8	7200	1.65	3.50	2.00	2.63	1.96	1.39	1.88	1.77	.94	4.32	1.00	
7	.88	1090599	1	10000	2.69	4.00	2.25	3.06	2.21	1.56	2.13	2.02	1.07	5.01	1.19	
8	1.00	1090633	1-1/4	15500	4.38	4.50	2.50	3.50	2.46	1.88	2.38	2.27	1.25	5.78	1.38	
9	1.13	1090651	1-3/8	18500	5.00	5.00	2.75	4.00	2.69	2.00	2.56	2.53	1.38	6.51	1.50	
10	1.25	1090679	1-1/2	22500	6.78	5.62	3.12	4.31	3.09	2.25	3.00	2.82	1.50	7.06	1.66	
11	1.50	1090697	2	40000	14.60	7.12	4.10	6.20	4.09	3.19	3.75	3.68	2.06	9.91	1.94	

Min. Eye Nut Size & Lifting Capacity

*Working Load Limit shown is for In-Line pull. Ultimate Load is 5 times the Working Load Limit. Rating based on standard tap size.

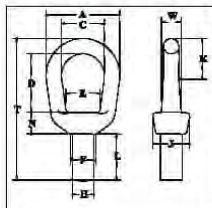
Rigging Accessories



S-405



- Forged Steel — Quenched and Tempered.



S-405 Lifting Eyes

Size No.	S-405 Stock No.	Working Load Limit Threaded (lbs.)*	Maximum Thread Diam. (in.)	Weight Each (lbs.)	Dimensions (in.)											
					A	C	D	E	F	H †	J	K	L	N	T	W
1	1090269	850	.31	.10	1.25	.75	1.02	.66	.50	.34	.69	.67	.69	.42	2.46	.31
2	1090287	1250	.38	.20	1.62	1.00	1.20	.75	.56	.41	.81	.82	.94	.55	3.00	.41
3	1090303	2250	.50	.50	2.00	1.25	1.44	1.00	.81	.53	1.13	1.13	1.25	.68	3.69	.50
4	1090321	3600	.63	.79	2.50	1.50	1.92	1.19	1.00	.66	1.31	1.38	1.50	.80	4.59	.69
5	1090349	5200	.75	1.25	3.00	1.75	2.28	1.38	1.12	.78	1.50	1.66	1.75	.99	5.55	.84
6	1090367	7200	.88	2.25	3.50	2.00	2.50	1.63	1.39	.91	1.88	1.91	1.88	1.06	6.16	1.00
7	1090385	10000	1.00	3.25	4.00	2.25	2.92	1.88	1.56	1.03	2.13	2.16	2.06	1.20	7.07	1.19
8	1090401	12500	1.13	4.70	4.50	2.50	3.35	1.94	1.88	1.16	2.38	2.47	2.50	1.40	8.16	1.38
10	1090410	18000	1.50	8.33	5.62	3.12	3.81	2.75	2.25	1.53	3.00	2.98	3.21	1.68	9.96	1.66

*Ultimate Load is 5 times the Working Load Limit. Rating based on UNC thread size shown in Max Thread Diameter column.
† Dimension before machining (as forged)

This page intentionally left blank.

Appendix A-4 GAC Changeout Procedure

This page intentionally left blank.

**GAC CHANGEOUT PROCEDURE
SOIL VAPOR EXTRACTION SYSTEM O&M PLAN
SUBSITE ST32 ONIZUKA VILLAGE
JOINT BASE PEARL HARBOR-HICKAM, HAWAII**

Following a determination that total petroleum hydrocarbon (TPH) has saturated the granular activated charcoal (GAC) (refer to Section 3.3.3 of the Operations and Maintenance [O&M] Plan), it will be necessary to change out the GAC. This involves using an industrial vacuum to remove and place the spent GAC in supersacks, followed by placing fresh GAC into the vessels.

Before conducting GAC changeout, all site personnel are responsible for knowing, understanding, and following the safety procedures outlined in the health and safety plan, and in the task-specific procedural activity hazard analyses (AHAs) (refer to Appendix F-2 and F-3 for the O&M AHA and the material safety data sheets for GAC, respectively). All tools and equipment need to be thoroughly inspected before use. Any deficiencies found will be repaired before use. The soil vapor extraction (SVE) system will be powered off before performing GAC changeout.

Materials recommended for GAC changeout include (but are not limited to) the following:

- Supersacks to contain spent GAC
- An industrial vacuum, such as the diesel-powered Hurricane 500 (cutsheet for Hurricane 500 provided with this GAC changeout procedure)
- Flexible hose long enough to reach from the vacuum unit to the GAC vessels (roughly 6-inch diameter, or similar)
- An all-terrain, extended reach forklift
- Fresh GAC
- Pallets (one for each supersack of GAC) removed from the vessels (Note that one supersack holds 1,000 pounds so two supersacks are required to support changeout of one vessel.)
- Stepstool or short ladder
- Socket wrench to remove GAC vessel manways and for placement of the manway adapter
- Photoionization detector (PID) to monitor air quality for presence of volatile organic compounds (VOCs) in ambient air/breathing zone
- Personal protective equipment (PPE) (i.e., hardhat, safety glasses, hearing protection, hand protection, safety-toe work boots, and work clothes)

Extraction of Spent Vapor GAC

An industrial vacuum, such as the diesel-powered Hurricane 500, can be used to extract the spent GAC and temporarily contain the material in a hopper mounted on the vacuum. The hopper can be elevated or lowered to the desired height before GAC removal. An all-terrain, extended reach forklift is required to be positioned with the forks under the hopper. The hoops at the top of an empty supersack can then be slipped onto the forks so that the forks hold the empty supersack under the hopper to contain spent GAC when it is being transferred from the hopper to the sack [Photo 1]. The industrial vacuum can be parked just outside the gated entrance to the SVE system building. Flexible hose should be securely attached to the inlet port of the vacuum using a hose clamp, duct tape, or similar means of attachment. A sufficient length of hose is needed to reach from the vacuum unit to each of the GAC vessels requiring changeout. A “stinger” can be constructed at the intake end of the hose to assist in manipulating the hose inside the GAC vessels during extraction.

Access to each vessel is gained by removing the bolts to remove the manway cover. The operator will need to use a step stool or short ladder to remove the manway cover. Immediately upon opening each manway, a PID should be used to monitor and document air quality. After setup, the vacuum is started and the operator manually manipulates the flexible vacuum hose inside the GAC vessel to remove all extractable GAC. The GAC vessels are not intended for personnel entry and confined space entry is not allowed. The operator must vacuum out the spent GAC until it can be visually confirmed that there are no deposits of spent GAC remaining [Photo 2]. Only minor residual amounts of spent GAC can be left. Following removal of the GAC from the vessel, the vessel internals should be inspected.

Storage of Spent GAC

Spent GAC in the vacuum hopper can then be transferred from the hopper to the super sack directly underneath it. Supersacks containing spent GAC must be placed on top of wooden pallets and can be temporarily staged either inside the fenced area at the SVE system building (limited space and difficult access), but after the work is completed they need to be transferred to the former John Rogers Tank Farm (JRTF) contractors waste staging area (or other designated location) on JBPHH pending final disposition. Before sealing the supersacks a representative sample of GAC needs to be collected to support waste profiling to support transport and disposal. The forklift can be used to move and position supersacks to their staging location. If supersacks containing spent GAC are to be staged at the JRTF, the supersacks must be loaded onto a transport vehicle and they must be driven out to JRTF. The pallets GAC supersacks can't be transported by forklift. A forklift would then also be needed to offload the supersacks from the transport vehicle to the staging area (placed on a pallet). All supersacks containing spent GAC must be tied up and secured under 10-mil black plastic sheeting or a tarp properly anchored.

Refilling Vessels with Fresh GAC

To refill a vessel with fresh GAC, a fabricated manway adapter equipped with a male and a female camlocks is installed over the manway [Photo 3]. This adapter can be secured to the manway opening using the same nuts and bolts that are used to secure the manway cover [Photo 4]. Fresh GAC in supersacks can be positioned outside the fenced area and adjacent to the industrial vacuum unit. With the GAC vessel manway adapter secured on the vessel,

the flexible hose can be re-routed so that the vacuum intake end is accessible to the fresh GAC in the supersacks and the outlet end of the hose is firmly and securely attached to one of the camlock fittings of the manway adapter. Using the industrial vacuum unit, the operator then manually manipulates the intake end of the hose to suck fresh GAC from the supersack adjacent to the vacuum unit, which will then convey the fresh GAC into the vessel through the manway adapter. As noted, the manway adapter has dual camlock ports. One of the ports must remain open to ambient air during backfill of fresh GAC to allow for airflow through the vessel. The GAC vessels should be filled to a level just below where the soil vapor enters each vessel during normal SVE system operation [Photo 5]. Once the GAC is placed in the vessel it should be consolidated as required. After fresh GAC has been transferred into a vessel, the manway adapter can be removed and the primary manway cover reinstalled and secured.

Changeout of Spent Liquid GAC

Changeout of the liquid GAC (LGAC) is generally performed in the same manner, with the added step that liquid inside the LGAC vessels must be drained first. Each LGAC vessel has a valve near the bottom that can be opened to drain the liquid [Photo 6]. So long as the LGAC train is still extracting chemicals from the liquid and breakthrough of the LGAC has not occurred, the drained liquid can be transferred to the infiltration gallery at the wellheads adjacent to the northwest side of the SVE system building [Photo 7]. If the extraction capacity of the LGAC has been reached, the drained liquid must be contained, managed, and disposed of as investigation-derived waste (IDW).

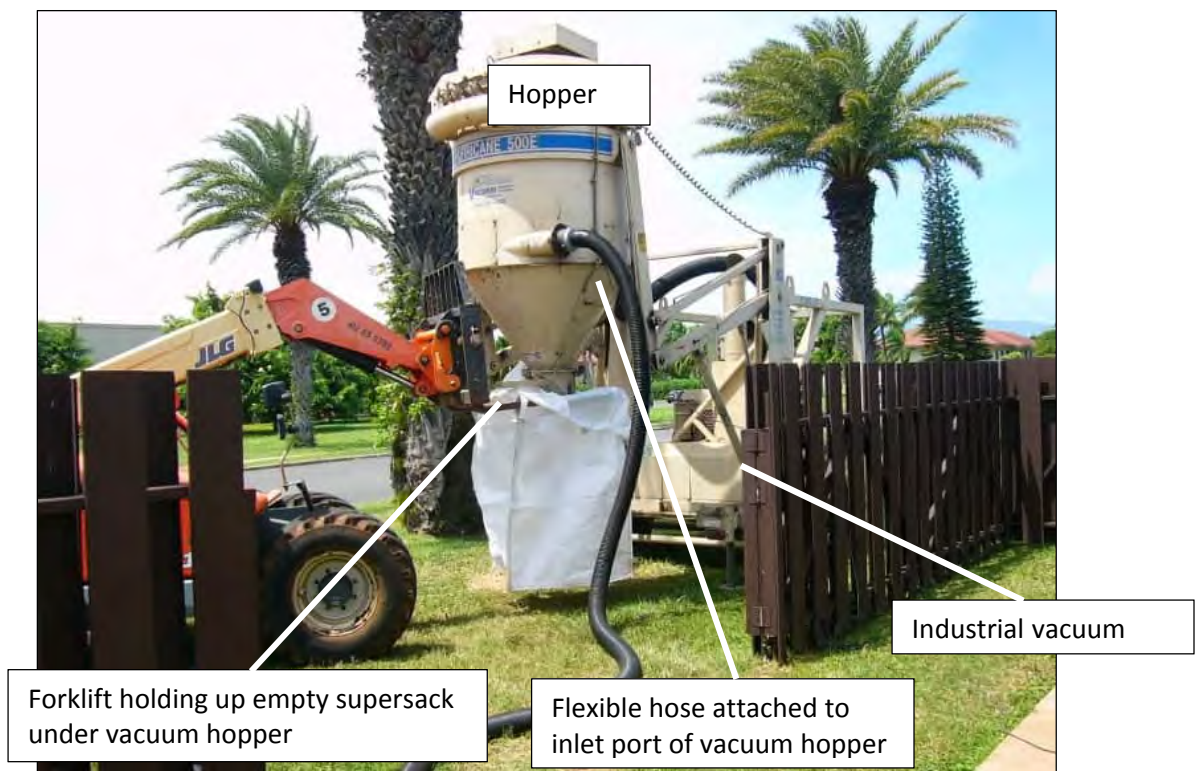


Photo 1. Setup for containment of extracted spent carbon.



Photo 2. View inside a GAC vessel after all extractable spent carbon has been removed.



Photo 3. Manway adapter used to fill vessels with fresh GAC.



Photo 4. Manway adapter secured onto GAC vessel and flexible hose attached during refill of vessel with fresh GAC.

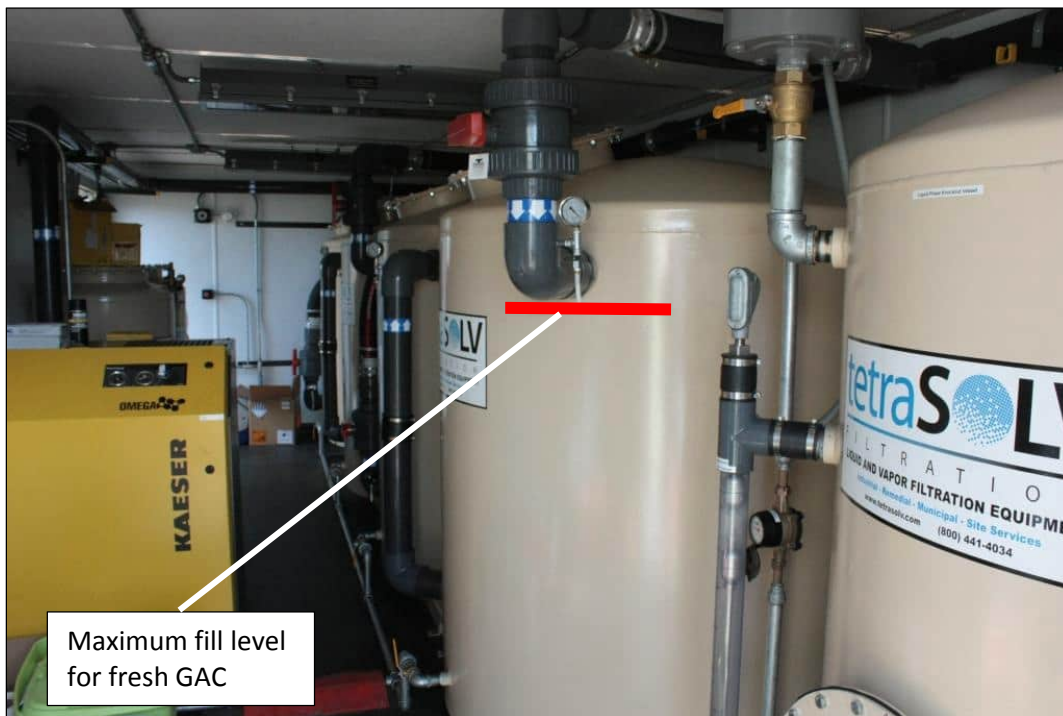


Photo 5. Maximum fill level during replenishment with fresh GAC. Gray pipe above red line is soil vapor intake into GAC vessel.



Photo 6. Valve location on an LGAC train vessel used to drain liquid before LGAC changeout.

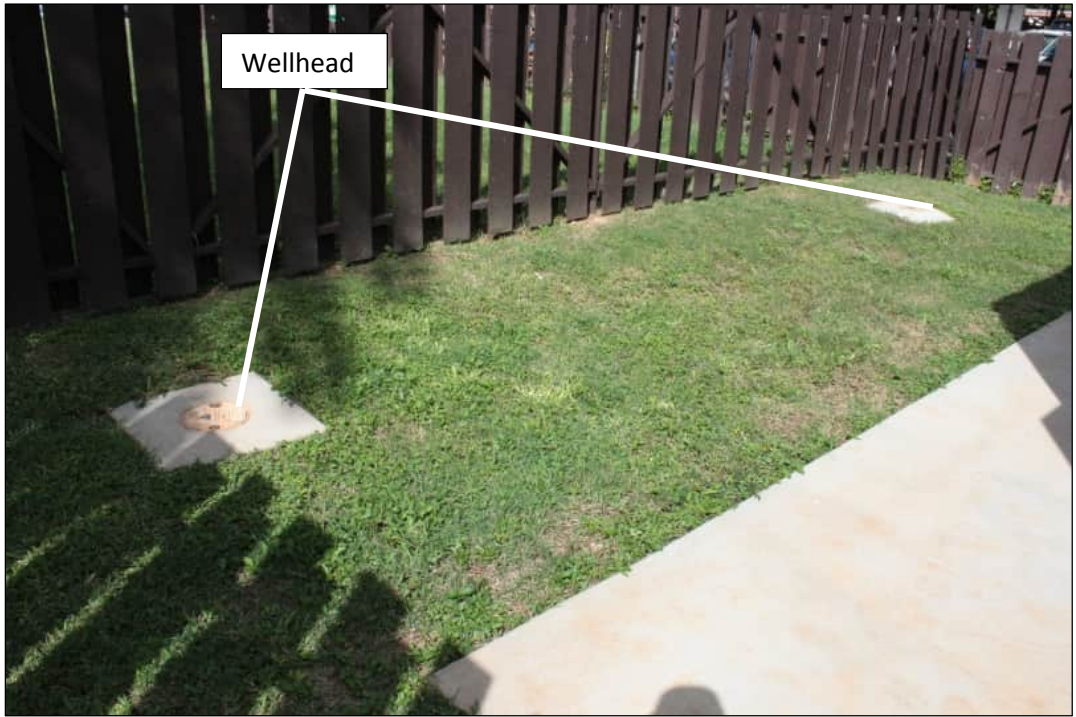


Photo 7. Wellheads of the infiltration gallery.



HURRICANE 500

HURRICANE 500 SPECIFICATIONS

- **TRAILER MOUNTED** Chassis - Tandem 7000# axles, 4" x 6" rectangular tube frame; four, 8 lug P235R- 16 ten ply, radials. DOT lighting with electric brakes.
- **POWER SOURCE** John Deere turbo-charged diesel engine, 6 cylinder, 170 HP @ 2400 RPM.
- **P.T.O (clutch)** Twin Disc 11.5"
- **VACUUM AIR FLOW (blower)** Positive displacement, 2350 CFM capable of 27"Hg, 5 belt driven with guard. (Roots G16 DV or equal)
- **FILTRATION SYSTEM (3-Stage)**
 Stage 1: Cyclonic separation.
 Stage 2: Baghouse / 37 Teflon coated, quick change filter bags with continuous reverse pulse air cleaning.
 Stage 3: High efficiency blower safety filter.
- **HYDRAULICS** 3.5 GPM, 2700 PSI, direct driven
- **ENCLOSURE** Lockable steel shroud over engine. (fiberglass shroud available)
- **INSTRUMENT PANEL** (fully enclosed) 12 volt key start, Murphy safety system (low oil pressure/ high water temperature-auto shut down)
 Gauges: oil pressure, water temperature, ammeter, tachometer with hour meter, filter cleaning on/off switch, material vacuum & dump time controls.
- **AIR COMPRESSOR** Direct drive Midland twin cylinder, water cooled and oil pressure fed. Midland air dryer with electronic heater.
 AMSC certified air tank mounted on vibration isolators. (Provides air to pneumatic controls and the self cleaning filter system)

STANDARD EQUIPMENT

- Paint-one color (custom lettering available)
- Wet or dry operation
- Tool box
- Automatic cone vibrator
- 100 gallon fuel tank
- Adjustable pintle hook
- Emergency stop button
- 10" inspection door (Hopper)

OPTIONS

- Spare tire & carrier
- Cold weather package
- HEPA filtration
- Slide gate discharge
- Auxiliary 50 gallon fuel tank
- Hydraulic lift leg to level trailer
- 16" manhole on baghouse
- High reach package for discharge up to 11'
- Asbestos / hazardous waste package
- Parking brake
- Fiberglass locking shroud
- Auger in cone
- Auxiliary air hose 120 PSI
- Skid mount
- Hydraulic surge brake
- 4 point certified lifting cage
- 150 HP electric motor

SAFETY FEATURES

- OSHA approved belt guard
- Remote emergency stop button
- Safety struts for baghouse
- Emergency brake away chain
- Wheel chocks
- Optional HEPA filtration
- Electric brakes
- Low oil or high temp engine shutdown

Dimensional Drawing On Reverse Side



Industrial Vacuum Equipment Corporation
 N7959 Birch Road • Ixonia, WI 53036
 800-331-4832 • 920-261-1136 • FAX 920-261-7117
www.industrialvacuum.com



HURRICANE 500

DIMENSIONS

WIDTH 8'3"

WEIGHT 9,500 lbs.



* High reach options up to 11 ft available.

Appendix A-5 Factory Acceptance Testing Checklist

This page intentionally left blank.

Factory Acceptance Testing of *SVE Building*

Item #	Description	Observation and Actions	Resolution	Date Resolved
General Items				
1	All major equipment installed; Vapor and Liquid Phase GAC canisters, pump stand, batteries, etc.	All installed	n/a	8/7/14
2	Verify installation of D-rings (4 on each side) for crane lift	All installed	n/a	8/7/14
3	Finalize Building Plan Drawing showing location of D-Rings and other updated features	Completed	n/a	8/13/14
4	Double check all wiring terminations per Outback diagram	Action Item - Tetrasolv	Complete	8/15/14
5	Provide pre-threaded mount for wireless outdoor antenna and procure adapter/connector for antenna with any necessary connecting cable	Action Item - Tetrasolv	Will be done today	8/22/14
6	Program lower limit on VFD of 25%	Action item – Tetrasolv	Will be completed today	8/14/14
7	Verify battery cable size and secure mounting in battery cabinet for shipping. Verify fan and thermocouple in battery cabinet	Cable and batteries installed, discussed installation of hold down rods for shipping. Fan and thermocouple to be installed week of 8/11/14	Complete	8/18/14
8	Check battery voltage status/display on PLC. Check overall PLC function (to extent possible) with regard to battery status	Batteries could not be tested during shop test (A/C power only). Combined voltage will be displayed on PLC. Discussed testing individual battery voltages under load, once delivered. Tetrasolv to confirm individual battery test procedure with OES.	We will attempt this today	8/22/14

Factory Acceptance Testing of *SVE Building*

Item #	Description	Observation and Actions	Resolution	Date Resolved
Transportation Related				
1	Verify approach to labeling, packaging, and anchoring PVC flanged piping that is remove for shipping.	PVC header pipes for VGAC beds are joined by rubber fernco fitting, which will be loosened and lowered so the pipes are not touching/rigidly mounted during shipping. The ferncos will be refitted at the site.	n/a	8/7/14
2	Discharge Stack	4" galvanized steel shipped secured inside building for shipping, to be mounted once delivered. The penetration through the wall will need to be sealed once mounted.	n/a	8/7/14
3	Confirm method to secure door, lovers, etc. to support shipping.	Louvers will be secured with tape and/or zip ties. Doors will be keyed alike (keys in control panel)	n/a	8/7/14
4	External Antenna for Verizon Modem	Action item for Tetrasolv – ensure proper adapter for antenna (requested by programmer) is provided and provide location for external mounting of antenna	Will do today	8/22/14
5	Assume tube lighting will be removed before shipment and packaged and secured for shipping	LED bulbs to be shipped wrapped in bubble wrap.	n/a	8/7/14
6	Temporary seal slot in floor (there are rogue waves along the shipping route)	Per conference call 8/12/14, slot to be covered with form fitting plywood and sealed with non-hardening caulk or similar method. Same method to be used for discharge stack opening.	n/a	8/7/14
7	UL or Other Certified Inspection of Panels	MET Labs Inspection week of 8/11/14, exact date TBD Action item – Confirm MET Labs test date	Complete	8/20/14
8	Status of O&M Manual Including Startup and Shutdown Procedures	O&M Manual to be prepared by Tetrasolv, will be forwarded after building ships	n/a	8/7/14

Factory Acceptance Testing of *SVE Building*

Item #	Description	Observation and Actions	Resolution	Date Resolved
9	Determination of spare parts inventory, finalize list and set delivery date (gaskets, seals, indicator lights, fuses, etc.)	No spare parts were part of the SOW. Near term, the only spare parts needed should be LED bulbs (in case of breakage/defects) and blower oil (first blower oil change is 500 h). Blower oil is Kaeser Omega SB 220 synthetic blower fluid. Action item for KCH – order 5 quarts of SB 220 (or approved equivalent, it's a straight 50 weight synthetic) oil delivered to site	n/a	8/7/14
10	Ability to access the programming remotely?	Yes – Verizon equipment installed	n/a	8/7/14
11	Lighting installed, spare bulbs?	Yes. Action Item –confirm part # and manufacturer for spare LED bulbs		
12	Spare exterior panel, touch up paint	Spare panel to be shipped with container. Action item – Tetrasolv to order/ship 2 gallons of touch up paint to site		
13	Backup program available for reload	Will be maintained by Tetrasolv/ and programmer	n/a	8/7/14
14	Confirm and make arrangements (RAPID GATE PASS) for Doug to come to the Site.	Discussed with OEM. Action item – confirm site visit by Tetrasolv	I did the rapid gate pass info. Should be set	
Vapor Phase GAC				
1	Anchorage of VPGAC Vessels	Anchored with Grade 8 bolts	n/a	8/7/14
2	Accessibility to upper access to support GAC Change-out	Yes – at least 2-3 feet of clearance	n/a	8/7/14
3	Confirmation of presence of vapor sampling points between GAC vessels	Per conference call 8/12/14 Doug please confirm sample ports are located on influent, intermediate, and effluent points for each pair of VGAC beds; on the inlet to the blower; on each of the three manifold legs (I did not see these during the shop test), and on the influent, intermediate, and effluent points for the LGAC beds.	All are in place, See Attached pics.	8/22/14

Factory Acceptance Testing of *SVE Building*

Item #	Description	Observation and Actions	Resolution	Date Resolved
4	Presence of drain valves on GAC vessels	Yes	n/a	8/7/14
5	Ability to run GAC Vessels in two trains of two vessels, sufficient valves present	Yes	n/a	8/7/14
6	GAC loaded to proper fill level, record if virgin or regenerated	VGAC beds not yet loaded during shop test. Action item for Tetrasolv – fill beds before shipping	Complete	8/22/14
7	Look at stack configuration, penetration, and packaging for installation when arrives at site, and ask what the SCFM is so we can run an emission calculation.	4" penetration in wall, stack not viewed during shop test, will be shipped loose. Max scfm will be approximately 310 scfm, confirmed during shop test	n/a	8/7/14
8	Confirm shipment date and arrival date	Target ship date is Monday August 18. Action item - Tetrasolv to confirm ship date with Matson		
9	Identify the sail date and what the vessel number is from Matson and loading window at pier and method of loading on vessel	Action item - Tetrasolv to confirm ship date and port arrival in Long Beach		
Blower System				
1	Blower safety guards and sound deadening are installed	Yes	n/a	8/7/14
2	Verify blower amp draw at various VFD settings using amp meter	50%, 7" Hg. 135 cfm 19 A 50%, 10" Hg. 135 cfm 23 A 75%, 5.5" Hg, 248 cfm 14.6 A 75%, 7.5" Hg, 228 cfm 19 A 100%, 5" Hg, 315 cfm 19 A 100%, 7.5" Hg, 300 cfm 24 A 26.5 max motor A with safety factor 23-24 A max recommended by Programmer Note that amp draw is sensitive to applied vacuum pressure and rpm (load)	n/a	8/7/14

Factory Acceptance Testing of *SVE Building*

Item #	Description	Observation and Actions	Resolution	Date Resolved
3	Verify knock-out tank is plumbed correctly (up-flow through tank) and pump out functionality.	Yes	n/a	8/7/14
4	Check liquid phase GAC plumbing, leak check if possible	Action item - Tetrasolv to conduct leak check. Thread sealant noticed on most joints (not all)	Scheduled for today	8/22/14
5	Blower motor rotation confirmed	Yes	n/a	8/7/14
6	Discharge stack supports	Action item – Tetrasolv to install pre-threaded mounts for galvanized discharge stack and ship bracing loose with container	Complete	8/18/14
7	Vibration isolators in place	Yes	n/a	8/7/14
8	Vibration damping between stack and blower body – vent penetration sealed	Not completed, will be completed on-site		
Piping Installation				
1	Labels and flow direction on piping	Action item for Tetrasolv – install labels	Complete	8/20/14
2	Inspection of entry of SVE Piping manifold and connection to VGAC	Connections are 3” FNPT on the bottom of the manifold legs. Connection to VGAC is overhead Sch 80 PVC via vacuum rated petroleum hose with camlocks	n/a	8/7/14
3	Piping installed with proper connections for support and to minimize vibration	Yes	n/a	8/7/14
Panels and Service Entrance				
1	Arc Flash stickers on disconnects	Action item for Tetrasolv and/or MET – install arc flash stickers	Complete	8/20/14
2	Labels of circuits in panel boards	Action item for Tetrasolv – label circuits in fuse box and also connections in load center panels	Complete	8/20/14
3	Lockout Tagout tangs on breakers	Action item for Tetrasolv – install lockout tang for main fuse box	Working on this should know today	8/22/14

Factory Acceptance Testing of *SVE Building*

Item #	Description	Observation and Actions	Resolution	Date Resolved
4	Conduit runs neat and organized	Yes	n/a	8/7/14
5	Will electrical service entrance access be cut at fabricator or in field	In field – 7 one-inch penetrations	n/a	8/7/14
6	Outback Radian diagram (.pdf)	Action item - to be forwarded by Tetrasolv	Complete	8/20/14
7	Continuity checks complete before electrical energizing	Action item - to be completed by Tetrasolv /MET	Complete	8/14/14
8	Confirm status of programming	To be completed by Wednesday 8/13/14. Action item for KCH - confirm programming status Wednesday	Will complete today	8/22/14
Testing Procedure				
1	Testing procedure 1) Motor rotation 2) No excessive vibration 3) Vapor leaks in piping 4) Testing of telemetry system 5) Programming and any hard wired interlocks	1) Pass 2) Pass 3) Action item 4) On-site test 5) On-site test		

NOTE: Names of personnel with specific actions were removed from the checklist and replaced with company names

Appendix A-6
Checklist for Monthly Inspection of SVE Process, Wells, and
Ancillary Equipment

This page intentionally left blank.

Checklist for Monthly Inspection
 SVE Process, Wells, and Ancillary Equipment
 Off-Grid Solar Powered SVE System
 Joint Base Pearl Harbor, Hickam, Hawaii

Note: AGM Batteries, Inverter Load System, and Auxiliary AC and DC Electrical Equipment covered under Checklist in Appendix 2F and Performance Monitoring under Appendix D

Item	Inspection Details	Observations	Recommendations (Describe If Any)
Effluent Discharge Related System			
ED-1	Inspect physical condition of the effluent pump and ensure valve handle at base of knockout tank is open		
ED-2	Remove and clean the "Y" Strainer and Basket Strainer		
ED-3	Inspect liquid level gauge for any particulate or coating and allow the floating mechanism to move freely. If necessary disassemble and clean the unit.		
ED-4	Open the two (2) well covers at the infiltration gallery and inspect for standing water		
GAC Treatment System			
GC-1	Confirm setting of the manual throttle values		
GC-2	Confirm functioning of the Magnehelic gauges		
GC-3	Confirm setting of the motorized valve actuators		
GC-4	Confirm sample valves are closed		
GC-5	Inspect that valves are in the proper position for the Train being used.		
GC-6	Confirm sample ports are closed on both VGAC and LGAC Trains		
GC-7	Confirm exhaust fan is operational behind VGAC vessels		
General Building			
B-1	Inspect functionality of indoor and outdoor lighting		
B-2	Confirm signage on building door and fence are in place and clean		
B-3	Confirm all safety equipment is present		
B-4	Confirm that fire extinguishers have been inspected and tagged as such, monthly		

Checklist for Monthly Inspection
 SVE Process, Wells, and Ancillary Equipment
 Off-Grid Solar Powered SVE System
 Joint Base Pearl Harbor, Hickam, Hawaii

Note: AGM Batteries, Inverter Load System, and Auxiliary AC and DC Electrical Equipment covered under Checklist in Appendix 2F and Performance Monitoring under Appendix D

Item	Inspection Details	Observations	Recommendations (Describe If Any)
B-5	Inspect fencing and proper functioning of the gate and lock mechanisms		
B-6	Inspect for excessive growth in grass and weeds around building and PV array and coordinate with Base for removal		
B-7	Inspect the inlet air louvers are functional and not blocked		
	Confirm the proper opening, closing, and locking of building doors		
B-8	Inspect and clean the inside building floor and concrete pad and stoups around the building		
SVE Vaults			
SV-1	Confirm vault lids are free of an obstructions		
SV-2	Open vault and confirm functionality of the lid mechanism		
SV-3	Inspect and remove any debris in the vaults		
SV-4	Confirm SVE well cleanout cap is in place		
SV-5	Confirm ball valve in proper position based on system operation		
Date	Time of Inspection (Local)	Personnel Present	Weather Conditions

Attach pictures and additional sheets as necessary.

Appendix B Off-Grid Electrical System

This page intentionally left blank.

Appendix B-1 O&M Manual for Off-Grid System

This page intentionally left blank.

**PV OFF-GRID O&M
SOIL VAPOR EXTRACTION SYSTEM O&M PLAN
SUBSITE ST32 ONIZUKA VILLAGE
JOINT BASE PEARL HARBOR-HICKAM, HAWAII**

The SVE system and its ancillary components are entirely powered by the PV array adjacent to the building (off-grid system). The primary direct current (DC) disconnect at the PV array is a series of 6 combiner boxes at the north end of the PV array [see Photo 1]. Each combiner box is associated with a string of 12 PV panels. In order for the PV array to supply DC current to the Outback charging system inside the SVE system building, the switches on the outside of the combiner boxes must be turned to ON. For safety reasons, only a qualified electrician should open the combiner box doors or work directly with PV wiring.

An additional DC disconnect switch is located inside the electrical room [Photo 2]. This switch is housed in a large cabinet and is clearly labeled as the DC Disconnect on the outside (all six PV circuits feed into this disconnect). This switch must also be ON for the DC current circuit to be connected and power to be provided to the SVE system components. If maintenance on the PV and/or electrical portion of the system is required, the DC disconnects at the combiner boxes and inside the electrical room must be locked out and tagged out (LOTO) by a qualified electrician.

Any amount of sunlight on the PV array will always produce DC current. With DC disconnects in the ON (or closed circuit) position, the current will run to the Outback charge management system. Primary components of the Outback system include six charge controllers to help manage the charge from the PV array, two Radian inverters to convert DC to alternating current (AC), the Mate 3 to program and monitor the system, and the battery bank to absorb and maintain a charge for a constant source of power [Photos 2 and 3]. At the base of each of the two Radian inverters is a load center behind a stainless steel cover door [Photo 2]. Behind this door is a series of breakers that control power to the internal Outback charging components. These breakers can be opened to break the circuit and cut off power to the Outback charge system. **For additional details refer to the emergency shutdown procedure in Appendix B-5.**

The circuit breaker panel for the lights, ventilation fans, three phase converter, and the programmable logic control (PLC) panel is located to the right of the PLC panel [Photo 4]. Individual equipment that each breaker switch is assigned to, is labeled adjacent to the switch. In addition, the PLC cabinet has an on/off handle on the right side that will shut down power to the PLC panel when in OFF position [Photo 5]. This position is labeled on the base of the handle and is **colored green**. If the handle is in OFF position, power will be cut off to the PLC panel. To supply power back to the PLC, the handle must be switched up to the ON position which is **colored red**. This handle has a safety mechanism in the right side of the base of the handle through the use of a screw on the side of the handle base [Photo 5]. When the handle is switched up to ON, it will only go approximately half way then stop. At this position, a flathead screwdriver must turn the screw to release a lock mechanism and allow for the handle to travel all the way up to the ON position, and provide power to the PLC panel. The PLC panel door can be opened for maintenance or inspection at the handle on the front of the panel [Photo 4]. When the PLC is powered on, there is live current inside the cabinet and the door can only be opened by a trained and qualified electrician.

Touchscreen Control Panel

The touchscreen control panel allows for programmable control of the SVE system operation. It also provides real-time system status data. Programmable controls and system status data are summarized below.

The touchscreen control panel is also controllable using a smartphone with a data connection. The “VNC Viewer” application is downloadable for free from the android or iOS app store. Once downloaded, the app will prompt you for a password, which is currently established as “111111”. Once setup is complete, the operator will be able to view the same HMI touchscreen display as on the PLC panel at the site. System operation through the VNC Viewer is real-time, and programmable controls can be adjust using the smartphone as a touchscreen.

Programmable Controls

Blower Enable and Off Voltage Settings

The SVE system is engineered so that the blower will turn on automatically in the morning when sunlight on the PV panels increases the voltage of the battery bank to reach a programmed voltage threshold. This is the “Blower Enable Voltage” [Photo 6]. Once the blower is on and the system is running, it will run until the battery bank voltage drops to reach the “Blower Off Voltage”, which is generally after the sun stops generating power from the PV array. The “Blower Enable Voltage” and “Blower Off Voltage” values can be programmed using the HMI touchscreen by tapping inside the rectangular area labeled on the touchscreen and entering the desired value once the numerical keyboard pops up. Once the voltage reaches the “Blower Enable Voltage” and turns the blower on, the load created will instantly decrease the voltage by one to 1.5 volts.

The “Blower Off Voltage” should be set at least 2 volts lower than the enable voltage to prevent the system from repeatedly turning on and off in relatively quick succession.

Date and Time

The “Operator Interface Date & Time” at the upper right corner of the touchscreen displays the current date and time of day. Each of these can be adjusted as necessary by tapping on the day or time display, which will then bring up a pop-up window to allow for adjustment.

Vacuum Blower Switch and Target Speed

The vacuum blower digital switch located generally near the center of the touchscreen has three settings; HAND, OFF, and AUTO [Photo 6]. Because the system is engineered to run automatically, during normal operation the blower should generally be left in **AUTO**. If the blower needs to be manually shut down, tap OFF and the switch will move to that position and shut the blower down. If the blower is to be turned on, but not on an automatic schedule, tap **HAND** to manually turn it on. If the blower is run on **HAND** mode, it will not shut down automatically and must either be switched back to **OFF** or **AUTO**. Anytime the blower is on, the light will turn **green** at VACUUM BLOWER RUNNING.

The speed of the variable frequency drive (VFD) to control the vacuum rate of the blower is controllable in percentages. To change the percent VFD, synonymous with blower speed, tap under “**Touch to Change**” in the VACUUM BLOWER TARGET SPEED window [Photo 6]. A pop-up will appear with a numerical keypad that is used to adjust the blower speed. **The minimum speed accepted is 25%**. In general, the higher the speed, the higher the load put on the charging system and the sooner the battery bank voltage will reach the OFF threshold after the sun has set.

In general, a speed of 75% is recommended so that a sufficient vacuum is applied to the SVE wells, while allowing the voltage to keep the system running after sunset

Vapor Extraction Wells #1, 2, and 3

The three SVE wells each have their own switch with **HAND**, **OFF**, and **AUTO** settings [Photo 6]. Tapping the word **HAND** will engage the motorized actuator at the well manifold inside the equipment room to open the valve. Tapping **OFF** will engage the actuator for that well to close. Tapping **AUTO** will have the actuator for that well either be open or closed, based on the 24-hour clock dial for each well [Photo 6]. The timers for each well can be set by tapping the hour numbers to either have a well be **ON** (**green display color** for the hour) or **OFF** (**black display color** for the hour). **THERE MUST NEVER BE A TIME WHERE THE BLOWER IS ON AND NONE OF THE ACTUATOR VALVES ARE OPEN. THIS CONDITION WILL DEADHEAD THE BLOWER AND POTENTIALLY DAMAGE THE SVE SYSTEM.** Each well has an indicator light to easily determine whether a well is opened or closed.

Condensate Transfer Pump

The condensate transfer pump is the liquid centrifugal pump located at the knockout tank inside the treatment room. When the water level inside the knockout tank reaches a threshold level, as determined by float gauge, the pump will automatically turn on and drain the knockout tank. This will function automatically if the switch [Photo 6] on the touchscreen is turned to **AUTO**. Using the touchscreen, the switch can also be manually operated by switching to **HAND**, or can be turned off by switching to **OFF**.

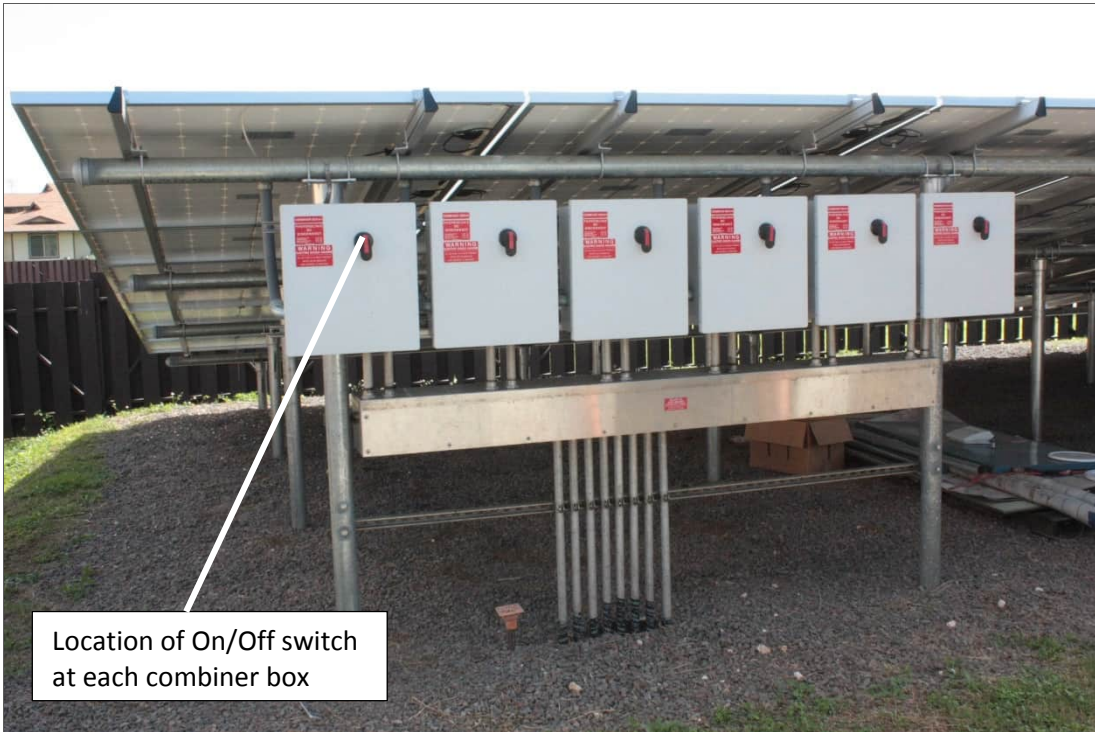
System Status Data

The on/off voltage settings are programmed in the blue panel titled “**Solar Power System Info**” at the upper left of the touchscreen. Additional data pertaining to the system charging and power status are displayed in this panel. These data are drawn directly from the Outback Mate 3 mounted in between the Outback Radian inverters. The State of Charge (SOC) on the display reflects the daily minimum and maximum charge capacity of the battery bank as a whole.

The Active Alarm Status Display panel on the touchscreen include numerous alarms within the system designed to be protective of the integrity of the system. If operational conditions of the system change such that an alarm is tripped, the corresponding alarm light will turn on in red color. The fault can then be fixed and the **yellow “Alarm Reset”** button at the top of the touchscreen can be tapped to reset the alarm status [Photo 6].

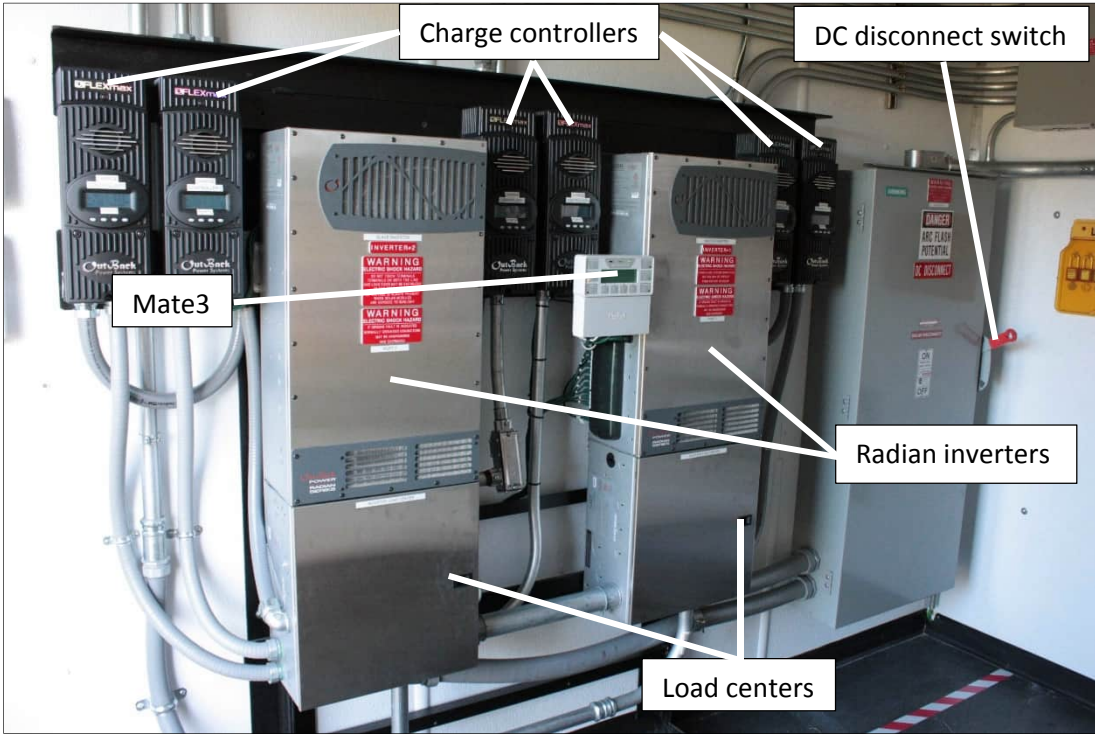
The AC voltage and kilowatt output data coming out of the Radian inverters, as well as the current battery bank voltage, are displayed on electronic dials near the top of the touchscreen. These real-time data are not controlled by the touchscreen, but are data output directly sourced from the Mate 3. Additional system data output provided on the display include; extraction well air temperature, equipment room atmosphere % LEL, and variable frequency drive (VFD) output and usage data.

As a general rule of thumb, it is desired that the “Current” under VFD Output Data not exceed 23 amps for an extended period of time.



Location of On/Off switch at each combiner box

Photo 1. Combiner boxes at PV array.



Charge controllers

DC disconnect switch

Mate3

Radian inverters

Load centers

Photo 2. DC disconnect switch and Outback charge management system



Photo 3. Battery bank

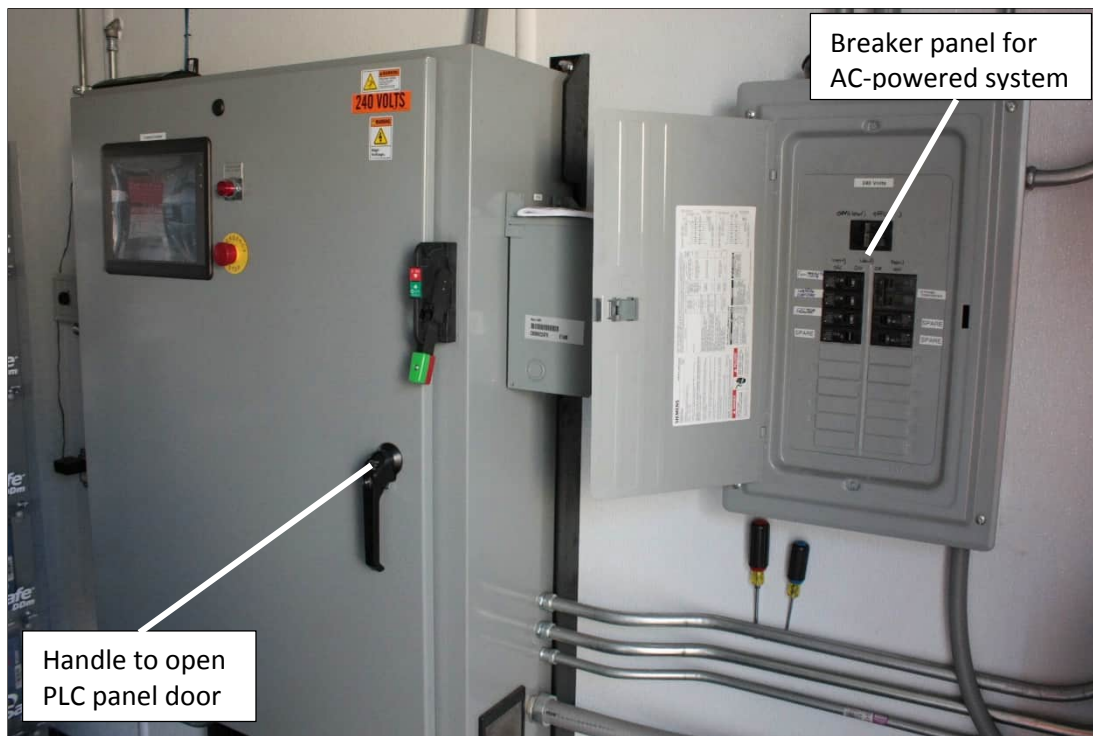


Photo 4. Circuit breaker panel for AC-powered system components

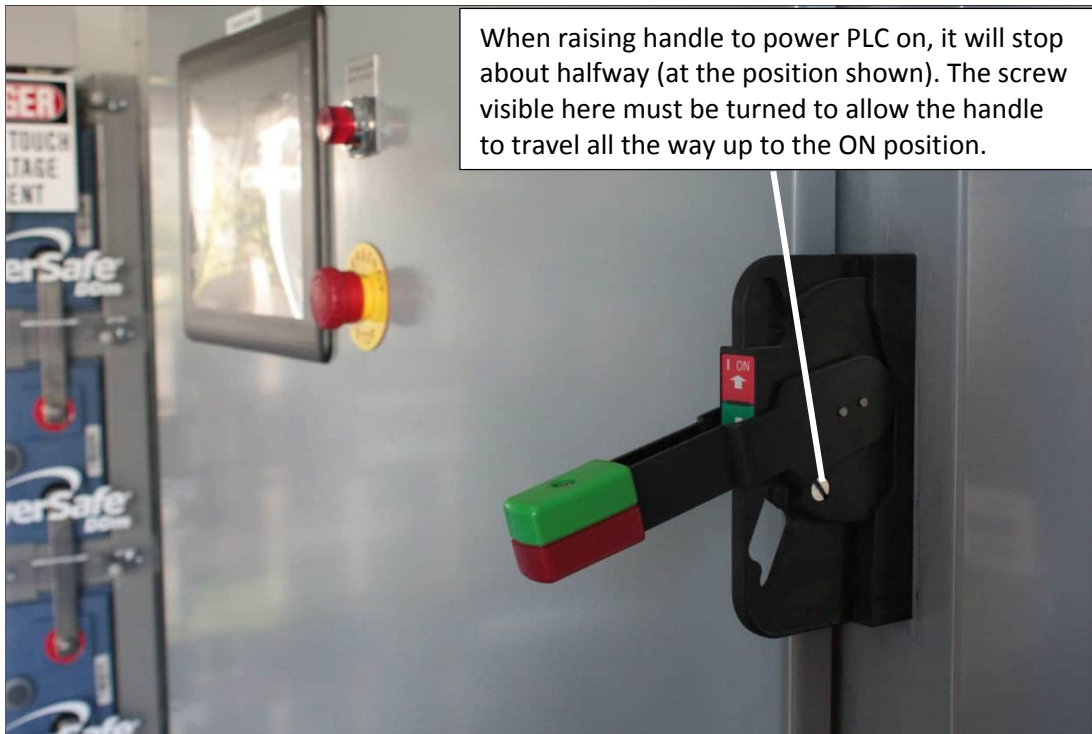


Photo 5. PLC panel on/off handle and unlock mechanism (screw)

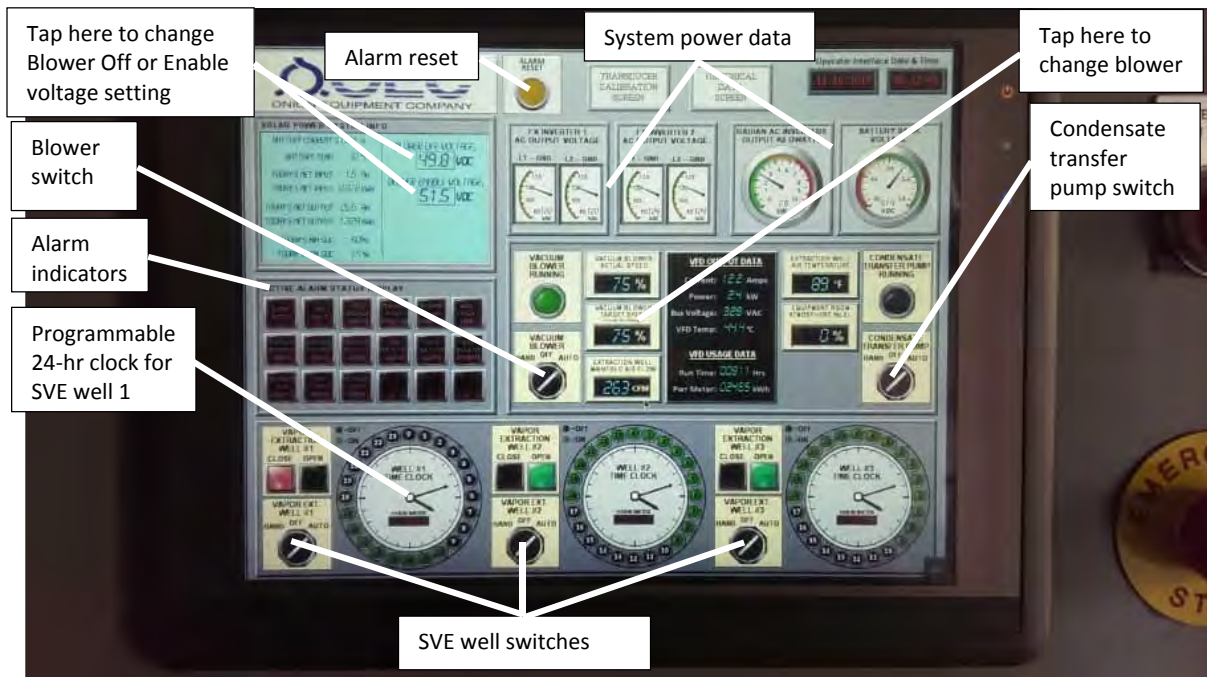
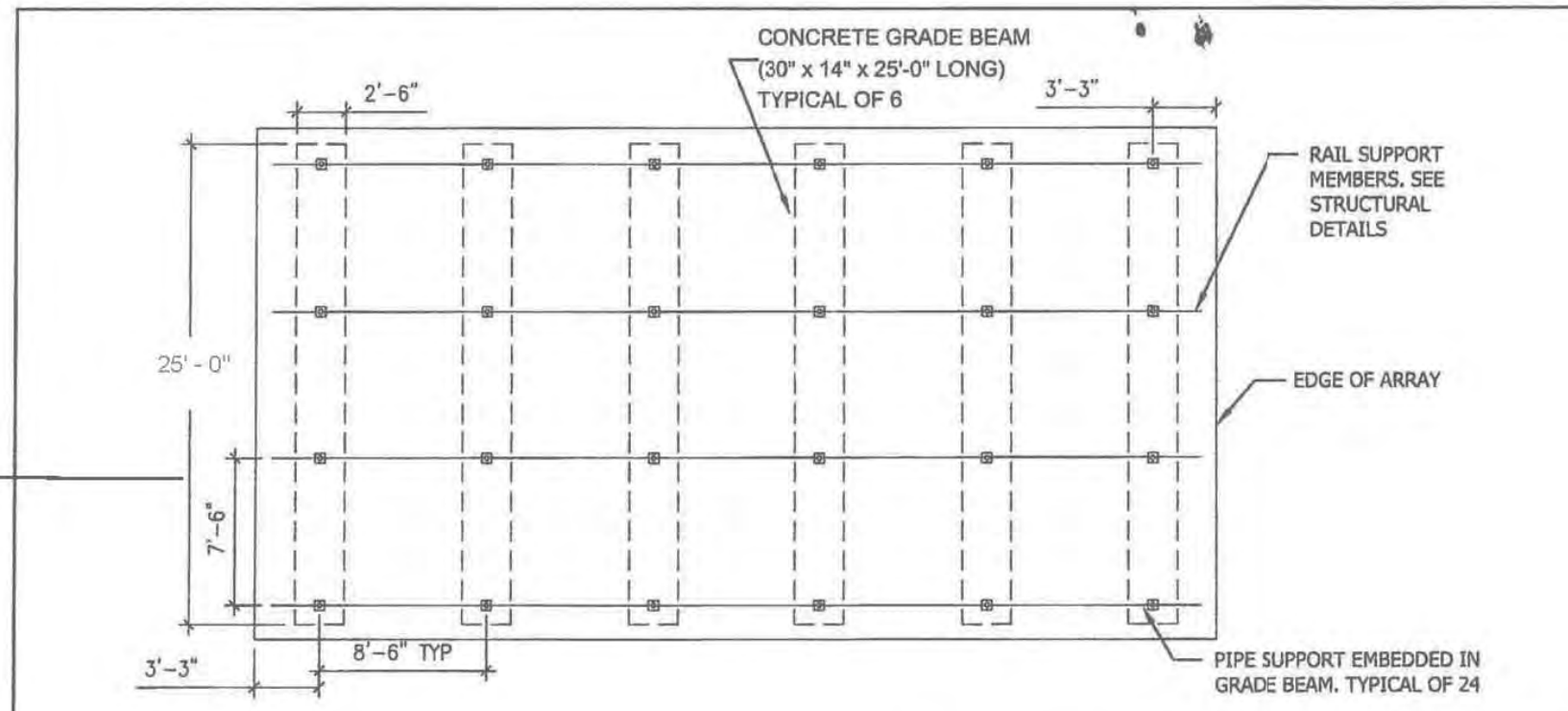


Photo 6. Primary controls and data display on the HMI touchscreen

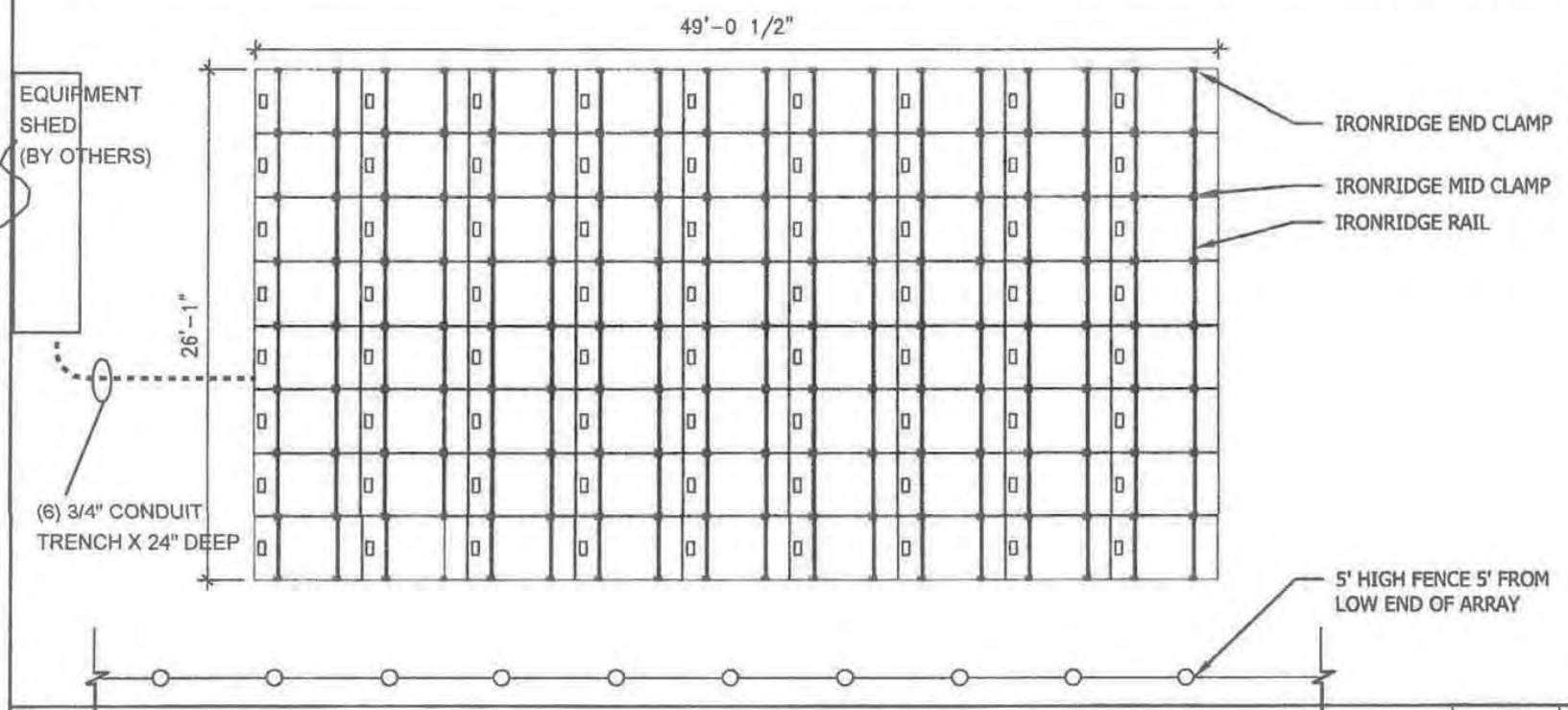
Appendix B-2 Electrical Drawings (PV and Control Room)

This page intentionally left blank.



GRADE BEAM LAYOUT

SCALE
1/8" = 1'-0" 2



PANEL LAYOUT

SCALE
1/8" = 1'-0" 1

System Specifications

Solar Modules
(72) - SUNIVA OPT-265-60-4-100 - 265 watt

Inverters
(2) - OUTBACK - RADIAN GS8048A

Mounting System
IRONRIDGE RACKING

System Size
19.08 kW DC (STC)




THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

Paul W. Craig
Signature - Paul W. Craig
17 July 2014
Date



The IronRidge products and pipe support structure have been reviewed by Stirling Madison Lofquist, Inc. for compliance with the structural calculations. The foundations have been designed by others.



SOLAR ENERGY DESIGN AND INSTALLATION

905 Kalaianaoale Highway #21
Kaliua, Hawaii 96734
(808) 262-6600
info@sunetric.com
www.sunetric.com

OFF-GRID PV SYSTEM
JOINT BASE PEARL HARBOR
HICKAM, HAWAII

DATE:	05/09/2014	
PROJECT MANAGER:	PF	
DESIGNED BY:	SD	
DRAWN BY:	SD	
CHECKED BY:		
NO.	DATE	REVISIONS

ROOF PLAN - BUILDING ELEVATIONS

Sheet 1 of 3

E1-1

This page intentionally left blank.



THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION
Paul W. Craig
Signature - Paul W. Craig
17 July 2014
Date

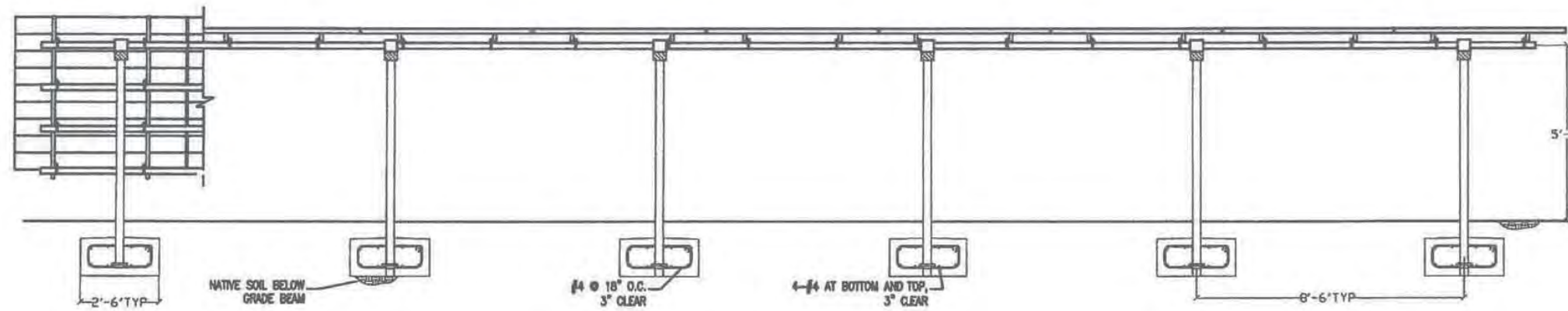
EXP: 30 APRIL 2016



SOLAR ENERGY DESIGN AND INSTALLATION

905 Kolaniana'ole Highway #21
Kailua, Hawaii 96734
(808) 262-6600
Info@sunetric.com
www.sunetric.com

**OFF-GRID
PV SYSTEM**
JOINT BASE PEARL HARBOR
HICKAM, HAWAII



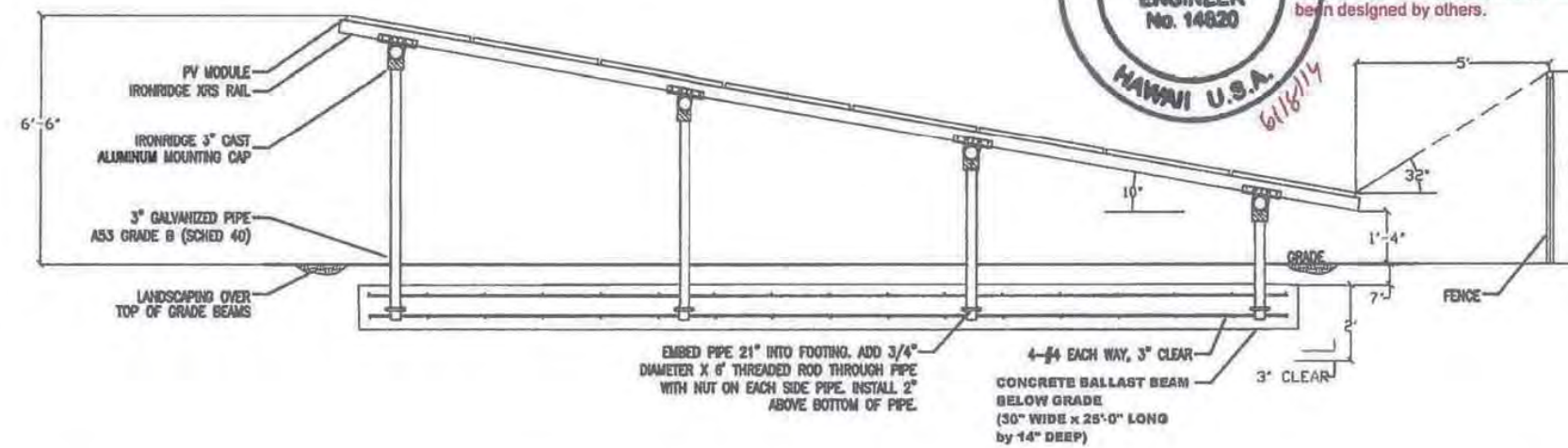
NORTH ELEVATION

SCALE
3/8" = 1'-0" 2



The IronRidge products and pipe support structure have been reviewed by Sterling Madison Lofquist, Inc. for compliance with the structural calculations. The foundations have been designed by others.

6/16/14



ARRAY SECTION VIEW

SCALE
1/4" = 1'-0" 1

CONCRETE NOTES:

1. CONSTRUCTION SHALL CONFORM TO INTERNATIONAL BUILDING CODE-2006 AND LOCAL REGULATORY AGENCIES REQUIREMENTS.
2. ALL CONCRETE WORK SHALL COMPLY WITH ACI 301 & 318 LATEST EDITION.
3. ALL SLAB ON GRADE WORK SHALL BE DONE IN ACCORDANCE WITH ACI 302-IR.
4. CONCRETE SHALL BE 3000 PSI @ 28 DAY COMPRESSIVE STRENGTH.
5. MAXIMUM SLUMP 4". WATER TO CEMENT RATIO: FROM .47 TO .53
6. AGGREGATE GRADATION AND QUALITY SCALE SHALL BE IN ACCORDANCE WITH ACI 302-IR.
7. REINFORCEMENT SHALL BE ASTM A615 GR60.
8. MINIMUM CONCRETE COVER SHALL BE 3" TO EARTH, 2" TO SKY.
9. CONTRACTOR SHALL VERIFY ALL PERTINENT DIMENSIONS PRIOR TO BEGINNING OF CONSTRUCTION.

DATE:	05/09/2014	
PROJECT MANAGER:	PF	
DESIGNED BY:	SD	
DRAWN BY:	SD	
CHECKED BY:		
NO.	DATE	REVISIONS

ARRAY SECTION VIEW

Sheet 2 of 3

E1-2

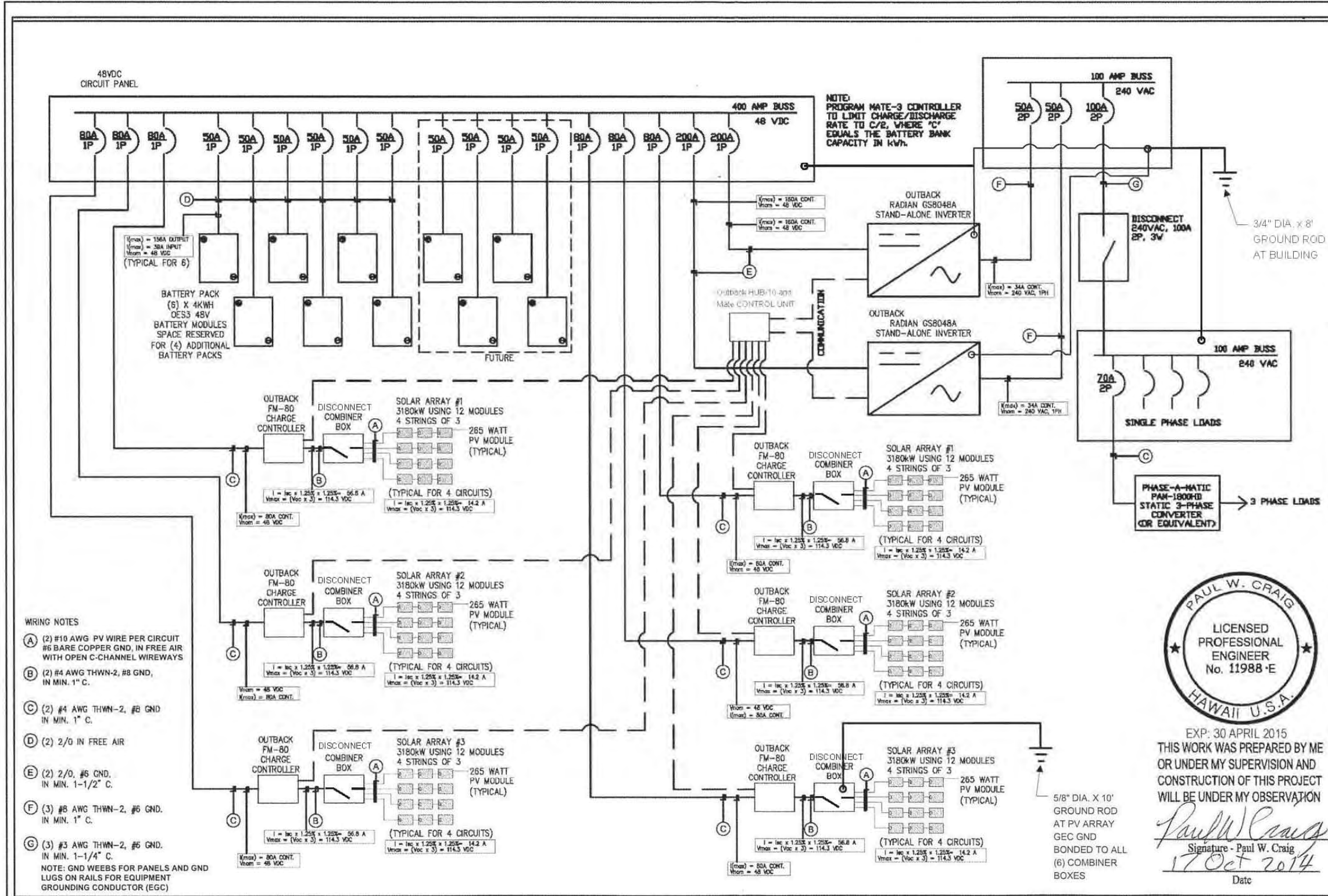
This page intentionally left blank.



SOLAR ENERGY DESIGN
AND INSTALLATION

905 Kalanianaʻole Highway #21
Kailua, Hawaii 96734
(808) 262-6600
info@sunetric.com
www.sunetric.com

**OFF-GRID
PV SYSTEM**
JOINT BASE PEARL HARBOR
HICKAM, HAWAII



- WIRING NOTES**
- (A) (2) #10 AWG PV WIRE PER CIRCUIT #6 BARE COPPER GND, IN FREE AIR WITH OPEN C-CHANNEL WIREWAYS
 - (B) (2) #4 AWG THWN-2, #8 GND, IN MIN. 1" C.
 - (C) (2) #4 AWG THWN-2, #8 GND IN MIN. 1" C.
 - (D) (2) 2/0 IN FREE AIR
 - (E) (2) 2/0, #6 GND, IN MIN. 1-1/2" C.
 - (F) (3) #8 AWG THWN-2, #6 GND, IN MIN. 1" C.
 - (G) (3) #3 AWG THWN-2, #5 GND, IN MIN. 1-1/4" C.
- NOTE: GND WEBS FOR PANELS AND GND LUGS ON RAILS FOR EQUIPMENT GROUNDING CONDUCTOR (EGC)



EXP: 30 APRIL 2015
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION
Paul W. Craig
Signature - Paul W. Craig
17 Oct 2014
Date

SINGLE LINE DIAGRAM

SCALE
N.T.S. 1

DATE:	05/09/2014	
PROJECT MANAGER:	PF	
DESIGNED BY:	SD	
DRAWN BY:	SD	
CHECKED BY:		
NO.	DATE	REVISIONS
011	10.3.14	Grounding notes
013	11.30.14	Grounding Rod

SINGLE LINE DIAGRAM

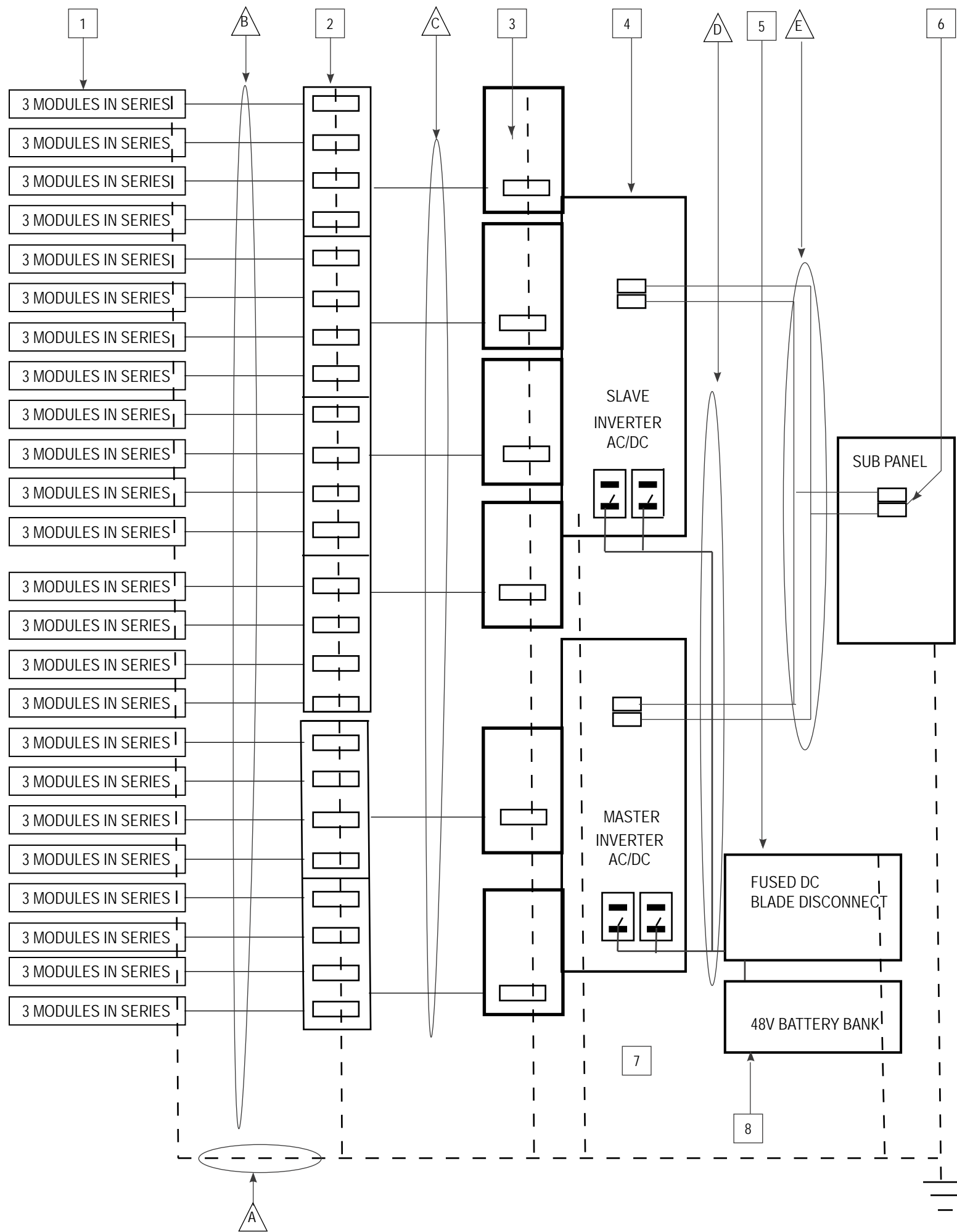
Sheet 3 OF 3

E1-3

This page intentionally left blank.

Appendix B-3
Re-start Inverter/Load Center Rewiring One-Line Diagram

This page intentionally left blank.



- EQUIPMENT SCHEDULE (NEGATIVE GROUND)**
- 1 72 Photovoltaic Modules
3PV MODULES WIRED IN SERIES CREATING 24 PARALLEL STRINGS
 - 2 (6) IDENTICAL COMBINER BOXES
SOLAR BOS CS12 SOLAR COMBINER BOX W/ 4 15 A STRING FUSES
 - 3 (6) OUTBACK POWER FM80 CHARGE CONTROLLERS, W/ (6) 80A PV INPUT BREAKERS AND (6) OB80A GND FAULT BREAKERS
 - 4 (2) OUTBACK POWER RADIAN 8048 OFF GRID 8000WATT INVERTERS
W/ DUAL 50Aac OUTPUT BREAKERS AND DUAL 175Adc INPUT BREAKERS
 - 5 SIEMENS BLADE TYPE DC DISCONNECT W/ (2) 350ADC FUSES
 - 6 125A BR SUB PANEL
(1) 2P 100A CUTTLER HAMMER BREKAER
 - 7 (2) 175A DC DISCONNECT BREAKERS IN EACH INVERTER
 - 8 48V BATTERY BANK (W/ (2) 175A DC DISCONNECT)

- CONDUIT AND CONDUCTOR SCHEDULE:**
- A GROUND CONDUCTOR #8AWG THWN-2 INSULATED GROUND CONDUCTOR RAN SEPARATELY
 - B (24) #10AWG UVRATED STRING CONDUCTORS ENTERING 1" STRAIN RELIEF INTO LIQUID TIGHT FLEX, WITH #8 GROUND CONDUCTOR RAN SEPARATELY PER COMBINER
 - C (10) #4AWGTHWN-2 ARRAY CONDUCTORS IN 1" EMT W/ # 6AWG GROUND CONDUCTOR TO INVERTER
 - D 4/0 Cu DC CONDUCTORS IN 2" EMT CONDUIT W/ #8 THNN GROUND CONDUCTOR > 10' TO INVERTER LOAD CENTERS
 - E EXISTING #1CU AC CONDUCTORS IN 1 1/4" EMT

COCONUT COAST ELECTRIC, INC.

(808) 651 7732 gary@solsystems.org

**SUBSITE ST32
ONIZUKA VILLAGE
SVE SYSTEM INSTALLATION
JOINT BASE PEARL HARBOR
HICKAM, HAWAII**

SYSTEM SIZE:
19.8 KW - PV SYSTEM

DATE:
01/30/2016
REV. DATE:
//_/____

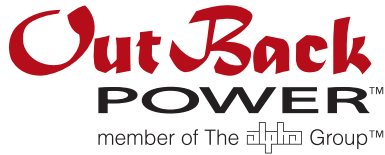
**SINGLE LINE WIRING
DIAGRAM**

EARTH
GROUND

This page intentionally left blank.

Appendix B-4 Inspection Form and Warranty

This page intentionally left blank.



OutBack Batteries

Limited Warranty

OutBack Power Technologies, Inc. ("OutBack") provides a limited warranty ("Warranty") against defects in materials and workmanship for its battery products ("Product"). The Warranty term for a particular Product series is defined on Table 1 (see below). The Warranty term is defined the same for all Product models in that Product series.

"Stable Grid" is defined as a utility grid company or service which experiences few power failures. A battery backup system would be used infrequently and for short term backup only. The system would incur minimal Product usage.

"Unstable Grid" is defined as a utility grid company or service which experiences frequent or recurring power failures. A battery backup system would incur noticeable (more than minimal) Product usage.

Table 1 Warranty Term

Product Series	U.S. or Canada		International	
	Stable Grid	Unstable Grid/Off Grid	Stable Grid	Unstable Grid/Off Grid
EnergyCell RE	Two (2) years	Two (2) years	One (1) year	One (1) year
EnergyCell GH	Four (4) years	One (1) year	Four (4) years	One (1) year

The term of this Warranty begins on the Product initial purchase date, or initial ship date, whichever is later. This must be indicated on the invoice, bill of sale, and/or registration submitted to OutBack. This Warranty applies to the original Product purchaser, and is transferable only if the Product remains installed in the original use location.

The warranty does not apply to any Product or Product part that has been modified or damaged by the following:

- installation or removal;
- normal wear and tear;
- accident, abuse, or neglect;
- shipping or transportation;
- lightning, fire, floods or acts of God;
- incidents not foreseeable by OutBack;
- operation with temperature variation more than 5°F (2.78°C) between cells
- routine or daily discharge of more than 40% of capacity
- charging, discharging, or commissioning contrary to instructions
- incidental or consequential damage caused by other components of the power system;
- alteration, disassembly, or service by an unauthorized facility
- any other make/model in the same battery bank as the Product

OutBack's liability for any defective Product, or any Product part, shall be limited to the repair or replacement of the Product, at OutBack's discretion. OutBack does not warrant or guarantee workmanship performed by any person or firm installing its Products. This Warranty does not cover the costs of installation, removal, shipping (except as described below), or reinstallation of Products or parts of Products.

THIS LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY APPLICABLE TO OUTBACK PRODUCTS. OUTBACK EXPRESSLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTIES OF ITS PRODUCTS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. OUTBACK ALSO EXPRESSLY LIMITS ITS LIABILITY IN THE EVENT OF A PRODUCT DEFECT TO REPAIR OR REPLACEMENT IN ACCORDANCE WITH THE TERMS OF THIS LIMITED WARRANTY AND EXCLUDES ALL LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR PRODUCTS NOT BEING AVAILABLE FOR USE OR LOST REVENUES OR PROFITS, EVEN IF IT IS MADE AWARE OF SUCH POTENTIAL DAMAGES. IF YOU ARE A CONSUMER THAT PURCHASED THIS PRODUCT IN A MEMBER STATE OF THE EUROPEAN UNION, YOU MAY HAVE ADDITIONAL STATUTORY RIGHTS UNDER DIRECTIVE 1999/44/EC. THESE RIGHTS MAY VARY FROM EU MEMBER STATE TO EU MEMBER STATE. SOME STATES (OR JURISDICTIONS) MAY NOT ALLOW THE EXCLUSION OR LIMITATION OF WARRANTIES OR DAMAGES, SO THE ABOVE EXCLUSIONS OR LIMITATIONS MAY NOT APPLY TO YOU.

Additional Service and Battery Recycling

How to Register the Product

To register your product, use the online form at the following website location:

<http://www.outbackpower.com/resources/warranty/>

Or, complete the Registration card provided with the product and mail it to the address on the card.

Arranging for Warranty Service

In the event of a failure, Warranty service is provided by the installer, dealer, or distributor. Defective Product will be replaced under Warranty. In the event that the installer, dealer, or distributor cannot provide support or needs more information, contact OutBack Technical Support at +1.360.435.6030 or direct at +1.360.618.4363 or support@outbackpower.com. To ensure Warranty coverage, this contact must be within the Warranty period beginning on the invoice date. During this period, OutBack Power Technologies will repair or replace a Product covered under this Warranty that is confirmed defective.

Troubleshooting

One party will need to work with an OutBack Technical Support representative to perform troubleshooting. This is a required step and requires a qualified technician to be present at the site of the Product with a quality DC voltmeter. The OutBack representative will request voltmeter readings and other information. Because Product performance is dependent on temperature, in order to validate the Warranty OutBack may request documentation verifying that the Product was operated in a temperature-controlled environment.

If OutBack determines the Product or Product part is defective and that the defect is covered under this Warranty, OutBack will then and only then ship a repaired or replacement Product or Product part to the purchaser freight prepaid, non-expedited, using a carrier of OutBack's choice, where applicable. The warranty period of any repaired or replacement Product or Product part is ninety (90) days from the date of shipment from OutBack, or the remainder of the initial warranty term, whichever is greater. OutBack reserves the right to request Products to be returned to OutBack for analysis.

This Warranty is void for any Product that has been modified by the customer without authorization by OutBack. A Product with a voided warranty will be treated the same as one with an expired warranty.



IMPORTANT: Recycle Batteries

Batteries are considered hazardous waste and must be recycled according to local jurisdiction. The following websites and phone numbers provide additional information for recycling electronic products and batteries.

Recycling Information

Earth 911, USA

Website: <http://www.Earth911.com>
Address: 14646 N. Kierland Blvd., Suite 100
Scottsdale, AZ 85254
Phone: +1.480.337.3025 (direct)

Environmental Protection Agency, USA

Website: <http://www.epa.gov/wastes/conservation/materials/eycycling/donate.htm>
Address: EPA USA
Office of Resource Conservation and Recovery
(5305P)
1200 Pennsylvania Avenue NW
Washington, DC 20460

Keep America Beautiful, USA

Website: <http://www.kab.org/>
Email: info@kab.org
Address: 1010 Washington Boulevard
Stamford, CT 06901
Phone: +1.203.659.3000 (Main number)
Fax: +1.203.659.3001

OurEarth.org, USA

There is a place on the website for contacting OurEarth using email. No direct email address is provided.
Website: <http://www.ourearth.org>
Address: P.O. Box 62133
Durham, NC 27715
Phone: +1.410.878.6485

National Institute of Recyclers, Mexico

Website: <http://www.inare.org.mx/>
Email: a57841279@prodigy.net.mx,
margarita@inare.org.mx
Phone: +1.55.57.85.9160
Fax: +1.55.57.84.1279


Office of Waste Management, Canada

Website: http://www.portaec.net/library/recycling/recycling_in_canada.html
Address: Office of Waste Management
Conservation and Protection
Environment Canada
Ottawa, Ontario K1A 0H3
Phone: +1.819.997.2800

EuroRecycle.net, Europe

The following website provides general information about recycling in Europe. It also provides a list of companies and organizations that provide recycling information or assistance.
Website: <http://euro.recycle.net>
Email: <http://euro.recycle.net/cgi-bin/feedback1.cgi?w=27>
(This is an online form providing a means to contact the owners of the website.)

El cliente debe asegurar el envío o aceptar el riesgo de pérdida o daños durante el envío. Si es necesaria una caja de envío para la devolución de un Producto, OutBack se la enviará bajo petición.

	<p>IMPORTANTE:</p> <p><i>OutBack no se hace responsable de los daños durante el transporte ocasionados por Productos incorrectamente embalados, de las reparaciones que estos daños podrían requerir ni de los costes de estas reparaciones.</i></p>
--	---

Si, a la recepción del Producto, OutBack determina que el Producto o parte del Producto es defectuoso y que el defecto se incluye en los términos de esta Garantía, OutBack enviará entonces y solo entonces al comprador un Producto reparado o de sustitución o la parte del Producto a portes pagados, en envío no urgente, empleando un servicio de mensajería elegido por OutBack.

Si el Producto se avería en un plazo igual o inferior a noventa (90) días desde la fecha de compra original, OutBack lo cambiará por uno nuevo. Si el Producto se avería en un plazo superior a noventa (90) días e inferior o igual a la duración de la garantía, OutBack, a su criterio, reparará y devolverá el Producto, o enviará un Producto de repuesto. OutBack determinará si un Producto debe ser reparado o sustituido de acuerdo con la antigüedad y el modelo del Producto. OutBack autorizará el envío por adelantado de un repuesto en función de la antigüedad y el modelo del Producto.

En los casos en los que un comerciante o distribuidor de OutBack cambie un Producto de más de noventa (90) días por otro nuevo, OutBack NO indemnizará a dicho comerciante o distribuidor con existencias nuevas a menos que el intercambio haya sido autorizado por adelantado por OutBack.

Solución de problemas/Ningún honorario encontrado de defecto

En caso de que falle un Producto, el cliente se deberá contactar con un representante del servicio de asistencia técnica de OutBack y llevar a cabo los pasos que se le indiquen para la resolución del problema. Este paso debe realizarse antes de que se pueda efectuar una devolución. La resolución de problemas requiere que esté presente en las instalaciones del Producto un técnico calificado con un voltímetro de calidad tanto de CC como de CA. Deberá proporcionar al representante de OutBack las lecturas del voltímetro, los mensajes de error del Producto y cualquier otro tipo de información. Una gran cantidad de problemas puede resolverse en las instalaciones del Producto. Si el cliente no está dispuesto o no puede proporcionar estas lecturas (o visitar las instalaciones) y se descubre que el Producto no tiene problemas tras la devolución, OutBack puede obligar al cliente a pagar hasta 180,00 dólares americanos por la mano de obra y la manipulación.

Fuera de Garantía

Si un Producto está fuera de garantía, OutBack podrá repararlo y sustituirlo si el cliente asume los costes. De forma alternativa, si fuese aplicable y bajo petición, OutBack puede enviar por adelantado piezas de repuesto a cambio de una suma de dinero.

Si es necesaria una caja de envío para la devolución de un Producto fuera de garantía, OutBack se la enviará bajo petición. El cliente es responsable del pago del envío a OutBack.

El período de garantía de cualquier Producto reparado o de sustitución, así como de cualquier parte del Producto, es de noventa (90) días a partir de la fecha de envío desde OutBack, o igual al período de validez restante de la garantía inicial, el que sea mayor de los dos.


Esta Garantía queda anulada para cualquier Producto que haya sido modificado por el cliente sin la autorización de OutBack. Un Producto con una garantía anulada se tratará del mismo modo que uno con la garantía vencida.

Actualizaciones de Garantía

Para las actualizaciones de la declaración de garantía, consulte el sitio web siguiente:

<http://www.outbackpower.com/resources/warranty/>

Información sobre el reciclaje

	<p>IMPORTANTE: Reciclaje de sistemas electrónicos y baterías</p> <p>Las baterías se consideran residuos peligrosos y se deben reciclar de acuerdo con la normativa local. Los inversores y otros sistemas electrónicos contienen metales y plásticos que se deben reciclar. Los siguientes sitios web y números de teléfono proporcionan información adicional para el reciclaje de productos electrónicos y baterías.</p>
---	---

Earth 911, EE. UU.	
Sitio web:	http://www.Earth911.com
Dirección:	14646 N. Kierland Blvd., Suite 100 Scottsdale, AZ 85254
Tel.:	+1.480.337.3025 (directo)
Agencia para la protección del medio ambiente (EPA), EE. UU.	
Sitio web:	http://www.epa.gov/wastes/conserves/materials/ecycling/donate.htm
Dirección:	EPA USA Office of Resource Conservation and Recovery (5305P) 1200 Pennsylvania Avenue NW Washington, DC 20460
Keep America Beautiful, EE. UU.	
Sitio web:	http://www.kab.org/
Correo electrónico:	info@kab.org
Dirección:	1010 Washington Boulevard Stamford, CT 06901
Tel.:	+1.203.659.3000 (Número principal)
Fax:	+1.203.659.3001
Instituto nacional de recicladores, México	
Sitio web:	http://www.inare.org.mx/
Correo electrónico:	a57841279@prodigy.net.mx , margarita@inare.org.mx
Tel.:	+1.55.57.85.9160
Fax:	+1.55.57.84.1279
Departamento de recursos naturales de Canadá	
Sitio web:	http://www.nrcan-rncan.gc.ca/mms-smm/busi-indu/rec-rec-eng.htm
Dirección:	580 Booth Ottawa, ON K1A 0E8
Tel.:	+1.613.995.0947
Teléfono para sordomudos:	+1.613.996.4397 (Teléfono general y para sordomudos: de lunes a viernes, de 8:30 a.m. a 4:30 p.m., hora del Este)
EuroRecycle.net, Europa	
El siguiente sitio web proporciona información sobre el reciclaje en Europa. También incluye una lista de compañías y organizaciones que proporcionan información y ayuda sobre el reciclaje.	
Sitio web:	http://euro.recycle.net
Correo electrónico:	http://euro.recycle.net/cig-bin/feedback1.cgi?w=27 (Esta dirección es un formulario en línea que se utiliza como medio para ponerse en contacto con los propietarios del sitio web).

5-Year Limited Warranty

OutBack Power Technologies, Inc. ("OutBack") provides a five (5) year limited warranty ("Warranty") against defects in materials and workmanship for its inverter/chargers, charge controllers, communication/monitoring products, and system integration equipment and enclosures ("Product"), with the exception of the OBX OutBack Extreme Series products, which have a one (1) year limited warranty.

The term of this Warranty begins on the Product(s) initial purchase date, or the date of receipt of the Product(s) by the end user, whichever is later. This must be indicated on the invoice, bill of sale, and/or warranty registration card (or online form) submitted to OutBack. This Warranty applies to the original OutBack Product purchaser, and is transferable only if the Product remains installed in the original use location.

The warranty does not apply to any Product or Product part that has been modified or damaged by the following:

- installation or removal;
- alteration or disassembly;
- normal wear and tear;
- accident or abuse;
- corrosion;
- lightning;
- repair or service provided by an unauthorized repair facility;
- operation or installation contrary to manufacturer product instructions;
- fire, floods or acts of God;
- shipping or transportation;
- incidental or consequential damage caused by other components of the power system;
- any product whose serial number has been altered, defaced or removed;
- any other event not foreseeable by OutBack.

OutBack's liability for any defective Product, or any Product part, shall be limited to the repair or replacement of the Product, at OutBack's discretion. OutBack does not warrant or guarantee workmanship performed by any person or firm installing its Products. This Warranty does not cover the costs of installation, removal, shipping (except as described below), or reinstallation of Products or parts of Products.

THIS LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY APPLICABLE TO OUTBACK PRODUCTS. OUTBACK EXPRESSLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTIES OF ITS PRODUCTS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. OUTBACK ALSO EXPRESSLY LIMITS ITS LIABILITY IN THE EVENT OF A PRODUCT DEFECT TO REPAIR OR REPLACEMENT IN ACCORDANCE WITH THE TERMS OF THIS LIMITED WARRANTY AND EXCLUDES ALL LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR PRODUCTS NOT BEING AVAILABLE FOR USE OR LOST REVENUES OR PROFITS, EVEN IF IT IS MADE AWARE OF SUCH POTENTIAL DAMAGES. IF YOU ARE A CONSUMER THAT PURCHASED THIS PRODUCT IN A MEMBER STATE OF THE EUROPEAN UNION, YOU MAY HAVE ADDITIONAL STATUTORY RIGHTS UNDER DIRECTIVE 1999/44/EC. THESE RIGHTS MAY VARY FROM EU MEMBER STATE TO EU MEMBER STATE. SOME STATES (OR JURISDICTIONS) MAY NOT ALLOW THE EXCLUSION OR LIMITATION OF WARRANTIES OR DAMAGES, SO THE ABOVE EXCLUSIONS OR LIMITATIONS MAY NOT APPLY TO YOU.

How to Register the Product

To register your product, use the online form at the following website location:

<http://www.outbackpower.com/resources/warranty/>

Or, complete the Warranty Registration card provided with the product and mail it to the address provided on the card.

How to Arrange for Warranty Service

During the warranty period beginning on the invoice date, OutBack Power Technologies will repair or replace products covered under this limited warranty that are returned to OutBack Power Technologies' facility or to an OutBack Power Technologies authorized repair facility, or that are repaired on site by an OutBack Power Technologies authorized repair person.

Contacting OutBack Technical Support

To request warranty service:

Telephone: **+1.360.435.6030** (Main Office)
+1.360.618.4363 (Technical Support)

Email: **support@outbackpower.com**

To ensure warranty coverage, this contact must be within the effective warranty period. If service is required, the OutBack Technical Support representative will issue a Return Material Authorization (RMA) number.

Return Material Authorization (RMA)

A request for an RMA number requires all of the following information:

1. Product model and serial number;
2. Proof-of-purchase in the form of a copy of the original Product purchase invoice or receipt confirming the Product model number and serial number;
3. Description of the problem;
4. Validation of problem by Technical Support, and
5. Shipping address for the repaired or replacement equipment.

Upon receiving this information, the OutBack representative can issue an RMA number.

Returning Product to OutBack

After receiving the RMA number, the customer must pack the Product(s) authorized for return, along with a copy of the original purchase invoice and product registration, *in the original Product shipping container(s) or packaging providing equivalent or reasonable protection*. The RMA number must be written on the outside of the packaging where it is clearly visible.

If Product is within the warranty period, OutBack will cover pre-paid shipping with prior arrangement.

The Product(s) must be shipped back to OutBack Power Technologies in their original or equivalent packaging, to the following address:


OutBack Power Technologies

RMA # _____
17827 – 59th Avenue N.E.
Arlington, WA 98223 USA



This page intentionally left blank.

The customer must insure the shipment, or accept the risk of loss or damage during shipment. If a shipping box is needed for return of a Product, OutBack will, upon request, send a shipping box.

	<p>IMPORTANT:</p> <p><i>OutBack is not responsible for shipping damage caused by improperly packaged Products, the repairs this damage might require, or the costs of these repairs.</i></p>
---	---

If, upon receipt of the Product, OutBack determines the Product or Product part is defective and that the defect is covered under the terms of this Warranty, OutBack will then ship a repaired or replacement Product or Product part to the purchaser freight prepaid, non-expedited, using a carrier of OutBack's choice, where applicable.

If Product fails in ninety (90) or fewer days from original purchase date, OutBack will replace with a new Product. If Product fails after ninety (90) days and up to expiration of warranty, OutBack will, at its discretion, either repair and return a Product, or ship a replacement Product. OutBack will determine whether a Product is to be repaired or replaced in accordance with Product age and model. OutBack will authorize advance shipment of a replacement based on Product age and model.

In cases where an OutBack dealer or distributor replaces a Product more than ninety (90) days old with a new Product, OutBack will NOT compensate that dealer or distributor with new stock unless the exchange was authorized in advance by OutBack.

Troubleshooting/No-Fault-Found Fee

In the event of a Product failure, the customer will need to work with an OutBack Technical Support representative to perform the necessary troubleshooting. This is a required step before a return can be performed. Troubleshooting requires a qualified technician to be present at the site of the Product, with a quality voltmeter that measures both DC and AC. The OutBack representative will request voltmeter readings, error messages, and other information. Several problems can be resolved on-site. If the customer is unable to provide the requested information and the Product is found to have no problems upon return, OutBack may choose to charge additional labor and handling fees up to \$180.00 U.S.

Out of Warranty

If Product is out of warranty, OutBack will repair and return Product for a fee. Alternately, if applicable, OutBack will advance-ship replacement parts for a fee upon request.

If a shipping box is needed for return of out-of-warranty Product, OutBack will send a shipping box upon request. The customer is responsible for paying shipping to OutBack.

The warranty period of any repaired or replacement Product or Product part is ninety (90) days from the date of shipment from OutBack, or the remainder of the initial warranty term, whichever is greater.

This Warranty is void for any Product that has been modified by the customer without authorization by OutBack. A Product with a voided warranty will be treated the same as one with an expired warranty.

Warranty Updates

For updates to the warranty statement, check the following website:

<http://www.outbackpower.com/resources/warranty/>

Recycling Information



IMPORTANT: Recycle Electronics and Batteries

Batteries are considered hazardous waste and must be recycled according to local jurisdiction. Inverters and other electronics contain metals and plastics that should also be recycled. The following websites and phone numbers provide additional information for recycling electronic products and batteries.

<p>Earth 911, USA</p> <p>Website: http://www.Earth911.com Address: 14646 N. Kierland Blvd., Suite 100 Scottsdale, AZ 85254 Phone: +1.480.337.3025 (direct)</p>
<p>Environmental Protection Agency, USA</p> <p>Website: http://www.epa.gov/wastes/conservation/materials/ecycling/donate.htm Address: EPA USA Office of Resource Conservation and Recovery (5305P) 1200 Pennsylvania Avenue NW Washington, DC 20460</p>
<p>Keep America Beautiful, USA</p> <p>Website: http://www.kab.org/ Email: info@kab.org Address: 1010 Washington Boulevard Stamford, CT 06901 Phone: +1.203.659.3000 (Main number) Fax: +1.203.659.3001</p>
<p>OurEarth.org, USA</p> <p>There is a place on the Website for contacting OurEarth.org using email. No direct email address is provided.</p> <p>Website: http://www.ourearth.org Address: P.O. Box 62133 Durham, NC 27715 Phone: +1.410.878.6485</p>
<p>National Institute of Recyclers, Mexico</p> <p>Website: http://www.inare.org.mx/ Email: a57841279@prodigy.net.mx, margarita@inare.org.mx Phone: +1.55.57.85.9160 Fax: +1.55.57.84.1279</p>
<p>Office of Waste Management, Canada</p> <p>Website: http://www.portaec.net/library/recycling/recycling_in_canada.html Address: Office of Waste Management Conservation and Protection Environment Canada Ottawa, Ontario K1A 0H3 Phone: +1.819.997.2800</p>
<p>EuroRecycle.net, Europe</p> <p>The following website provides general information about recycling in Europe. It also provides a list of companies and organizations that provide recycling information or assistance.</p> <p>Website: http://euro.recycle.net Email: http://euro.recycle.net/cgi-bin/feedback1.cgi?w=27 (This is an online form providing a means to contact the owners of the website.)</p>



De cinco años (5) limitó garantía

OutBack Power Technologies, Inc. ("OutBack") proporciona cinco (5) años de garantía limitada ("Garantía") contra defectos en materiales y habilidad para sus inversor/corces, controladores de carga, monitor de batería y productos de comunicación ("Producto"), a excepción del Interior de OBX productos de serie Extremos, que tienen un uno (1) año de garantía limitada.

El plazo de vigencia de esta Garantía comienza en la fecha de compra inicial del Producto, o en la fecha de la recepción del Producto por el usuario final, la fecha que sea posterior. Esto debe indicarse en la factura, recibo y/o registro de la garantía enviado a OutBack. Esta Garantía es aplicable al comprador original del Producto OutBack, y es transferible únicamente si el Producto permanece instalado en el lugar de uso original.

La garantía no es aplicable a ningún Producto o parte del Producto que haya sufrido modificaciones o daños por lo siguiente:

- Instalación o desmontaje;
- Modificación o desarme;
- Desgaste normal;
- Accidente o abuso;
- Corrosión;
- Rayos;
- Reparación o servicio realizados por un taller no autorizado;
- Funcionamiento o instalación contrarios a las instrucciones del fabricante;
- Fuego, inundación o fuerza mayor;
- Transporte;
- Daños accidentales o derivados, ocasionados por otros componentes del sistema eléctrico;
- Cualquier producto cuyo número de serie haya sido alterado, desfigurado o eliminado;
- Cualquier otra circunstancia no prevista por OutBack.

La responsabilidad de OutBack por cualquier Producto defectuoso, o cualquier parte del Producto, estará limitada a la reparación o sustitución del Producto, a criterio de OutBack. OutBack no garantiza los trabajos realizados por la persona o empresa que instale sus Productos. Esta Garantía no cubre los costos de instalación, desmontaje, transporte (salvo las excepciones que se describen más adelante) o reinstalación de los Productos o partes de Productos.

ESTA GARANTÍA LIMITADA ES LA ÚNICA GARANTÍA APLICABLE A PRODUCTOS OUTBACK. OUTBACK RECHAZA EXPRESAMENTE CUALQUIER OTRA GARANTÍA EXPLÍCITA O IMPLÍCITA DE SUS PRODUCTOS, INCLUIDAS, ENTRE OTRAS, LAS GARANTÍAS IMPLÍCITAS DE COMERCIABILIDAD O IDONEIDAD PARA UN FIN DETERMINADO. OUTBACK TAMBIÉN LIMITA EXPRESAMENTE SU RESPONSABILIDAD EN CASO DE REPARACIÓN O SUSTITUCIÓN DE UN PRODUCTO DEFECTUOSO DE ACUERDO CON LOS TÉRMINOS DE ESTA GARANTÍA LIMITADA Y EXCLUYE TODA RESPONSABILIDAD POR LOS DAÑOS ACCIDENTALES O DERIVADOS, INCLUYENDO, SIN LIMITACION ALGUNA, CUALQUIER RESPONSABILIDAD POR LA INDISPONIBILIDAD DE LOS PRODUCTOS O LUCRO CESANTE, INCLUSO EN EL CASO DE QUE HAYA SIDO ADVERTIDA DE TALES DAÑOS POTENCIALES. SI ES UN CONSUMIDOR QUE ADQUIRIÓ ESTE PRODUCTO EN UN ESTADO MIEMBRO DE LA UNIÓN EUROPEA, PUEDE TENER DERECHOS LEGALES ADICIONALES BAJO LA DIRECTIVA 1999/44/CE. ESTOS DERECHOS PUEDEN VARIAR DE UN ESTADO MIEMBRO DE LA UE A OTRO. ALGUNOS ESTADOS (O JURISDICIONES) NO CONTEMPLAN LA EXCLUSIÓN O LIMITACIÓN DE GARANTÍAS O DAÑOS, POR LO QUE ESTAS LIMITACIONES O EXCLUSIONES PUEDEN NO AFECTARLE.

Cómo registrar el producto

Para registrar su producto, utilice la forma en línea en la posición siguiente de sitio web:

<http://www.outbackpower.com/resources/warranty/>

O, completa la tarjeta de Matrícula de Garantía proporcionado con el producto y envíe lo a la dirección proporcionado en la tarjeta.

Cómo solicitar el servicio de la garantía

Durante el plazo de garantía que comienza en la fecha de la factura, OutBack Power Technologies reparará o cambiará aquellos productos cubiertos por esta garantía limitada que sean devueltos a las instalaciones de OutBack Power Technologies o a un taller de reparación autorizado por OutBack Power Systems, o que sean reparados en las instalaciones del consumidor por un técnico de reparaciones autorizado por OutBack Power Technologies.

Para contactar OutBack Apoyo Servicio de asistencia técnica

Para solicitar el servicio de la garantía:

Teléfono: **+1.360.435.6030** (Oficina principal)
+1.360.618.4363 (Asistencia técnica)

Correo electrónico: **support@outbackpower.com**

Para asegurar la cobertura de la garantía, deberá ponerse en contacto con OutBack durante el período efectivo de la garantía. Si fuese necesario el servicio, el representante de la asistencia técnica de OutBack emitirá un número de autorización de devolución del material (RMA).

Autorización de devolución de material (RMA)

Para solicitar un número RMA debe facilitarse toda la información que se indica a continuación:

1. modelo y número de serie del Producto,
2. la prueba de compra en forma de copia de la factura original del Producto o un recibo que confirme el número de modelo y el número de serie del Producto,
3. descripción del problema,
4. la validación del problema por asistencia técnica; y
5. dirección de envío del equipo reparado o de sustitución.

Tras la recepción de esta información, el representante de OutBack podrá emitir un número RMA.

Devolución de un Producto a OutBack

Después de recibir el número RMA, el cliente debe embalar el/los Producto/s autorizado/s para su devolución, junto con una copia de la factura de compra original y el certificado de garantía, en el embalaje original del Producto/s o en un embalaje que ofrezca una protección equivalente o razonable. El número RMA debe escribirse en el exterior del embalaje donde se pueda ver claramente.

Si el producto se encuentra dentro del período de garantía, OutBack cubrirá los costos prepagos del transporte con previo acuerdo.

El Producto o los Productos deben enviarse de vuelta a OutBack Power Technologies en su embalaje original o equivalente a la siguiente dirección:

OutBack Power Technologies

RMA # _____
17827 – 59th Avenue N.E.
Arlington, WA 98223 Estados Unidos

This page intentionally left blank.

Product Registration Form

The purchase of an OutBack Power Technologies product is an important investment. Registering the products will help us maintain the standard of excellence you expect from us in terms of performance, quality, and reliability.

Please take a moment to register and provide us with some important information. Registration can be done as follows:

- Go to the following website:
<http://www.outbackpower.com/resources/warranty/> or
- Fill out the information on this page and mail it the address below.

Registro del Producto

La adquisición de un producto de OutBack Power Technologies es una inversión importante. Al registrar nuestros productos, nos ayudará a mantener el estándar de excelencia que espera de nosotros en términos de rendimiento, calidad y fiabilidad.

Dedique unos minutos al registro del producto y a proporcionarnos información importante. El registro se puede hacer del siguiente modo:

- Diríjase al siguiente sitio web:
<http://www.outbackpower.com/resources/warranty/> o
- Llene la información en esta página y envíelo la dirección abajo.

OutBack Power Technologies
Attn: Warranty Registration
17825 – 59th Avenue N.E.
Suite B
Arlington, WA 98223 USA

La Forme d'enregistrement de produit

L'achat d'un produit d'OutBack Power Technologies est un investissement important. Enregistrer les produits aideront nous maintenir la norme d'excellence que vous prévoyez de nous sur le plan de l'exécution, de la qualité, et de la fiabilité.

S'il vous plaît prendre un moment pour enregistrer et fournir nous avec des informations importantes. L'enregistrement peut être fait comme suit :

- Aller au site Web suivant : <http://www.outbackpower.com/resources/warranty/> ou
- Remplir les informations sur cette page et l'envoie l'adresse au-dessous.

Produktregistrierung

Der Kauf eines Produkts, das von OutBack Power Technologies gemacht wird, ist eine wichtige Investition. Registrieren der Produkte wird uns helfen, den Standard der Vortrefflichkeit Sie beizubehalten, erwarten von uns in Begriffen der Leistung, Qualität, und Zuverlässigkeit.

Bitte nehmen Sie einen Moment zu registrieren und uns mit einigen wichtigen Informationen zu versorgen. Registrierung kann folgendermaßen gemacht werden:

- Gehen Sie zur Folgenden Website:
<http://www.outbackpower.com/resources/warranty/> oder
- Füllen Sie die Informationen über diese Seite aus und schicken Sie es die Adresse unten ab.

Please check ALL factors affecting purchase decision:	Marque TODOS los factores que afectan la decisión de compra:	S'il vous plaît vérifier TOUS les facteurs qui affectent la décision d'achat :	Bitte prüfen Sie ALLE Faktoren, die Kaufentscheidung beeinflussen:
<input type="checkbox"/> Grid-Interactive Capability <input type="checkbox"/> Product Reputation <input checked="" type="checkbox"/> Back-up Capability <input type="checkbox"/> Reputation of OutBack Power Technologies <input type="checkbox"/> Value <input type="checkbox"/> Looks <input type="checkbox"/> Other _____	<input type="checkbox"/> Capacidad de interactivo en la red eléctrica <input type="checkbox"/> Reputación del producto <input type="checkbox"/> Capacidad de respaldo <input type="checkbox"/> Reputación de OutBack Power Technologies <input type="checkbox"/> Valor <input type="checkbox"/> Apariencia <input type="checkbox"/> Otros _____	<input type="checkbox"/> La capacité pour fonctionner comme réseau interactif <input type="checkbox"/> Réputation de produit <input type="checkbox"/> La capacité pour fonctionner comme la Sauvegarde <input type="checkbox"/> La réputation d'OutBack Power Technologies <input type="checkbox"/> Valeur <input type="checkbox"/> Apparence <input type="checkbox"/> Autre _____	<input type="checkbox"/> Fâhig von Bedienung Netz-interaktiv <input type="checkbox"/> Produktruf <input type="checkbox"/> Backup Befähigung <input type="checkbox"/> Ruf von OutBack Power Technologies <input type="checkbox"/> Wert <input type="checkbox"/> Erscheinung <input type="checkbox"/> Anderer _____

Extended Warranty

Where required by local authority, OutBack Power Technologies offers a five-year (5) extension to the standard five-year (5) Limited Warranty for certain products for a total effective warranty coverage period of ten (10) years. To request a limited warranty extension, mail this page with payment in the appropriate amount, to OutBack Power Technologies at the address provided above.

Please submit within 90 days of the first retail sale of the product and indicate the quantity of each product.

- Radian Series Inverter/Charger \$899 USD per unit
- GTFX or GVFX Series Inverter/Charger \$599 USD per unit
- FLEXmax Series Charge Controller \$250 USD per unit

Garantía prolongada

Dónde es necesario por administración local, OutBack Power Technologies ofrece cinco años (5) extensión al estándar de cinco años (5) Garantía Limitada para ciertos productos para un período efectivo total de alcance de garantía de diez (10) años. Para solicitar una extensión limitada de garantía, envíe esta página con el pago en la cantidad apropiada, a OutBack Power Technologies en la dirección indicada anteriormente.

Favor de someter dentro de 90 días de la primera venta del producto e indique la cantidad de cada producto.

- Inversor/Cargador de la serie Radian \$899 USD por unidad
- Inversor/Cargador de la Serie GTFX o GVFX \$599 USD por unidad
- Regulador de carga de la Serie FLEXmax \$250 USD por unidad

Extension de garantie

Où exigé par l'autorité locale, OutBack Power Technologies offre un cinq-an (5) l'extension au cinq-an de norme (5) A Limité Garantie pour les certains produits pour une période de couverture de garantie efficace totale de dix (10) les ans. Pour demander une extension limitée de garantie, envoyer cette page avec le paiement dans la quantité appropriée, à OutBack Power Technologies à l'adresse fournie au-dessus.

S'il vous plaît soumettre dans 90 jours de la première vente au détail du produit et indiquer la quantité de chaque produit.

- L'onduleur/chargeur de la gamme Radian \$899 USD par l'unité
- L'onduleur/chargeur de la gamme GTFX ou GVFX \$599 USD par l'unité
- Contrôleur de charge de la gamme FLEXmax \$250 USD par l'unité

Ausgedehnte Garantie

Zu wo erforderlich durch Kommune, OutBack Power Technologies einem fünf jährigen (5) Verlängerung der Standard fünf jährig (5) beschränkte Haftung für gewisse Produkte für eine gesamte effektive Garantie Abdeckung Periode von zehn (10) Jahre anbietet. Um eine beschränkte Haftung Verlängerung zu erbitten, schicken Sie diese Seite mit Zahlung im passenden Betrag, zu OutBack Power Technologies an der Adresse ab, die oben versorgt wird.

Bitte reichen Sie innerhalb 90 Tagen des ersten Einzelhandels Verkauf des Produkts ein und zeigen Sie die Quantität jedes Produkts an.

- Radian Baureihen Wechselrichter/Lader \$899 USD pro Einheit
- Wechselrichter/Lader der GTFX oder GVFX Baureihe \$599 USD pro Einheit
- Laderegler der FLEXmax Baureihe \$250 USD pro Einheit

SYSTEM OWNER (Propietario del sistema, Propriétaire de système, System Eigentümer)		
Name (Nombre, Nom, Name)		
Address (Dirección, Adresse, Anschrift)		
City, State, Postal or Zip Code (Ciudad, Estado, Código Postal, La ville, l'État, Postal ou la Fermeture à glissière Code, Stadt, Staat, Postalisch oder Schwung Kodiert)		
Country (País, Pays, Land)		
Telephone Number (Teléfono, Numéro de téléphone, Telefon)		
E-mail (Correo electrónico, e-mail, E-mail)		
FIRMWARE UPDATES (Actualizaciones de Firmware, Remettre à jour de microprogramme, Firmware Aktualisierungen)		
Do you want to be notified about firmware updates? ¿Quiere ser notificado acerca de actualizaciones de Firmware? Voulez-vous être notifiés de remettre à jour de microprogramme ? Wollen Sie über Firmware-Aktualisierungen benachrichtigt werden?		
	<input checked="" type="checkbox"/> YES (Si, Oui, Ja)	<input type="checkbox"/> NO (No, Non, Nein)
SYSTEM PURCHASE (Sistema adquirido, Achat de système, Systemkauf)		
Product Model Number (Número de modelo del producto, Le Nombre de Modèle de produit, Produktmodellnummer)	Re2000	
Product Serial Number (Número de serie del producto, Numéro de série de produit, Produktseriennummer)	E4200198935 +	
Sold by (Vendido por, Vendu par, Verkauft durch)	Coconut Coast Electric	
Purchase Date (Fecha de compra, Acheter la Date, Kaufen Sie Datum)	09/01/2015	
INSTALLATION INFORMATION (Información sobre instalación, Informations sur l'installation, Installationen Informationen)		
System Install/Commission Date (Fecha de instalación/puesta en marcha del sistema, La Date d'installer / Mise en service de système, System Installieren Sie/Kommission Datum)	09/17/2015	
PV Array Wattage (Dimensiones de la matriz del sistema, Valeur en watts de générateur PV (photovoltaïque), PV-Feld Watt zahl)	19KW	Nominal Voltage → (Voltaje nominal de la matriz del sistema, Tension nominal, Nennwert Spannung) 48VDC
Type of PV Modules (Tipo de Módulos de FV, Le type de Modules de PV, Typ von PV Modulen)	Suniva OPT265-60-4-100	
System Battery Bank Size (Amp-Hours) (Tamaño del banco de las baterías del sistema (Amp-hora), La Taille du groupe de batteries du système (les Ampères-Heures), Systembatteriebankgröße (Ampere-Stunden))	1716AH	
Brand and Model of Batteries (Marca y modelo de las baterías, Marquer et Modèle des batteries, Marke und Modell von Batterien)	Outback Power RE2000	
Brand and model of Generator (if used) (Marque y el modelo de Generador (si utilizado), Marquer et le modèle de Générateur (si utilisé), Marke und Modell des Generators (wenn verwendet))	N/A	
INSTALLER INFORMATION (Información Sobre el instalador, Informations d'installateur, Monteur-Information)		
Contractor Number (Número de contratista, Nombre d'entrepreneur, Unternehmer-Nummer)	Coconut Coast Elec. C-26809	
Installer Name (Nombre del instalador, Nom d'installateur, Monteur-Name)	Gary D. Seals	
Installer Address (Dirección del instalador, Adresse d'installateur, Monteur Anschrift)	430 Kaholalele rd	
Installer City, State, Postal or Zip Code, Country (Ciudad, Estado, Código Postal, País del instalador; La ville d'installateur, l'État, Postal ou la Fermeture à glissière Code, Pays; Monteur Stadt, Staat, Postalisch oder Schwung Kodiert)	Kapaa, Hi 96746	
Installer Telephone/E-mail (Teléfono/correo electrónico/del instalador, Installateur téléphone/e-mail, Monteur Telefone/e-Mail)	808-651-7732 gary@solsystems.org	
EXTENDED WARRANTY (La Garantía prolongada, Garantie Prolongée, Ausgedehnte gebetene Garantie):		
Make payable to (Haga pagadero a, Faites payable, Machen Sie zahlbar):	Product (producto, produit, Produkt):	Quantity (cantidad, quantité, Quantität):
OutBack Power Technologies	Inverter/Charger (Inversor/cargador, Onduleur / chargeur, Wechselrichter/Lader)	<input type="checkbox"/> Radian <input type="checkbox"/> GTFX/GVFX
Total: \$	Charge Controller (Regulador de carga, Contrôleur de charge, Laderegler)	<input type="checkbox"/> FLEXmax 60 <input type="checkbox"/> FLEXmax 80 <input type="checkbox"/> FM Extreme

Battery Inspection Sheet: Hickam AFB SVE site
Outback RE-2000

9/10/2015
checked by G. seals

CRATE #	CELL #	LAST 3 OF CELL SERIAL #	CELL VOLTAGE VOLTS DC	
C R A T E 1 2 6	1	595-A	2.16	
	2	595-B	2.16	
	3	594-A	2.16	
	4	594-B	2.16	
	5	938-A	2.16	
	6	938-B	2.16	
	7	996-A	2.6	
	8	996-B	2.16	
	9	937-A	2.16	
	10	937-B	2.16	
	11	597-A	2.16	
	12	597-B	2.16	
C R A T E 1 2 7	13	935-A	2.15	
	14	935-B	2.15	
	15	957-A	2.15	
	16	957-B	2.15	
	17	973-A	2.14	
	18	973-B	2.14	
	19	947-A	2.16	
	20	947-B	2.16	
	21	956-A	2.15	
	22	956-B	2.15	
	23	964-A	2.15	
	24	964-B	2.15	
C R A T E 1 2 9	25	511-A	2.16	
	26	511-B	2.16	
	27	538-A	2.16	
	28	538-B	2.16	
	29	540-A	2.15	
	30	540-B	2.15	
	31	516-A	2.16	
	32	516-B	2.16	
	33	530-A	2.16	
	34	530-B	2.16	
	35	531-A	2.15	
	36	531-B	2.15	
C R A T E	37	982-A	2.16	
	38	982-B	2.16	
	39	954-A	2.14	
	40	954-B	2.14	
	41	951-A	2.14	
	42	951-B	2.14	
	43	941-A	2.14	

This page intentionally left blank.

Appendix B-5 Emergency Shutdown Procedure

This page intentionally left blank.

EMERGENCY SHUTDOWN

FOR
HICKAM AFB SVE POWER ROOM

1- TURN OFF SOLAR PV SUPPLY

TO BE DONE AT COMBINER BOXES 1-6



TURN DISCONNECT SWITCHES LEFT COUNTER CLOCKWISE TO OFF POSITION

DISCONNECT SWITCHES

2- TURN OFF AC & DC BREAKERS AT (2) INVERTER LOAD CENTERS

TO BE DONE IN ELECTRICAL ROOM BELOW INVERTERS



TURN ALL AC & DC BREAKERS TO OFF POSITIONS (START AT TOP LEFT OF EACH LOAD CENTER AND MOVE DOWN AND RIGHT) **SWITCHING LARGE 175ADC BREAKERS OFF LAST**

AC BREAKERS

DC BREAKERS (LAST)

4- TURN OFF DC DISCONNECT BLADE SWITCH

TO BE DONE IN ELECTRICAL ROOM



IN BACK LEFT CORNER OF ELECTRICAL ROOM LARGE RED HANDLE - PULL DOWN

DC BATTERY DISCONNECT

REVERSE ORDER TO RESTART

This page intentionally left blank.

Appendix B-6
Checklist for AGM Quarterly Battery Inspection

This page intentionally left blank.

Checklist For Quarterly Inspection
 AGM Battery Rack, Inverter Load Center, and Ancillary Equipment
 Off-Grid Solar Powered SVE System
 Joint Base Pearl Harbor, Hickam, Hawaii

Item	Inspection Details	Observations	Recommendations (Describe If Any)
AGM Battery Rack Related Inspections			
AGM-1	Clean batteries as specified in the procedure if evidence of dust accumulation, mild corrosion		
AGM-2	Update Maintenance Records use current RE-2000 install sheet as a comparative baseline to track the following;		
	Individual cell voltages		
	Cell to cell connection resistance (ohms)		
	Terminal connection resistance (ohms)		
Equipment room ambient temperature			
AGM-3	Other Items Noted		
Balance of System Related Inspections			
BSI-1	Batteries including floor plate, proper operation of shields, and check rack is level in all directions		
BSI-2	Signage is in place and readable inside of control room and on the door		
BSI-3	Fan in control room operational and filter free of dust and debris		
BSI-4	Connections within the main DC Disconnect (De-energize)		
BSI-5	Charge controller and record settings		
BSI-6	Low voltage (DC) instrumentation and control wiring		
BSI-7	Operability of the PLC as related to the proper operation of the battery and inverter system		
BSI-8	AC power side in the Control Room		
BSI-9	Interior and connections within the combiner boxes (De-energize)		
BSI-10	System grounds		

Checklist For Quarterly Inspection
 AGM Battery Rack, Inverter Load Center, and Ancillary Equipment
 Off-Grid Solar Powered SVE System
 Joint Base Pearl Harbor, Hickam, Hawaii

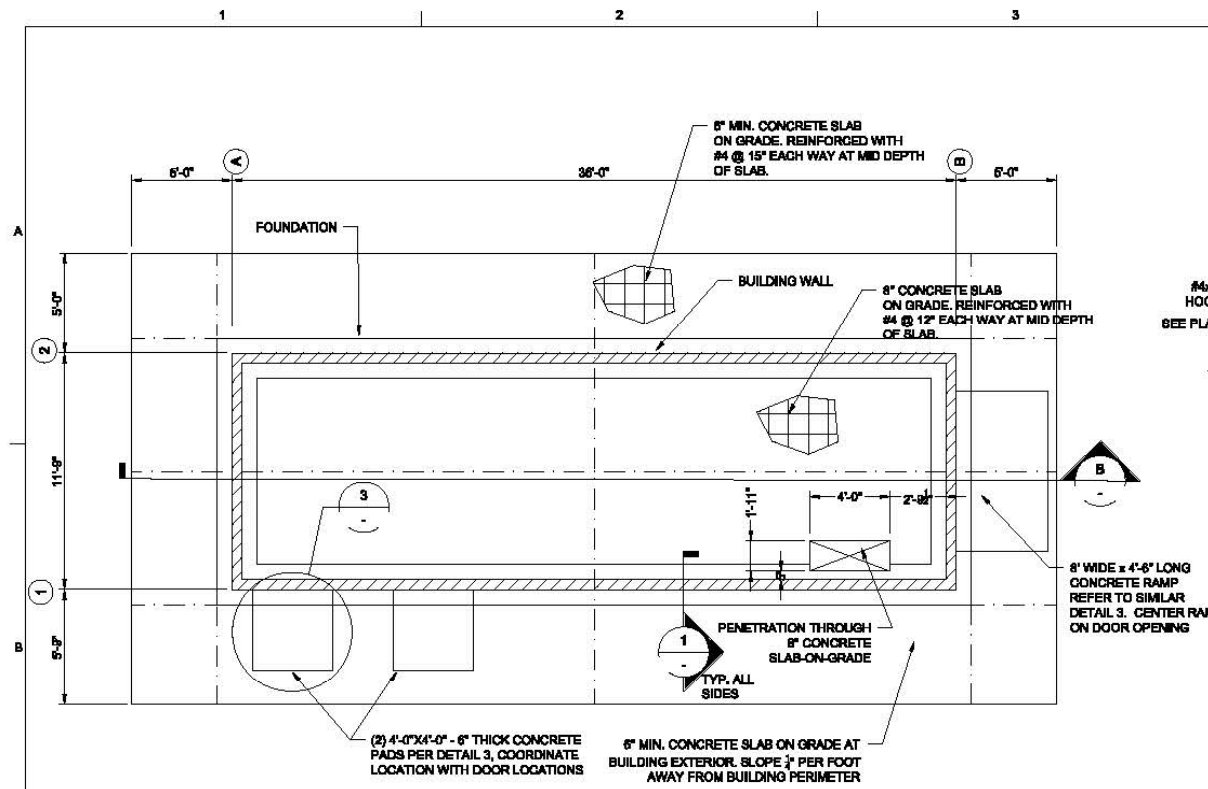
Item	Inspection Details	Observations	Recommendations (Describe If Any)
BSI-11	Mate 3 and download data to review proper operation		
BSI-12	Other Items Noted		
PV Array Related Equipment			
PV-1	Conduct general inspection under and around the PV Array		
PV-2	Check PV racking and associated bonding hardware for corrosion, damage, or deformation (repair or replace if observed)		
PV-3	Check visible portions of PV conductors to look for compromises in the wire insulation (nicks, cuts, etc.). Note: do not touch any exposed portion of wire		
PV-4	Inspect the top side of the PV panels to look for cracks, excessive debris, etc.		
PV-5	Inspect the bottom side off the PV panels to look for cracks or significant scratches in the white backing of the panels.		
PV-6	Observe for and remove any vegetation that could impede the operation of the PV Array		
Date	Time of Inspection (Local)	Personnel Present	Weather Conditions

List Attachments Associated with Checklist (including pictures)

- Completed Battery Maintenance Report (from PowerSafe Safety, Storage, Operating and Maintenance Manual for VRL Battery Systems mSeries, DDm, DDS, DDV, and SC, 2008 by EnerSys, page 28)
- Pictures
- Other support documentation

Appendix C Foundation Design Drawing

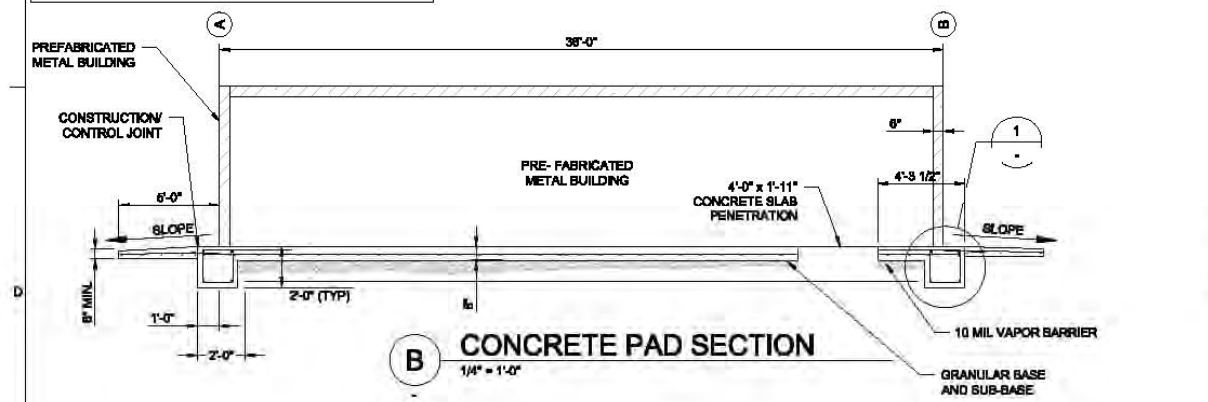
This page intentionally left blank.



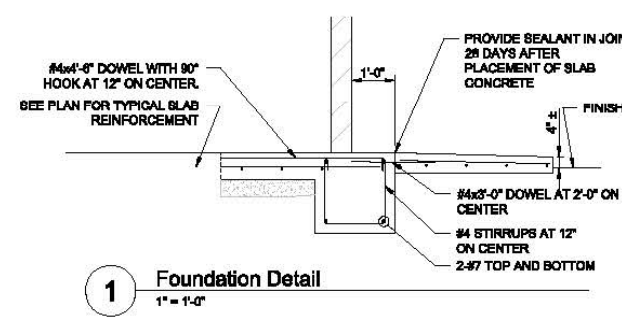
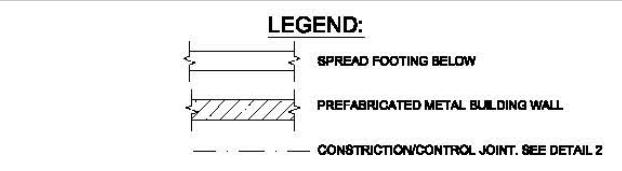
A CONCRETE PAD PLAN
1/4" = 1'-0"

PLAN NOTES:

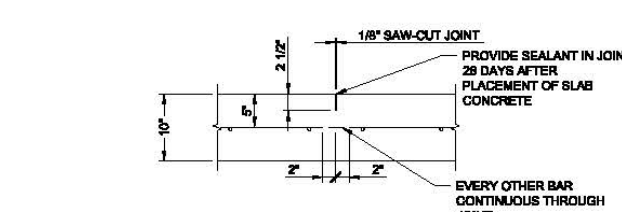
- 8" CONCRETE PAD AND PERIMETER FOOTINGS SHALL BE A MONOLITHIC CONCRETE PLACEMENT. THE EXTERIOR 8" MIN. SLAB ON GRADE MAY BE PLACED SEPARATELY.
- AT CONTRACTORS OPTION, THE SIDES OF THE 2x2 PERIMETER FOUNDATION MAY BE "LAID BACK" AND PLACED NEAT AGAINST THE SUBGRADE.



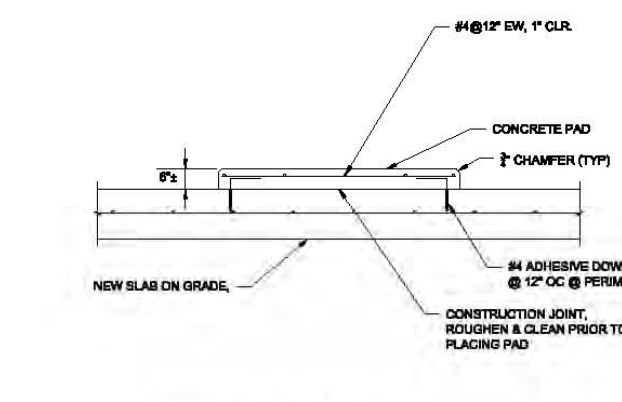
B CONCRETE PAD SECTION
1/4" = 1'-0"



1 Foundation Detail
1" = 1'-0"



2 CONSTRUCTION/CONTROL JOINT DETAIL
1" = 1'-0"



3 CONCRETE PAD DETAIL
3/4" = 1'-0"

GENERAL

- STRUCTURES ARE DESIGNED TO ACT AS A STRUCTURAL UNIT UPON COMPLETION. DESIGN AND PROVIDE NECESSARY BRACING, TEMPORARY SUPPORTS, AND SHORING TO RESIST FORCES, INCLUDING UPLIFT, ON THE STRUCTURE DURING CONSTRUCTION. WORK SHALL BE COORDINATED WITH THE VARIOUS TRADES TO AVOID CONFLICT OR INTERFERENCE WITH REINFORCING STEEL OR STRUCTURAL STEEL MEMBERS.

DESIGN CRITERIA

- APPLICABLE CODES AND SPECIFICATIONS:
ALL APPLICABLE LOCAL BUILDING CODES
I.B.C 2006 INTERNATIONAL BUILDING CODE WITH AMENDMENTS
A.C.I 318-08, BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE AND COMMENTARY
- DESIGN LOADS
DEAD LOAD: AS SPECIFIED BY BUILDING MANUFACTURER
LIVE LOAD:
ROOF LIVE LOAD: AS SPECIFIED BY BUILDING MANUFACTURER
GROUND FLOOR LIVE LOAD: 150 PSF
WIND LOAD: AS SPECIFIED BY BUILDING MANUFACTURER
SEISMIC LOAD: AS SPECIFIED BY BUILDING MANUFACTURER

CONCRETE

- ALL CAST IN PLACE CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF FC=4000 PSI
- STEEL REINFORCING BARS SHALL CONFORM TO A.S.T.M. A615, GRADE 60.
- CONCRETE DESIGN IS IN CONFORMANCE WITH A.C.I. 318-08 FOR BUILDINGS.
- DETAIL FABRICATE AND ERECT REINFORCEMENT BARS, INCLUDING BAR SUPPORTS, SPACERS, ETC. IN ACCORDANCE WITH THE LATEST EDITION OF A.C.I. 316
- CONCRETE COVER FOR REINFORCEMENT BARS SHALL CONFORM TO THE FOLLOWING, UNLESS INDICATED OTHERWISE ON THE DRAWINGS:
CAST AGAINST EARTH: 3 INCHES
EXPOSED TO WEATHER OR EARTH: 2 INCHES
- CONCRETE FINISHES:
EXTERIOR: LIGHT BROOM
INTERIOR: NON SLIP
- SEALANTS: 1 COMPONENT SELF LEVELING POLYURETHANE
BASIS OF DESIGN SHALL BE SIKAFLEX 1SL BY SIKA CORP.

FOUNDATIONS

- ALL FOOTINGS SHALL BEAR ON COMPETENT SOIL WITH A BEARING CAPACITY OF 2000 PSF OR GREATER.
- ALL FOOTINGS SHOULD BE EMBEDDED AT LEAST 24 INCHES BELOW THE LOWEST ADJACENT FINISH GRADE.
- LOCATE ALL EXISTING UNDERGROUND UTILITIES PRIOR TO BEGINNING ANY WORK. RELOCATE AND/OR PROVIDE ADEQUATE MEANS OF SUPPORT AND PROTECTION OF ALL UTILITIES AT ANY TIMES WHILE PERFORMING WORK.
- PERFORM ALL CLEARING, GRUBBING, AND STRIPPING WORK WITHIN THE LIMITS SHOWN.
- OVER-EXCAVATE AT LEAST 36 INCHES IN DEPTH AND 12 INCHES BEYOND FOOTING LINES AND GRADES AS SHOWN OR AS REQUIRED TO ACCOMPLISH THE CONSTRUCTION AND AS APPROVED BY THE ENGINEER. IF HARD INTACT CORAL IS ENCOUNTERED SHALLower THAN 36 INCHES, PROVIDE A MINIMUM OF 24-INCH OVER-EXCAVATION INTO THE CORAL.
- THE SUBGRADE BELOW THE FOOTINGS SHALL BE PROBED FOR POSSIBLE CAVITIES OR VOIDS TO A DEPTH OF AT LEAST 18 FEET. THE PROBES SHALL BE SPACED AT 18 FEET INTERVALS. IF CAVITIES OR VOIDS ARE FOUND, NOTIFY AND COORDINATE WITH THE ENGINEER ON TREATMENT METHOD. PROBING HOLES SHALL BE GROUTED WITH SAND-CEMENT-WATER MIXTURE.
- AS APPROVED BY THE ENGINEER, AFTER COMPLETION OF OVER-EXCAVATION AND PRIOR TO BACKFILLING, SCARIFY, THOROUGHLY MOISTURE CONDITIONED TO WITHIN 2 PERCENT OF OPTIMUM MOISTURE CONTENT AND COMPACT TO AT LEAST 95 PERCENT RELATIVE COMPACTION THE TOP 8 INCHES OF SUBGRADE. COMPACTION IS NOT REQUIRED IF THE BOTTOM OF OVER-EXCAVATION CONSISTS OF INTACT CORAL.
- PROOF-ROLL THE EXCAVATION SURFACE WITH A LOADED DUMP TRUCK OR SIMILAR HEAVY-WHEELED VEHICLE TO DETECT SOFT OR LOOSE ZONES. IF SOFT OR LOOSE ZONES ARE FOUND, EXCAVATE THE SOFT OR LOOSE MATERIAL TO A DEPTH ACCEPTED BY THE ENGINEER, THEN FILL WITH CLSM.
- REPLACE OVER-EXCAVATION WITH CLSM TO THE FOOTING LINES AND GRADES AS SHOWN.
- CLSM SHALL HAVE A 28-DAY UNCONFINED COMPRESSIVE STRENGTH OF AT LEAST 500 PSI.

CONCRETE SLAB-ON-GRADE

- LOCATE ALL EXISTING UNDERGROUND UTILITIES PRIOR TO BEGINNING ANY WORK. RELOCATE AND/OR PROVIDE ADEQUATE MEANS OF SUPPORT AND PROTECTION OF ALL UTILITIES AT ANY TIMES WHILE PERFORMING WORK.
- PERFORM ALL CLEARING, GRUBBING, AND STRIPPING WORK WITHIN THE LIMITS SHOWN.
- OVER-EXCAVATE AT LEAST 36 INCHES IN DEPTH AND 12 INCHES BEYOND SLAB LINES AND GRADES AS SHOWN OR AS REQUIRED TO ACCOMPLISH THE CONSTRUCTION AND AS APPROVED BY THE ENGINEER. IF HARD INTACT CORAL IS ENCOUNTERED SHALLower THAN 36 INCHES, PROVIDE A MINIMUM OF 24-INCH OVER-EXCAVATION INTO THE CORAL.
- THE SUBGRADE BELOW THE SLAB SHALL BE PROBED FOR POSSIBLE CAVITIES OR VOIDS TO A DEPTH OF AT LEAST 10 FEET. THE PROBES FREQUENCY SHALL BE AT LEAST ONE PROBE PER 10 SQUARE FEET OF SLAB AREA. IF CAVITIES OR VOIDS ARE FOUND, NOTIFY AND COORDINATE WITH THE ENGINEER ON TREATMENT METHOD. PROBING HOLES SHALL BE GROUTED WITH SAND-CEMENT-WATER MIXTURE.
- PLACE SPECIFIED EARTH FILL TO THE LINES AND GRADES SHOWN. PLACE FILL MATERIAL IN MAXIMUM 8 INCH LIFTS AND COMPACT EACH LIFT TO NOT LESS THAN 95 PERCENT RELATIVE COMPACTION IN ACCORDANCE WITH ASTM D1557.
- PROOF-ROLL THE EXCAVATION SURFACE WITH A LOADED DUMP TRUCK OR SIMILAR HEAVY-WHEELED VEHICLE TO DETECT SOFT OR LOOSE ZONES. IF SOFT OR LOOSE ZONES ARE FOUND, EXCAVATE THE SOFT OR LOOSE MATERIAL TO A DEPTH ACCEPTED BY THE ENGINEER, THEN FILL WITH CLSM.
- CLSM SHALL HAVE A 28-DAY UNCONFINED COMPRESSIVE STRENGTH OF AT LEAST 500 PSI.

400 EMBASSY ROW SUITE 600 6800 PEACOCK BLVD ATLANTA, GA 30328 PH: 770.864.8096		TSIP FOR SUBSITE ST32 ONIZUKA VILLAGE JOINT BASE PEARL HARBOR-HICKAM, HAWAII	
CH2MHILL		HICKAM AFB BLOWER HOUSE	
CONCRETE PAD PLAN		CONCRETE PAD PLAN	
NO.	DATE	DR	CHK
DESIGN		A. GILLUM	M. MERCEDE
REVISION		P. DESAULTELS	P. DESAULTELS
BY	APVD		
NONE			
VERIFY SCALE			
BAR IS ONE INCH ON ORIGINAL DRAWING			
DATE: JUNE 2014			
PROJ: 484321			
DWG: G-1001			
SHEET: 1 of 1			

This page intentionally left blank.

Appendix D

Performance and Pressure Monitoring Forms

This page intentionally left blank.

Appendix D-1 Performance Monitoring Log

This page intentionally left blank.

Performance Monitoring Log

KB06 Onizuka Village Treatability Study

Name: _____	Date: _____
Time: _____	Weather: _____

BATTERIES/INVERTERS		SVE SYSTEM (Circle The Operating Well Leg/s)	
Battery Pack SOC (%)		SVE-1	Vacuum (in Hg)
Battery Pack Voltage (V)			Flow (fpm)
Battery Room Temperature (F):		SVE-2	Vacuum (in Hg)
VFD Setting (%)			Flow (fpm)
Current (amps):		SVE-3	Vacuum (in Hg)
Power (kW):			Flow (fpm)
Charge Controller 1 Output (kW)		Effluent Pump Totalizer	(gallons)
Charge Controller 2 Output (kW)		Blower Flow Rate	(cfm)
Charge Controller 3 Output (kW)		Blower Effluent Temp	(F)
Charge Controller 4 Output (kW)		Blower Run Time	(Hours)
Charge Controller 5 Output (kW)			
Charge Controller 6 Output (kW)			

Performance Monitoring Log

KB06 Onizuka Village Treatability Study

VAPOR PHASE CARBON PID SAMPLING

Pre VGAC 1		VOCs/PPM
		LEL %
Mid Bed		VOCs/PPM
		LEL %
Post VGAC 2		VOCs/PPM
		LEL %
Breathing Zone:		VOCs/PPM
Discharge Stack Noise Level:		dBA

COMMENTS:

Appendix D-2 Pressure Monitoring Form

This page intentionally left blank.

KB06 Onizuka Village Treatability Study – Pressure Monitoring Form

Date: _____

Name: _____

	Location	Time	VMP/PMP Vacuum (inWC)	MultiRAE		GEM2000					Comments		
				VOCs (ppmv)	LEL (%)	With Carbon Filter? (Y/N)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	Balance (%)		LEL (% CH ₄)	
SVE-1 Well-Vac (inHg): Blower Speed (%):	SVE1-PMP1												
	SVE1-PMP2												
	VMP3-06A												
	SVE1-PMP5												
	SVE1-PMP6												
	SVE1-PMP7												
	SVE1-PMP3												
	SVE1-PMP8												
	VMP3-14												
	SVE1-PMP9												
	VMP3-02												
	SVE1-PMP10												
	SVE1-PMP4												

KB06 Onizuka Village Treatability Study – Pressure Monitoring Form

Date: _____

Name: _____

	Location	Time	VMP/PMP Vacuum (inWC)	MultiRAE		GEM2000					Comments	
				VOCs (ppmv)	LEL (%)	With Carbon Filter? (Y/N)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	Balance (%)		LEL (% CH ₄)
SVE-2	SVE2-PMP2											
Well-Vac (inHg):	SVE2-PMP1											
Blower Speed (%):	VMP2-11											
SVE-3	SVE3-PMP2											
Well-Vac (inHg):	VMP2-21											
Blower Speed (%):	SVE3-PMP3											
	VMP2-15											
	VMP2-08											
	SVE3-PMP1											

KB06 Onizuka Village Treatability Study – Pressure Monitoring Form

Date: _____

Name: _____

	Location	Time	VMP/PMP Vacuum (inWC)	MultiRAE		GEM2000					Comments	
				VOCs (ppmv)	LEL (%)	With Carbon Filter? (Y/N)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	Balance (%)		LEL (% CH ₄)
MWs	MW-01											
	MW-02											
	MW-04											
	SS01-MW15											
	Temp Well TW5											
	Temp Well TW6											
	Temp Well TW7											
	Temp Well TW8											
	Temp Well TW9											

- Proximal portion monitoring points
- Distal portion monitoring points

This page intentionally left blank.

Appendix E

CD of Supporting Information

This page intentionally left blank.

Appendix F

Health and Safety Supporting Information

This page intentionally left blank.

Appendix F-1 Safety Notification

This page intentionally left blank.

Safety Notification

Before conducting any operations and maintenance (O&M) activities, the attached Accident Prevention Plan (APP) and the associated Activity Hazard Analysis (AHAs) will be reviewed and understood. If there are any questions, if something is not clear, or if the work activity is not covered in the APP and AHA, **STOP WORK**, and notify John Culley, the KCH Program Health and Safety Manager (206-660-3367) to determine the appropriate action and needed resource to provide the necessary clarification and/or guidance. Note that the included AHA is not applicable to AGM battery system modification and replacement.

NOTE 1: O&M on the Absorbent Glass Mat (AGM) batteries and all electrical systems will only be conducted by a **QUALIFIED ELECTRICIAN** which is Coconut Coast Electric.

NOTE 2: Only a qualified electrician can **Lock Out Tag Out** Equipment.

Before the start of any work activity, review the **appropriate vendor-provided information** in the banker box at the site and/or from the Internet for the specific model installed. In particular, but not limited to the following:

- For work involving the AGM batteries, it is **REQUIRED** that information and all Safety Requirements be reviewed and understood in the following documents:
 - Outback Power “EnergyCell RE High Capacity Battery Installation Guide and Owner’s Manual”
 - EnerSys PowerSafe “Safety, Storage, Operating and Maintenance Manual”
- Before any work on the Rotary Blower, the following manual will be reviewed including all safety measures:
 - Assembly and Operating Manual, Rotary Blower, DB C vac, KAESER
- A complete listing of all manuals and equipment cut sheets is provide in Section 3.2.1 for the SVE System and Section 3.2.2 for the Off-Grid Photovoltaic System, if the information is not referenced in these sections please contact the appropriate vendor

IF UNSURE STOP WORK

This page intentionally left blank.

Appendix F-2 O&M Activity Hazard Analysis

This page intentionally left blank.

Activity Hazard Analysis (AHA)

SVE System and PV Array Operation and Maintenance

ACTIVITY/WORK TASK:	Soil Vapor Extraction (SVE) System and Photovoltaic (PV) Array Operation and Maintenance	Overall Risk Assessment Code (RAC) (Use highest code)				M	
	SIGNATURES	Activity #		AHA #			
PWD/OICC/ROICC OFFICE		Risk Assessment Code (RAC) Matrix					
NAME & DATE ACCEPTED BY GDA:		Severity	Probability				
CONTRACT NUMBER:	N62473-09-D-2622		Frequent	Likely	Occasional	Seldom	Unlikely
TASK ORDER/DELIVERY #:	CTO KB06						
PRIME CONTRACTOR:	KCH						
SUBCONTRACTOR:	n/a						
NAME AND DATE OF REVIEWER:			Catastrophic	E	E	H	H
DATE OF INITIAL INSPECTION:		Critical	E	H	H	M	L
CONTRACTOR COMPETENT PERSON:	Ryan Ketza/HNL (not applicable to electrical work, only can be a licensed electrician)	Marginal	H	M	M	L	L
SITE SAFETY and HEALTH OFFICER	Ryan Ketza/HNL	Negligible	M	L	L	L	L
ACCEPTANCE BY GOVERNMENT DESIGNATED AUTHORITY (GDA)		Review each "Hazard" with identified safety "Controls" and determine (RAC)					
E = EXTREMELY HIGH (PWO/OICC/ROICC)		Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard". Place the highest RAC at the top of AHA. This is the overall risk assessment code for this activity					
H = HIGH RISK (FEAD DIRECTOR)		"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible after controls are in place					
M = MODERATE RISK (CM or ET or PAR)							
L = LOW RISK (ET or PAR)							
		"Probability" is the likelihood to cause an incident, near miss, or accident did occur and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely after controls are put in place.					
Job Steps	Hazards	Controls				RAC	
General site safety	Electrocution	<ul style="list-style-type: none"> Only licensed/qualified electricians are authorized to work on energized systems including opening panels, removing panel covers, voltage measurements, and Lock Out-Tag Out. Heed all posted signage identifying locations of electrical systems and do not work in these areas. Assume all electrical equipment and wires are energized until verified otherwise by testing. Know the location of all E-Stops and Disconnects 				L	

IAW EM 385 01.A.13 Contractor-Required AHA "Work will not begin until the AHA for the work activity has been accepted by the GDA"

The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)

SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
	Hand Tools and Hand Injury	<ul style="list-style-type: none"> Inspect before use and confirm hand tools are in good condition and sufficient for the work. Use hand tools only for their intended purpose. Where protective work gloves when using hand tools that allow for sufficient manual dexterity for the work. Beware of hand placement, protect your hand in the event the tool slips. 	L
	Hand injury	<ul style="list-style-type: none"> Refer to hand tools section. Avoid pinch points. Confirm there is no stored mechanical energy that can be released. 	L
	Eye injury	<ul style="list-style-type: none"> Wear protective eyewear that meets American National Standards Institute (ANSI) Z-87 at all times 	L
	Head injury	<ul style="list-style-type: none"> Wear ANSI-approved hardhats at all times when overhead hazards are present, in the manner they are designed (for example, brim forward, no modifications, and no ball caps underneath). 	L
	Injuries from slips/trips/falls	<ul style="list-style-type: none"> Keep walking path around SVE Building and PV Array clear, if possible. Ensure floor in SVE Building is free of debris and dirt. Avoid wet or slippery areas. Maintain good housekeeping by consolidating supplies out of walkways and immediate work areas. Keep extension cords bundled as much as possible. Identify any immovable obstructions to field team for awareness by communicating potential hazard and flagging obstructions. Avoid area if possible. Work at a steady pace, do not run and hurry. 	L
Changing oil at blower motor	Hand injury	<ul style="list-style-type: none"> Allow time for the blower oil to cool before changing. Use properly sized socket and wrench to loosen and tighten nuts. Wear protective gloves. Switch off the power supply disconnecting device and verify that it is locked in the OFF position. 	L
	Contact with oil	<ul style="list-style-type: none"> Read and understand the applicable procedures in the Kaeser Assembly and Operating Manual for the Rotary Blower which is maintained in the SVE Building. Wear long-sleeved clothing, protective gloves, and eye protection. 	L
	Oil release	<ul style="list-style-type: none"> Contain used oil immediately from the drain valve. Collect and properly dispose of waste oil and containers. 	L

IAW EM 385 01.A.13 Contractor-Required AHA “Work will not begin until the AHA for the work activity has been accepted by the GDA”

The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)

SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
Absorbent Glass Mat (AGM) Battery Rack	Hand tools	<ul style="list-style-type: none"> • Use only an electrician that has experience specific to AGM batteries. • Before O&M on or around the AGM Batteries, refer to the <i>Outback PowerSafe DDm Installation Manual for Modular Battery Systems (Publication No. US-DDm-IM-003 November 2003 as well as the EnerSys Safety, Storage, Operating, and Maintenance Manual (Publication No. US-VR-OM-002 March 2008)</i>, both of which are maintained in the SVE Building. • DO NOT REMOVE plastic protective shields over the battery terminals and connections on the battery rack. 	L
Operating Electrical Power Tools with use of extension cords	Electric Shock/Electrocution	<ul style="list-style-type: none"> • Purchase and use power tools that have been approved by a national testing laboratory, such as Underwriter’s Laboratories (UL) or equivalent and equipped with either a 3-prong plug or classified as “Double-Insulated” • Visually inspect each power tool used before each day’s usage. Check for cuts, exposed wiring, damaged plugs, missing ground pins, and cracked housing. If damaged, the power tool must be tagged with a “Damaged or Defective Equipment – DO NOT USE” tag or equivalent and removed from service immediately. • Purchase extension cords that have been approved by a national testing laboratory, such as UL or equivalent. Do not use “homemade” extension cords. • Visually inspect extension cords before each day’s usage. Check for cuts, exposed wiring, damaged plugs, and missing ground pins. If damaged, extension cords must be removed from service immediately. • Periodically conduct testing of extension cord’s grounding, resistance or conductivity per applicable regulations. • Protect employees by using ground fault circuit interrupter or electronic load detector on extension cords, at wall sockets, or integrated in the electrical system. • Avoid fastening extension cords using staples, nails or with wire. • Extension cords are not intended for permanent use, only temporary. 	M
Changing air filter at blower	Hand injury	<ul style="list-style-type: none"> • Read and understand the applicable procedures in the Kaeser Assembly and Operating Manual for the Rotary Blower which is maintained in the SVE Building. • Wear protective gloves. 	

IAW EM 385 01.A.13 Contractor-Required AHA “Work will not begin until the AHA for the work activity has been accepted by the GDA”

The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)

SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
		<ul style="list-style-type: none"> • Switch off the power supply disconnecting device and verify that it is locked in the OFF position. • Properly dispose of dust filter as municipal solid waste. • Refer to “Hand Tools” section. • Use hand tools designed for the intended purpose to remove the access plate and attach the steel plate for connection to the vacuum hose • Watch out for any sharp edges on covers • Provide ladder access, as needed for air filter above granular activated carbon (GAC) vessels, including a second person to steady any ladder, stool, or platform. 	L
Change Fluorescent Light Bulbs	Hand Injury and Falls	<ul style="list-style-type: none"> • Use hand tools designed for the intended purpose • Watch out for any sharp edges on covers • Ladder access is required, including a second person to steady any ladder, stool, or platform. • Have the second person assist with providing the new light bulbs and handling the spent bulbs • Properly package the bulbs for handling and disposal 	M
	Ladder hazards	<ul style="list-style-type: none"> • Use correct ladder safety procedures (maintain three-point contact while on ladder, do not stand on or near top step, and do not overextend your reach). • Use a tool belt or bucket attached to a hand line to raise and lower tools and equipment. • Ensure ladder is set on level surface. • Do not stand on unopened A-frame ladder. • Do not use the ladder if damaged. • Tie-off the ladder. • If using an extension ladder to gain access to a working surface, the ladder must extend 3 feet beyond the working surface • Perform a ladder inspection: <ol style="list-style-type: none"> 1. Ladder locks are fully functional 2. Ladder feet should be of the non-skid variety and in satisfactory condition (never loose or worn) 3. Rungs are not damaged 4. Vertical rails are intact 5. Inspect entire ladder for flaws, cracks, distortion, dents, bad pulleys, and loose rivets and fasteners. 	M

IAW EM 385 01.A.13 Contractor-Required AHA “Work will not begin until the AHA for the work activity has been accepted by the GDA”

The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)

SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
Cleaning of photovoltaic panels	Slips, trips, falls	<ul style="list-style-type: none"> • If using a step-stool, platform, or ladder ensure three points of contact at all times. If using a ladder do not overreach and insure it is firmly anchored. • A second person will be present at all times when doing work at elevation to steady the stool, ladder, and platform • Use a long-handled soft brush or squeegee to reach panel glass in the central portion of the array • Situational awareness; observe ground level and avoid sloped areas as much as possible • Maintain good housekeeping 	L
	Cracking panel glass	<ul style="list-style-type: none"> • Do not apply cold water onto hot glass. • Where possible, apply water in the early morning or late afternoon. • Situational awareness, use caution. • Do not use high pressure water application (standard garden hose-type pressure is sufficient). • Use car wash soap for cleaning of the PV array, avoid getting in the eye's by using goggles. • Ensure use of a hose to rinse the PV arrays doesn't get hung up on the stool, ladder, or platform. 	L
Application of standard off-the-shelf weed killer	Contact with chemical	<ul style="list-style-type: none"> • Maintain product Safety Data Sheets onsite and follow product instructions at all times. • Keep flow rate very low to avoid excessive application or overspray. • Wear nitrile gloves for hand protection and safety glasses for eye protection. 	L
Collecting pressure readings at Vapor Monitoring Points and Pressure Monitoring Points inside Onizuka Village	Hand and eye injury	<ul style="list-style-type: none"> • Be aware of potential pinch points. • Wear gloves that provide physical hand protection. • Use properly sized socket and wrench to loosen and tighten nuts on well covers. • Wear ANSI-rated eye protection. 	L
And SVE Vault Access	Biological hazards consisting of ant colonies, centipedes, etc.	<ul style="list-style-type: none"> • Once a well cover is opened, visually inspect inside of well vault before reaching gloved hand in to pull out the downhole monitoring tubing. 	L
	Slips, trips, falls when walking around inside Onizuka Village	<ul style="list-style-type: none"> • Situational awareness; observe ground level and avoid sloped areas and muddy spots as much as possible when walking. • Maintain good housekeeping. 	L

IAW EM 385 01.A.13 Contractor-Required AHA “Work will not begin until the AHA for the work activity has been accepted by the GDA”

The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)

SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
Off-gas monitoring/sampling, and condensate sampling inside SVE building	Hand and eye injury	<ul style="list-style-type: none"> • Be aware of potential pinch points. • Wear gloves that provide physical hand protection. • Use properly sized socket and wrench to loosen and tighten nuts on well covers. • Wear ANSI-rated eye protection. 	L
	Exposure to liquid or vapor	<ul style="list-style-type: none"> • Do not open sampling valves until proper fittings have been attached so that liquids or vapor cannot escape the SVE system. • Wear nitrile gloves. • Perform air monitoring and wear appropriate personal protective equipment (PPE) according to the Accident Prevention Plan and Site Safety Health Plan 	M
	Muscle strain	<ul style="list-style-type: none"> • Do not lift heavy sample coolers by yourself; split loads and/or get help. • Observe a path before carrying something and clear path if needed and is possible. 	L
Oversight of GAC change-out	Improper subcontractor training	<ul style="list-style-type: none"> • Ensure that subcontractor has valid forklift training credentials before operating a forklift. • Inspect all heavy equipment and trucks for leaks and ensure in a good condition • Ensure all spent and fresh activated GAC is stored on pallets in good condition in water-proof supersacks. • Ensure Material Safety Data Sheet for GAC is onsite and understood by the site personnel. • Use proper hand tools and access as applicable to the work for the hand removal of the GAC vessel covers. • Monitor subcontractor and verify they are following their own AHAs for their changeout procedures. • Ensure Subcontractor has present at the site the instruction for the Hurricane (or equivalent) vacuum system including provisions for fueling (units are diesel operated). • Provide monitoring equipment for the vapor space above the GAC. • Ensure Subcontractor has required respirator training. 	L

IAW EM 385 01.A.13 Contractor-Required AHA “Work will not begin until the AHA for the work activity has been accepted by the GDA”

The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)

SVE System and PV Array Operation and Maintenance

Equipment to be Used	Training Requirements and Competent or Qualified Personnel name(s)	Inspection Requirements
	<ul style="list-style-type: none"> • 40-hour/8-hour Hazardous Waste Operations and Emergency Response • Electrical Safety Awareness • Hand tools 	
PPE	<ul style="list-style-type: none"> • General PPE usage 	<ul style="list-style-type: none"> • Inspect before use; replace if deficient • Ensure appropriate for the intended use

IAW EM 385 01.A.13 Contractor-Required AHA “Work will not begin until the AHA for the work activity has been accepted by the GDA”
The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)

SVE System and PV Array Operation and Maintenance

Instructions for completing Contractor Activity Hazard Analysis

1. **Activity/Work Task** – Insert work/task this AHA is written for; such as, excavation, scaffold building, foundation preparation.
2. **PWO/OICC/ROICC** – Insert name of Public Works Office, Officer In Charge of Construction Office or Resident Officer in Charge of Construction (PWO/OICC/ROICC)
3. **Enter name and date AHA accepted by Government Designated Authority (GDA)**
4. **Enter contract number**
5. **Enter Task order or Delivery order number**
6. **Enter Prime Contractors name**
7. **Enter Subcontractors name**
8. **Enter date preparatory meeting was held**
9. **Enter date initial inspection was performed**
10. **Enter name of contractor competent person on site for this activity**
11. **Enter name of Prime Contractor Site Safety and Health Officer**
12. **Level of government person responsible for accepting the AHA, progressive signatures as level of risk increases.**
13. **Overall Risk Assessment code is highest code assigned to any job step after hazards are assessed and controls have been assigned**
14. **Schedule number is activity number from production daily reports**
15. **AHA number is the sequential number of all AHA's for this contract.**
16. **Job steps is the complete sequence of work, not general statements to complete the entire activity**
17. **Hazards is the known safety risks associated with completing the task**
18. **Controls is the safety measures in place to reduce the hazard to the lowest level possible**
19. **Risk Assessment code is where Severity and Probability intersect, place that letter E, H, M, or L in the RAC column**
20. **List all equipment to be used to complete this activity; that is, crane, backhoe, vehicle, and all heavy equipment**
21. **List the training requirements required by Engineering Manual (EM) 385, Safety Spec 01356 or Occupational Safety and Health Administration (OSHA) that apply to this task.**
List competent person(s) required for specific tasks in EM 385.
List qualified person(s) required for specific tasks in EM 385.
List CPR/First Aid training and qualification dates.
22. **List all inspection requirements of EM 385, Governmental Safety Requirements Specifications, or OSHA 29 Code of Federal Regulations 1926.**

IAW EM 385 01.A.13 Contractor-Required AHA “Work will not begin until the AHA for the work activity has been accepted by the GDA”.

The AHA shall be reviewed and modified, as necessary, to address changing site condition, operations, or change of competent and qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM batteries or any other construction-related work.

Appendix F-3

GAC and Blower Oil Material Safety Data Sheets

This page intentionally left blank.

EcoSorb C Series - Activated Carbon

SAFETY DATA SHEET

(REACH regulation (EC) n° 1907/2006 - n° 453/2010)

SECTION 1 : IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

Product name : EcoSorb C Series
Product code : Activated Carbon.

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use as an adsorbent in industrial, professional and consumer setting.

Use descriptor system (REACH) :

SU3 : PROC 1, 2, 3, 4, 5, 8a, 8b, 9, 14, 15, 22

SU22 : PROC 1, 2, 3, 4, 5, 8a, 8b, 9, 15

SU21 : PC 2, 3, 29, 35, 37, 39

The annexed exposure scenarios provide a complete listing per sector.

1.3. Details of the supplier of the safety data sheet

Registered company name : Jacobi Carbons GmbH.
Address : Lurgiallee 6-8.D-60439 .Frankfurt am Main.Germany.
Telephone : +49 69 719 107 0. Fax : +49 69 710 330 03.
msds@jacobi.net
www.jacobi.net

1.4. Emergency telephone number : +49 69 719 107 0.

Association/Organisation : Jacobi Carbons GmbH.

SECTION 2 : HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

In compliance with EC regulation No. 1272/2008 and its amendments.

This substance does not present a physical hazard. Refer to the recommendations regarding the other products present on the site.

This substance does not present a health hazard with the exception of possible occupational exposure thresholds (see paragraphs 3 and 8).

This substance does not present an environmental hazard. No known or foreseeable environmental damage under standard conditions of use.

In compliance with directives 67/548/EEC, 1999/45/EC and their amendments.

This substance does not present a physical hazard. Refer to the recommendations regarding the other products present on the site.

This substance does not present a health hazard with the exception of possible occupational exposure thresholds (see paragraphs 3 and 8).

This substance does not present an environmental hazard. No known or foreseeable environmental damage under standard conditions of use.

2.2. Label elements

In compliance with EC regulation No. 1272/2008 and its amendments.

No labelling requirements for this substance.

EcoSorb C Series - Activated Carbon

2.3. Other hazards

May cause CO and CO₂ emanations in the event of a fire.

According to the ECHA Guidance on chemical safety assessment, Chapter R11, section R11.1.2.1: "The PBT and vPvB criteria of Annex XIII to the Regulation do not apply to inorganic substances". As Activated Carbon - HDS type is to be considered as an inorganic substance, the PBT assessment is not applicable.

Wet Activated Carbon depletes oxygen from air and, therefore, dangerously low levels of oxygen may be encountered. Whenever workers enter a vessel containing activated carbon, the oxygen content should be determined and work procedures for potentially low oxygen areas should be followed.

SECTION 3 : COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substances

Composition :

Identification	(EC) 1272/2008	67/548/EEC	Note	%
CAS: 7440-44-0 EC: 931-328-0 REACH: 01-2119488894-16-0013 ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS)			[1]	100%

Information on ingredients :

A porous, amorphous, high surface area adsorbent material composed largely of elemental carbon.

[1] Substance for which maximum workplace exposure limits are available.

SECTION 4 : FIRST AID MEASURES

As a general rule, in case of doubt or if symptoms persist, always call a doctor.
NEVER induce swallowing by an unconscious person.

4.1. Description of first aid measures

In the event of exposure by inhalation :

Fresh air, rest.

Obtain medical attention if cough or respiratory symptoms develop.

In the event of splashes or contact with eyes :

Wash thoroughly with soft, clean water for 15 minutes holding the eyelids open.

If there is any redness, pain or visual impairment, consult an ophthalmologist.

In the event of splashes or contact with skin :

Rinse with water and soap.

Remove contaminated clothes.

Obtain medical attention if irritation becomes apparent.

In the event of swallowing :

Give at least 1/2 L of water to drink.

Obtain medical attention if gastrointestinal symptoms develop.

Do not induce vomiting.

4.2. Most important symptoms and effects, both acute and delayed

When large amounts are ingested orally, congestion may occur.

4.3. Indication of any immediate medical attention and special treatment needed

Specific and immediate treatment :

N/A

EcoSorb C Series - Activated Carbon

Information for the doctor :

Medications efficiency can be reduced by the adsorbing power of the activated carbon.

SECTION 5 : FIREFIGHTING MEASURES

Non-flammable.

5.1. Extinguishing media

Suitable methods of extinction

In the event of a fire, use :

- foam
- sprayed water or water mist
- powder
- carbon dioxide (CO₂)

Unsuitable methods of extinction

In the event of a fire, do not use :

- water
- water jet

in the closed areas, in order to avoid the water contamination.

5.2. Special hazards arising from the substance or mixture

A fire will often produce a thick black smoke. Exposure to decomposition products may be hazardous to health. Do not breathe in smoke.

In the event of a fire, the following may be formed :

- carbon monoxide (CO)
- carbon dioxide (CO₂)
- other decomposition products for the saturated activated carbon.

After a fire, smoldering hotspots within the activated carbon may be present for a long time.

Activated Carbon which has been allowed to smolder for a long time in a confined space may accumulate carbon monoxide above its lower explosion limit.

5.3. Advice for firefighters

Due to the toxicity of the gas emitted on thermal decomposition of the products, fire-fighting personnel are to be equipped with autonomous insulating breathing apparatus.

SECTION 6 : ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Consult the safety measures listed under headings 7 and 8.

For first aid worker

First aid workers will be equipped with suitable personal protective equipment (See section 8).

6.2. Environmental precautions

Prevent any material from entering drains or waterways.

6.3. Methods and material for containment and cleaning up

Retrieve the product by mechanical means (sweeping/vacuuming).

6.4. Reference to other sections

See also sections 2 & 8

EcoSorb C Series - Activated Carbon

SECTION 7 : HANDLING AND STORAGE

Requirements relating to storage premises apply to all facilities where the substance is handled.

7.1. Precautions for safe handling

Prevent dust generation. Apply good working practices and engineering procedures during discharge.
See the exposure controls and personal protection measures in the section 8.

Fire prevention :

Prevent access by unauthorised personnel.

Recommended equipment and procedures :

For personal protection, see section 8.
Observe precautions stated on label and also industrial safety regulations.
Ensure containment and adequate ventilation.

Whenever workers enter a vessel containing activated carbon, the oxygen content should be determined and work procedures for potentially low oxygen areas should be followed.

Prohibited equipment and procedures :

No smoking, eating or drinking in areas where the substance is used.

7.2. Conditions for safe storage, including any incompatibilities

Keep away from any chemical (solvents and strong oxidisers).
Keep away from heat sources.
Store in a well-ventilated area.

Storage

Store and keep away from any chemical (solvents and strong oxidisers).
Storage of wet activated carbon in a closed area can deplete oxygen from air.

Packaging

Store in the closed, original packaging.

7.3. Specific end use(s)

No data available.

SECTION 8 : EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Occupational exposure limits :

Non otherwise classified dusts : 10 mg/m³

- UK / WEL (Workplace exposure limits, EH40/2005, 2007) :

CAS	TWA :	STEL :	Ceiling :	Definition :	Criteria :
7440-44-0	4 mg/m ³	-	-	-	R

Biological limits :

/

Derived no effect level (DNEL) or derived minimum effect level (DMEL):

Final use:

Exposure method:
Potential health effects:
DNEL :

Workers.

Inhalation.
Short term local effects.
3 mg of substance/m³

Exposure method:
Potential health effects:

Inhalation.
Long term systemic effects.

EcoSorb C Series - Activated Carbon

DNEL :	3 mg of substance/m ³
Final use:	Consumers.
Exposure method:	Inhalation.
Potential health effects:	Short term local effects.
DNEL :	0.5 mg of substance/m ³
Exposure method:	Inhalation.
Potential health effects:	Long term systemic effects.
DNEL :	0.5 mg of substance/m ³

8.2. Exposure controls

Suitable technical inspections

Local exhaust ventilation is recommended.

For the use of Granular Activated Carbon, no risk management measures are mandatory, but only recommended.

Personal protection measures, such as personal protective equipment

Use personal protective equipment that is clean and has been properly maintained.

Store personal protective equipment in a clean place, away from the work area.

Never eat, drink or smoke during use. Remove and wash contaminated clothing before re-using. Ensure that there is adequate ventilation, especially in confined areas.

- Eye / face protection

Avoid contact with eyes.

Before handling powders or dust emission, wear mask goggles in accordance with standard EN166.

- Hand protection

Wear suitable protective gloves in the event of prolonged or repeated skin contact.

- Body protection

Work clothing worn by personnel shall be laundered regularly.

- Respiratory protection

Avoid breathing dust.

Type of FFP mask :

Wear a disposable half-mask dust filter in accordance with standard EN149.

Category :

- FFP2

Particle filter according to standard EN143 :

- P (White)

Exposure controls linked to environmental protection

Local exhaust ventilation to remove material at source.

Contained storage.

Regulated waste disposal.

SECTION 9 : PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

General information :

Physical state :	Solid in granules.
Odour:	None
Color:	Black



EcoSorb C Series - Activated Carbon

Important health, safety and environmental information

pH :	Not relevant.
pH (aqueous solution) :	7-11
Boiling point/boiling range :	Not specified.
Flash point interval :	Not relevant.
Explosive properties, lower explosivity limit (%) :	NA
Explosive properties, upper explosivity limit (%) :	NA
Vapour pressure (50°C) :	Not relevant.
Vapour density :	NA
Density :	200-700 kg/m3
Miscibility :	NA
Water solubility :	Insoluble. 0
	Method for determining the water solubility : OCDE Guideline 105 (Water solubility).
Partition coefficient: n-octanol/water :	NA
Viscosity :	NA
Evaporation rate :	NA
Melting point/melting range :	Not specified.
Self-ignition temperature :	Not specified.
Decomposition point/decomposition range :	Not specified.

9.2. Other information

Physical and chemical properties of the saturated activated carbon may be different from the virgin material.

SECTION 10 : STABILITY AND REACTIVITY

10.1. Reactivity

This product shows no reactivity under the specified conditions of storage, shipment and use.

10.2. Chemical stability

This substance is stable under the recommended handling and storage conditions in section 7.

10.3. Possibility of hazardous reactions

In contact with solvents and strong oxidisers.

10.4. Conditions to avoid

Avoid :

- formation of dusts
- heating
- heat
- humidity

Dusts can form an explosive mixture with air.

10.5. Incompatible materials

Keep away from :

- combustible material
- strong oxidising agents
- strong acids
- solvents

10.6. Hazardous decomposition products

The thermal decomposition may release/form :

- carbon monoxide (CO)
- carbon dioxide (CO2)

EcoSorb C Series - Activated Carbon

SECTION 11 : TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

11.1.1. Substances

Based on the physical and chemical properties of activated carbons, the absence of effects on toxicological studies and the therapeutic use of activated carbons as adsorbing agents for the treatment of acute poisoning and acute diarrhoea, it can be expected that Activated Carbon is not absorbed via the oral, dermal and inhalation routes.

Acute toxicity :

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)
Oral route : LD50 > 2000 mg/kg
Species : Rat
OECD Guideline 423 (Acute Oral toxicity/Acute Toxic Class Method)

Inhalation route : LC50 > 64.4 mg/l
Species : Rat
OECD Guideline 403 (Acute Inhalation Toxicity)

Skin corrosion/skin irritation :

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)
Corrosivity : No observed effect.
Species : Rabbit
OECD Guideline 404 (Acute Dermal Irritation / Corrosion)

Serious damage to eyes/eye irritation :

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)
Corneal haze : Average score = 0.00
Species : Rabbit
Duration of exposure : 72 h
OECD Guideline 405 (Acute Eye Irritation / Corrosion)

Iritis : Average score = 0.00
Species : Rabbit
Duration of exposure : 72 h
OECD Guideline 405 (Acute Eye Irritation / Corrosion)

Conjunctival redness : Average score = 0.67
Species : Rabbit
Duration of exposure : 72 h
OECD Guideline 405 (Acute Eye Irritation / Corrosion)

Conjunctival oedema : Average score = 0.33
Species : Rabbit
Duration of exposure : 72 h
OECD Guideline 405 (Acute Eye Irritation / Corrosion)

Respiratory or skin sensitisation :

- Inhalation No information available
- Skin Not sensitising.

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)
Local lymph node stimulation test : Non-Sensitiser.
Species : Mouse

EcoSorb C Series - Activated Carbon

OECD Guideline 429 (Skin Sensitisation: Local Lymph Node Assay)

Germ cell mutagenicity :

All the key studies indicate that the substance does not show any genotoxic potential. Therefore, it can be concluded that the substance is not mutagenic and does not need to be classified for mutagenicity according to the criteria outlined in Annex I of 1272/2008/EC (CLP / EU GHS) and Annex VI of 67/548/EEC (DSD/DPD).

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)

Mutagenesis (in vitro) :

Negative.

Species : Bacteria

OECD Guideline 471 (Bacterial Reverse Mutation Assay)

Ames test (in vitro) :

Negative.

With or without metabolic activation.

Species : S. typhimurium TA1535

Carcinogenicity :

No data available

Reproductive toxicant :

No data available

Specific target organ systemic toxicity - single exposure :

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)

Oral route :

C > 2000 mg/kg bodyweight

Species : Rat

SECTION 12 : ECOLOGICAL INFORMATION

12.1. Toxicity

12.1.1. Substances

As Activated Carbon is insoluble in water, no toxicity is expected.

12.2. Persistence and degradability

Activated Carbon - HDS type is a refractory material and not amenable to break down by any natural chemical or enzymatic processes.

AC - HDS cannot be rendered into a soluble form capable of being absorbed.

Therefore it cannot find its way to any cell site where it could be conceivably be biodegraded.

12.3. Bioaccumulative potential

The substance has a very low potential to bioaccumulate in aquatic species (e.g. fish), i.e. a BCF < 10.

The substance has no log Kow, the substance size will impede passing membranes (particles with size > 0.5µm) and is not soluble in water. The bioaccumulation study is thus infeasible.

12.4. Mobility in soil

No data available, as the substance is insoluble.

12.5. Results of PBT and vPvB assessment

According to the ECHA Guidance on chemical safety assessment, Chapter R11, section R11.1.2.1: "The PBT and vPvB criteria of Annex XIII to the Regulation do not apply to inorganic substances". As Activated Carbon - HDS type is to be considered as an inorganic substance, the PBT assessment is not applicable.

12.6. Other adverse effects

No data available.

EcoSorb C Series - Activated Carbon

SECTION 13 : DISPOSAL CONSIDERATIONS

Proper waste management of the substance and/or its container must be determined in accordance with Directive 2008/98/EC.

13.1. Waste treatment methods

Do not pour into drains or waterways.

Waste :

Waste management is carried out without endangering human health, without harming the environment and, in particular without risk to water, air, soil, plants or animals.

Recycle or dispose of waste in compliance with current legislation, preferably via a certified collector or company.

Do not contaminate the ground or water with waste, do not dispose of waste into the environment.

Soiled packaging :

Empty container completely. Keep label(s) on container.

Give to a certified disposal contractor.

Codes of wastes (Decision 2001/573/EC, Directive 2006/12/EEC, Directive 94/31/EEC on hazardous waste) :

- Exhausted Activated Carbon from Water Treatment: 19 09 04
- Exhausted Activated Carbon from flue gas treatment : 19 01 10*
- Exhausted Activated Carbon from Mineral Chemistry wastes : 06 07 02* - AC used for the chlorine production / 06 13 02* - saturated AC (except section 06 07 02*).
- Other applications: see the regulations of wates nomenclatures.

SECTION 14 : TRANSPORT INFORMATION

Transport product in compliance with provisions of the ADR for road, RID for rail, IMDG for sea and ICAO/IATA for air transport (ADR 2011 - IMDG 2010 - ICAO/IATA 2012).

14.0. Classification and special disposures:

ADR/RID: special disposure 646 (physically activated carbon)

IMDG: special disposure 925 (physically activated carbon)

IATA: special disposure A3

- Transport classification, by taking into account the special disposures:

ADR/RID: not dangerous

IMDG: not dangerous

IATA: not dangerous (if, when tested, doesn't meet the defined criteria).

- Details for classification:

See details below

14.1. UN number

1362

14.2. UN proper shipping name

UN1362=CARBON, ACTIVATED

14.3. Transport hazard class(es)

- Classification :

4.2

14.4. Packing group

III

14.5. Environmental hazards

-

14.6. Special precautions for user

ADR/RID	Class	Code	Pack gr.	Label	Ident.	LQ	Provis.	EQ	Cat.	Tunnel
	4.2	S2	III	4.2	40	0	646	E1	4	E

EcoSorb C Series - Activated Carbon

IMDG	Class	2°Label	Pack gr.	LQ	EMS	Provis.	EQ		
	4.2	-	III	0	F-A,S-J	223 925	E1		
IATA	Class	2°Label	Pack gr.	Passager	Passager	Cargo	Cargo	note	EQ
	4.2	-	III	472	0.5 kg	472	0.5 kg	A3	E1
	4.2	-	III	Forbidden	Forbidden	-	-	A3	E1

14.7. Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

No data available.

SECTION 15 : REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

- Particular provisions :

No data available.

15.2. Chemical safety assessment

A chemical safety assessment according to the rules stipulated in REACH directive has been performed. The appendices provide an overview of the risk management measures as based on this assessment.

SECTION 16 : OTHER INFORMATION

Since the user's working conditions are not known by us, the information supplied on this safety data sheet is based on our current level of knowledge and on national and community regulations.

It is at all times the responsibility of the user to take all necessary measures to comply with legal requirements and local regulations.

The information in this safety data sheet must be regarded as a description of the safety requirements relating to the substance and not as a guarantee of the properties thereof.

In compliance with directives 67/548/EEC, 1999/45/EC and their amendments.

Safety phrase :

S 22 Do not breathe dust.

Abbreviations :

DNEL : Derived No-Effect Level

ADR : European agreement concerning the international carriage of dangerous goods by Road.

IMDG : International Maritime Dangerous Goods.

IATA : International Air Transport Association.

ICAO : International Civil Aviation Organisation

RID : Regulations concerning the International carriage of Dangerous goods by rail.

WGK : Wassergefährdungsklasse (Water Hazard Class).

MATERIAL SAFETY DATA SHEET



Built for a lifetime.™

Date Issued: 02/02/2013

MSDS No: KAESER OMEGA FG-220

OMEGA FGB-220

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: OMEGA FGB-220
GENERAL USE: Lubricant and corrosion inhibitor
CHEMICAL FAMILY: Synthetic based lubricant

MANUFACTURER

Manufactured for Kaeser Compressors, Inc.
 511 Sigma Drive
 Fredericksburg, VA 22408
Product Stewardship: 281-354-8600

24 HR. EMERGENCY TELEPHONE NUMBERS

USA : 800-424-9300
International : 703-527-3887 (collect calls accepted)

2. HAZARDS IDENTIFICATION

POTENTIAL HEALTH EFFECTS

EYES: May cause irritation.

SKIN: May irritate the skin after prolonged periods of contact.

INGESTION: May cause diarrhea.

INHALATION: Hydrocarbon mist may line breathing passages with oil making breathing difficult.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	Wt.%	CAS
Poly Alpha Olefin Synthetic	58 - 62	68037-01-4
Synthetic Olefin	38 - 42	9003-29-6
Synthetic Corrosion and Antiwear	0.5 - 1	80939-62-4
Synthetic Oxidation Inhibitor	0.2 - 0.5	41484-35-9

COMMENTS: This product contains no hazardous substances within the definition of OSHA Regulation 29 CFR 1910.1200.

4. FIRST AID MEASURES

EYES: Flush with water until all residual material is gone. If irritation persists, seek medical help.

SKIN: Wash thoroughly with hand cleanser, followed by soap and water. Contaminated clothing should be dry cleaned before reuse.

INGESTION: Wash out mouth immediately. Do not induce vomiting. Consult physician.

INHALATION: Clear air passage. If respiratory difficulty continues, seek medical help.

5. FIRE FIGHTING MEASURES

FLASH POINT AND METHOD: 232°C (450°F) COC

AUTOIGNITION TEMPERATURE: > 315°C (600°F)

EXTINGUISHING MEDIA: Foam, dry powder, Halon®, carbon dioxide, sand, earth and water mist.
 Unsuitable: Water jet.

OTHER CONSIDERATIONS: Not flammable at ambient temp.

FIRE FIGHTING EQUIPMENT: Self-contained breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

SMALL SPILL: Contain spill and keep from entering waterways. Absorb on porous material. Large quantities can be pumped.

ENVIRONMENTAL PRECAUTIONS

LAND SPILL: Do not allow it to enter drains.

SPECIAL PROTECTIVE EQUIPMENT: Wear gloves and protective overalls.

7. HANDLING AND STORAGE

HANDLING: No special handling precautions necessary.

STORAGE: Do not store at elevated temperatures.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Glasses, if applied to parts in motion.

SKIN: Oil-proof gloves for hypersensitive persons.

RESPIRATORY: Hydrocarbon absorbing respirator if misting.

PROTECTIVE CLOTHING: Overalls.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: Liquid

ODOR: Mild Hydrocarbon

COLOR: Clear

pH: Neutral

PERCENT VOLATILE: None

VAPOR PRESSURE: < 0.01

VAPOR DENSITY: Greater than air

BOILING POINT: > 371°C (700°F)

POUR POINT: -40°C

FLASH POINT AND METHOD: 232°C (450°F) COC

EVAPORATION RATE: Negligible

DENSITY: > 0.8

OXIDIZING PROPERTIES: None

10. STABILITY AND REACTIVITY

STABILITY: Chemically stable under normal conditions. No photoreactive agents.

CONDITIONS TO AVOID: Powerful sources of ignition and extreme temperatures.

HAZARDOUS DECOMPOSITION PRODUCTS: Burning generates smoke, airborne soot, hydrocarbons and oxides of carbon, sulfur and nitrogen. Residue mainly comprised of soot and mineral oxides.

INCOMPATIBLE MATERIALS: Strong inorganic and organic acids, oxidizing agents.

11. TOXICOLOGICAL INFORMATION

ACUTE

ORAL LD₅₀: > 2000 mg/kg

Notes: Extrapolated from component data

INHALATION LC₅₀: Not applicable.

SKIN EFFECTS: Very mild

CHRONIC: None known.

SUBCHRONIC: Not known

CARCINOGENICITY

IARC: No

NTP: No

OSHA: No

SENSITIZATION: Not known

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA: Due to its fluid nature and specific gravity, this product will float or spread across water making it a nuisance contaminant. It is not thought to be toxic to marine or land organisms.

BIOACCUMULATION/ACCUMULATION: Relatively well behaved. Bioaccumulation potential nil.

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: Consider recycling. This product, as sold, does not meet the RCRA characteristics of a hazardous waste. Under RCRA, it is the responsibility of the user, at the time of disposal, to determine whether the product meets the RCRA criteria for hazardous waste. Contact a waste disposal company or local authority for advice.

EMPTY CONTAINER: See waste disposal section listed above.

14. TRANSPORT INFORMATION

DOT (DEPARTMENT OF TRANSPORTATION)

UN/NA NUMBER: N/A

OTHER SHIPPING INFORMATION: Nonhazardous

ROAD AND RAIL (ADR/RID): Bulk Nonhazardous

AIR (ICAO/IATA): Bulk Nonhazardous

VESSEL (IMO/IMDG): Bulk Nonhazardous

15. REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

311/312 HAZARD CATEGORIES: None

313 REPORTABLE INGREDIENTS: N/A

CERCLA (COMPREHENSIVE RESPONSE, COMPENSATION, AND LIABILITY ACT)

CERCLA REGULATORY: Nonhazardous

TSCA (TOXIC SUBSTANCE CONTROL ACT)

TSCA REGULATORY: All components are listed

CALIFORNIA PROPOSITION 65: N/A

CANADA

WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM): Not regulated

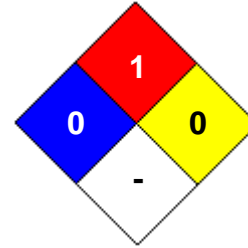
DOMESTIC SUBSTANCE LIST (INVENTORY): All components are listed

16. OTHER INFORMATION

REVISION SUMMARY: New MSDS

HMIS RATING

HEALTH:	0
FLAMMABILITY:	1
PHYSICAL HAZARD:	0
PERSONAL PROTECTION:	

NFPA CODES

MANUFACTURER DISCLAIMER: As of issue date, the information contained herein is accurate and reliable to the best of our knowledge. We do not warrant or guarantee its accuracy or reliability and shall not be liable for any loss or damage arising out of the use thereof. It is the user's responsibility to satisfy itself that the information offered for its consideration is suitable for its particular use.

Appendix D:
Soil Gas Sampling Standard Operating Procedure

Procedure I-B-3
Active Soil Gas Sampling

Active Soil Gas Sampling

1. Purpose

This standard operating procedure describes recommended soil gas sampling procedures for use by the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command (NAVFAC), Pacific personnel.

2. Scope

This procedure applies to all Navy ER projects performed in the NAVFAC Pacific Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in most recent version of the the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved and documented by the following prime contractor representatives: the CTO Manager and the Quality Assurance (QA) Manager or Technical Director. A Navy project representative (i.e., Remedial Project Manager or QA Manager) shall also concur with any deviations.

3. Definitions

3.1 ACTIVE SOIL GAS SAMPLING

The process of collecting a soil gas sample using mechanical equipment to create a hole, typically to a depth of 3 feet (or greater), and then using a vacuum pump to “actively” withdraw a soil-gas sample through stainless steel probes or plastic tubing. For whole gas sampling, the soil-gas sample is collected in a container that generally has a volume of 0.025 to 6.0 liters; for sorbent tube sampling, a volume of soil gas is drawn through a sorbent-packed tube, trapping contaminants onto the sorbent material. The gas/sorbent sample is then analyzed onsite by a mobile laboratory or sent to a fixed laboratory for analysis. The results provided by active soil-gas systems are most often reported in volume of gas per unit volume of air (e.g., parts per million by volume or part per billion by volume) or in units of mass per unit volume (e.g., milligrams per liter or micrograms per cubic meter).

3.2 PERMEABILITY

Permeability is the resistance of fluids, air, and gases to flow through a porous medium.

3.3 SATURATED ZONE

The saturated zone is the zone in which the voids in the rock (consolidated) or soil (unconsolidated) are filled with water at a pressure greater than atmospheric.

3.4 SOIL GAS

Soil gas is the atmospheric gases, vapor, and gaseous compounds present between soil particles in the subsurface. It can flow and migrate in response to pumping or pressure differentials.

3.5 VADOSE ZONE

The vadose zone is the unsaturated zone between the land surface and the water table. It includes the root zone, intermediate zone, and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched groundwater, may exist in the unsaturated zone

3.6 FIXED GAS

Fixed gases are gases that are considered permanent by percent in the atmosphere (e.g. nitrogen gas [N₂] and oxygen gas [O₂]).

3.7 BIOGENIC GAS

Biogenic gas is a gas that is synthesized by biological activity (e.g. methane [CH₄] and carbon dioxide [CO₂]).

4. Responsibilities

The prime contractor CTO Manager is responsible for ensuring that the soil gas survey activities conducted during the NAVFAC Pacific ER Program comply with this procedure. It is recommended that supervisory personnel have an understanding of the principles of soil gas and the physical characteristics of the vadose zone. This should be determined in consultation with the QA Manager or Technical Director. To a certain extent, adequate understanding of the physical characteristics of the vadose zone by field supervisory personnel is site specific and is subject to the judgment of the QA Manager or Technical Director. The CTO Manager is responsible for ensuring that all personnel involved in sampling and/or testing shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1, under *Specific Training Requirements* (DON 2014).

The prime contractor QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure.

The Field Manager is responsible for ensuring that all project field staff are familiar with these procedures.

Field sampling personnel are responsible for the implementation of this procedure.

5. Procedures

5.1 CONSIDERATIONS FOR MUNITIONS AND EXPLOSIVES OF CONCERN

Potential Munitions and Explosives of Concern (MEC) hazards may be encountered in any area formerly or currently occupied or used by the Department of Defense (DoD). MEC hazards may occur on the ground surface, in the subsurface, and within bodies of water, and may not always be readily observable, or identifiable. As a result, whether or not munitions-related activities ever occurred on the specific work area or within waters in which Navy operations/activities will take place, special care should always be taken when conducting field operations, especially intrusive activities, in the event that MEC may be encountered.

If the site is currently recognized as belonging in the Military Munitions Response Program and has a current, Naval Ordnance Safety and Security-accepted, site-specific Explosives Safety Submission (ESS) (per DON 2010), then field activities, especially intrusive activities, shall adhere to the safety procedures outlined within the ESS.

If suspected MEC is encountered on an active DoD installation, immediately notify your supervisor, DoD Point of Contact, and installation Point of Contact, who will contact and facilitate military Explosive Ordnance Disposal response.

5.2 BACKGROUND INFORMATION

The soil gas survey is a semi-quantitative technique for evaluating the distribution of contaminants in soil gas. The resulting data can be used to qualitatively evaluate the potential for, and extent of, certain types of contamination in soil and groundwater.

Soil gas sampling is most often used to:

- Help locate and characterize areas of contaminated soil or groundwater.
- Evaluate subsurface contaminant vapor concentrations in areas where significant concentrations of volatile or semivolatile contaminants are known to be present.
- Identify the potential for contaminated vapor migration and intrusion into overlying and nearby buildings or structures.

If the extent of contamination in soil and groundwater is already known, then soil gas samples are typically not required for site characterization. Soil gas is also not an appropriate characterization technique for non-volatile contaminants such as metals.

There are two broad categories of active soil gas:

1. *Whole air sampling* is the collection of a volume of gas in a sample container. As the name implies, “whole air” samples remain in a gas matrix while in the sample container, thus concentrations of targeted compounds are directly reported. Sample containers associated with whole air sampling are the sample bag (e.g., Tedlar bag) and the canister (e.g. Summa canister).
2. *Sorbent tube sampling* is the drawing a volume of air through a sorbent tube using a pump or other vacuum source and trapping contaminants onto the sorbent material. Unlike whole air sampling, concentrations of targeted compounds are measured by determining the mass of contaminant on the sorbent material, and dividing that mass by the volume of air that was drawn through the sorbent material.

The use of active soil gas surveying to locate potential source areas of subsurface contamination is based on aqueous phase/vapor phase equilibrium in the subsurface. Volatile organic compounds (VOCs) have a tendency to partition from the aqueous phase into the soil vapor phase because of their relatively low solubilities and high vapor pressures. Certain semivolatile compounds also behave in this manner. Generally, an organic compound with a relatively high Henry’s Law constant (i.e., the ratio of a compound’s equilibrium concentration in air to its equilibrium concentration in water) is likely to partition from soil or groundwater into soil gas. The presence of VOCs in shallow

soil gas depends on the following factors: (1) the volatilization of VOCs from soil or groundwater into the soil gas, (2) the presence of a chemical gradient in soil gas between the contaminant source and the ground surface, and (3) the physical properties of the soil. If VOCs are present in the soil gas in large enough quantities, they can be detected during a soil gas survey.

Typical compounds detected in soil gas include aromatic hydrocarbons (benzene, toluene, ethylbenzene, xylenes), aliphatic hydrocarbons with carbon ranges from C₁ – C₁₀ (methane, butane, pentane), mixtures (gasoline, jet propellant-4), and chlorinated hydrocarbons (chloroform, carbon tetrachloride, vinyl chloride).

Fixed gas (i.e., O₂ and N₂) and biogenic gas (i.e., CO₂, CH₄, nitrous oxide, and hydrogen sulfide) data obtained during a soil gas investigation also provide an indication of potential subsurface contamination. A concurrent increase in CO₂ and decrease in O₂ often indicates increased chemical or biological breakdown of organic compounds. This phenomenon is usually associated with the degradation of petroleum hydrocarbons; however, moisture content, natural organic content, and reduction/oxidation (redox) conditions in the soil can also affect fixed gas/biogenic gas ratios.

5.3 EQUIPMENT AND SUPPLIES

Soil gas sampling requires specialized equipment to install sampling points and obtain air samples. The following equipment and supplies are typically required to conduct soil vapor sampling:

- Hydraulic driving/hammering system designed to drill through pavement and install sampling probes and soil vapor extraction wells at depth
- Stainless steel drive points for setting vapor probes at depth
- For installation of sub-slab vapor probes: a hammer drill and various sized drill bits to establish sampling locations through concrete
- Vapor probes (permanent or temporary)
- Tubing (Teflon preferably for sample lines directly in contact with vapor sample) and fittings
- Oil-less air pump, syringe or evacuation chamber for purging sample lines of ambient air, checking for air leaks in the sampling train, etc.
- Sample containers: Summa canister, sorbent tubes, vials etc.
- Photoionization Detector
- Fittings, tools, syringes
- Helium gas and a Helium Detector (if used for field leak-testing)

The following sections discuss the equipment considerations for whole air sampling and sorbent cartridge sampling.

5.3.1 Whole Air Sampling Equipment and Supplies

Whole air samples may be collected in Summa canisters, gas-tight vials, or sample bags. Canisters are the preferred sampling containers, as gas-tight vials can contain only small sample volumes and sample bags should not be air shipped because the bags may be compromised due to

pressure/temperature differentials during transport and tend to sorb contaminants. When low-level definitive data is required, it is recommended that canisters be used. Consideration to the canister volume should be taken when low-level data is required or re-analysis is anticipated. For the purposes of this standard operating procedure, discussion of whole air samples will be focused on air samples collected using canisters. Refer to the State of Hawaii Department of Health (DOH) Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan (TGM) for guidance on using other sampling containers (DOH 2009).

5.3.1.1 SUMMA CANISTER

A Summa canister is a stainless steel container that has had the internal surfaces chemically deactivated to produce a surface that is nearly chemically inert which is important for minimizing reactions with the sample and maximizing recovery of target analytes from the container. Recovery of compounds from canisters is limited to 10 carbon aromatic hydrocarbons compounds and 12 carbon aliphatic compounds.

Canister Certification for Cleanliness

The Summa canister is provided by a vendor, who certifies that the canister is clean. It is important to verify that the certificate sufficiently documents that project contaminants are not present in the canister at a detection limit appropriate for the site investigation.

Typically, Summa canisters are either “batched” or “individually” certified clean. The definitions of cleanliness will vary among vendors, thus it is important to review the project goals with the vendor providing the Summa canisters. In general, the cleaning process involves a combination of dilution, heat, and high vacuum.

For a “batched” certified clean canister, a canister within the same “batch” has been certified for a subset of VOCs using a gas chromatography/mass spectrophotometer (GC/MS) to have less than a specified concentration. Canisters that are “batch” certified are appropriate for collecting samples with anticipated high concentrations and routine ambient air applications. U.S. Environmental Protection Agency (EPA) methods TO-14 or TO-15 are the analytical methods used to analyze air samples where low level detections are not required (EPA 1999).

For an “individually” certified clean canister, each canister is certified clean for a client-specified list of target analytes below the laboratory’s specified detection limits. Canisters that are “individually” certified are appropriate for collecting ambient and indoor air samples which are driven by risk or litigation. When collecting air samples with an individually certified clean canister, it is important to use the flow controller and pressure gauge associated with the canister. EPA method TO-15 selective ion monitoring (SIM) analysis is the analytical method used to analyze air samples requiring low level detection.

Canister Holding Times

Once a canister is certified clean, the recommend time for sample collection is within 30 days of certification. Following sampling, laboratories prefer to have canisters returned within 14 days of air sampling although 30 days has been recognized by the EPA as acceptable. However, the stability of the chemicals of concern should be the driver on the number of days to analysis. Consult the laboratory for appropriate holding times.

Canister Volumes (Sizes)

Summa canisters are available in various volumes, but the most commonly used sizes are 1 liter and 6 liters. Six liter volumes are typically used for collecting ambient or indoor air samples that require low levels of detection. Ambient and indoor air samples are usually collected over an 8 hour or 24 hour period. One liter canister volumes are typically used for soil vapor sampling and is the minimum volume the State of Hawaii recommends for final decision making purposes. Sample collection periods will ultimately define the size of the Summa canister used.

Associated Canister Hardware

Hardware associated with Summa canisters includes vacuum gauges, flow controllers (critical orifice) and particulate filters.

The flow controller limits the rate that a sample can be drawn into the Summa canister and ensures the sample flow rate over the targeted sampling period (i.e., time-integrated sampling). In general, sampling flow rates should not exceed 200 milliliters per minute (mL/min) or sampling pressures greater than 7 inches of mercury. The vacuum drawn should not strip vapor from the soil but rather sample the vapor within the pore spaces of the subsurface at equilibrium.

Built into most flow controllers are 2 micron particulate filters which eliminate particulates larger than two microns. Grab air samples are usually fitted with a 7 micron particulate filter which removes particles larger than 7 microns.

The vacuum gauge is used to indicate the initial pressure of the canister before sampling and the final pressure after sampling. Laboratories typically prepare Summa canisters with a vacuum of approximately 30 inches of mercury. The vacuum gauges provided by the supplier are typically not calibrated and are meant to provide relative measures of change. Summa canister providers should be consulted to ensure the appropriate size canister and appropriate critical orifice is used to meet project requirements. In addition, if more stringent requirements are needed to monitor the canister pressure, then the canister supplier should be consulted for alternative pressure gauges.

5.3.2 Sorbent Tube Sampling Equipment and Supplies

Sorbent tube sampling may be used for short-chain VOCs or longer chained VOC and semivolatile compounds with molecular weights up to 200 grams per mole which cannot be recovered from canisters. Sorbent tubes are typically stored and shipped chilled (prior to and after sampling) at 4 degrees Celsius but should be brought to ambient temperatures prior to use.

Flow rates drawn through the sorbent tubes should be no more than 200 mL/min. A syringe or a pump may be used to draw air through the sorbent tubes. A pump is used when large volumes of air are required for sampling.

5.3.2.1 SELECTION OF SORBENT TUBES

Selection of sorbent cartridges, solid phase sorbent and the evacuating system used to draw air through the sorbent will depend upon the target analytes of interest and the intent of data use. Sorbent tubes have a maximum sorption capacity before break through occurs. Consideration to the level of contamination will also influence the sorbent tube assembly. Consult with the analytical laboratory for selection of the appropriate sorbent material for the project analytes.

5.4 SELECTION OF SAMPLING LOCATIONS AND ANALYSES

The design of a soil gas survey program depends on the objectives of the program and the types of contaminants anticipated being present. The following items shall be considered when designing a soil gas program.

Number of Samples: This depends upon the extent of anticipated contamination, the size of the site, and the selected sample spacing.

Soil Types Expected to be Encountered (if known): The lithology of the subsurface must be considered when determining sampling locations, distance between samples, and sampling depth.

Depth of Samples: This will depend on the type of contamination, the depth to groundwater, and the objectives of the survey. For instance, evaluation of surface contamination may require only a 3- to 5-foot sampling depth whereas evaluation of deeper soil gas quality may require penetration to 20 feet. Samples may also be collected at several discrete intervals to provide a depth profile. Some flexibility exists in choosing a sampling depth or depths; however, once chosen, consistency across the site should be used.

Distance between Samples: For detecting the limits of plumes, spacing may be 50 to 100 feet or greater. Around a buried tank, spacing may be a few feet. Also consider the relative air permeability of the soil type(s) present. Soils with low air permeability (i.e., clays) may require closer sample spacing. Select spacing based on the objective(s) of the survey, subsurface conditions, and the nature of the target compounds. These factors shall be addressed in the project-specific work plan (WP).

Sampling Point Selection: Large spills, leaks, or plumes are often sampled on a predetermined sampling grid or by using real-time field data. Sample point selection for vapor intrusion concerns suggest locating subslab sample points within a building in areas where utilities or cracks serve as conduits for vapor intrusion, or commonly used spaces. Location access may also be an important factor.

Objectives of the Survey: If the objective is to define and delineate a soil vapor plume, then locate points throughout the suspected area. If the objective is to evaluate the potential for vapor intrusion into a building, then strategically locate subslab sampling locations within the building, at the source areas or around the building. In addressing vapor intrusion concerns, soil gas sample collection generally focuses in and around buildings within 100 feet of the source area. Point samples are used during the initial phases of an investigation to determine the extent and magnitude of subsurface vapor contamination and to assess potential exposure pathways. Soil gas samples are recommended from beneath the building slab and the potential source area. The depth beneath the subsurface and the target analytes should be taken into consideration when developing a soil vapor sampling strategy.

Timing of Sampling: Probe locations can be sampled in stages to meet the objectives of the survey. The first stage of sampling may involve widespread spacing of the probes. Later sampling should focus on areas where VOCs were detected during the first stage of sampling to define the lateral extent of soil gas contaminants, or delineate a source area. Later sampling events should include some overlap with earlier sampling points in order to provide a basis for correlation between data sets.

The frequency of a soil vapor investigation may also depend upon the objectives of the investigation. If vapor intrusion is a concern, collection of a soil vapor sample may occur in two distinct events to determine if seasonal/temporal variations change the soil vapor concentration beneath the slab or within the subsurface.

Selection of Analytes: Generally, only contaminants with relatively high Henry's Law constants are amenable to detection using soil gas; thus, analysis should focus on known indicator compounds at the site. Analytes should be selected to sample the compounds necessary to meet the objectives of the study and to maximize the number of locations sampled in a given period of time.

5.5 SAMPLING PROCEDURES

Summary Overview

Insert the soil gas probes into the ground using a hydraulic ram, pneumatic hammer, or other similar device. When the soil gas probe is at the desired sampling depth, a section of inert tubing is fitted to the top of the probe and connected to an air withdrawal system. The air withdrawal system is used to apply a vacuum to the system and draw soil gas from the surrounding formation into the probe. Purge the system for a sufficient amount of time to allow all of the atmospheric air to be removed, and ensure that a representative soil gas sample can be obtained. The amount of air to be removed is proportional to the volume of the sampling probe. Maintain an airtight seal around the soil gas probe at the ground surface to help prevent possible short-circuiting from atmospheric air diluting soil vapor gas concentrations. Purging of approximately 1.5 volumes permits removal of atmospheric air from the system with a minimum disturbance of the soil gas around the probe tip. Unlike purging of a groundwater monitoring well, purging of a soil gas probe should remove only the ambient air in the system. If a vacuum pump is used, record vacuum pressure and time required to purge the prescribed volume of gas from each probe to permit estimation of relative soil permeabilities.

When purging is complete, end the air withdrawals and allow the sampling system to return to atmospheric pressure. Withdraw the appropriate soil gas sample volume from the system using the vacuum in a Summa canister or pull soil gas through a sorbent tube using a vacuum pump.

Other methods of sample withdrawal and collection are acceptable as long as approval is obtained from the CTO Manager and QA Manager or Technical Director.

As part of the sampling procedure, record probe locations on a site map in accordance with Procedure I-I, *Land Surveying*. In addition, use field data forms (and chain-of-custody forms if necessary) to record observations regarding vapor sampling and probe installation. These field data forms may include, but are not limited to, vacuum pressures corresponding to steady flow, time required for the sampling system to reach atmospheric pressure, sampling depth, volume of soil gas extracted, soil characteristics, and procedures that are necessary to drive sampling probes to the target depth.

For additional information on the installation of temporary and permanent sample probes, please refer to the DOH TGM (DOH 2009, Section 7.9).

5.5.1 Purging Vapor Probe Locations

Once the vapor probe has been installed at the designated sampling location, the vapor probe should be purged of ambient or stagnant air. The volume of air space in sand packs installed with the vapor point should be included in purging if less than 24 hours has lapsed since installation of the probe.

5.5.2 Equilibrating Vapor Probe Locations

Following purging, vapor probe locations should be allowed to equilibrate. Equilibration times will depend upon the method of installation. The DOH TGM indicates that temporary probes reach equilibrium within 2 hours or so of installation, while permanent probes installed with a direct push rig typically require 8 to 24 hours. Vapor probes installed with a hollow auger are expected to require 48 hours of equilibration time. Equilibration times should be clearly communicated in the planning phases of a project and agreed upon by all project stakeholders.

5.5.3 Purging Sampling Trains

Following equilibration, connect an airtight canister assembly or sorbent cartridge assembly to the vapor probe using inert, rigid-walled tubing (i.e., Teflon, nylon, or stainless steel) and appropriate fittings.

This sampling train should be purged from ambient air prior to sampling. The rule of thumb for purging sample tubing is three tubing-volumes. The goal of purging is to have the tubing and other equipment filled with soil vapor prior to sample collection. Purging sample tubing can be accomplished by using a syringe, a pump or a canister and a three way valve. The purging of sample lines should not cause an excess vacuum on the soil. Stripping of vapor from soil should be avoided. The DOH TGM recommends that purging flow rates should not exceed 200 milliliters (mL) per minute and vacuum pressures should not exceed 7 inches of mercury.

5.5.4 Permeability Testing

While evacuating sample tubing of ambient air, the permeability of the sample location can be tested with a 20 or 50 mL syringe. If the syringe has difficulty drawing air from the probe location, the flow rates for sampling soil vapor need to be lowered. Alternatively, the sample location could be abandoned and another sampling location installed.

5.5.5 Leak Testing

Prior to sampling, the sample train should be leak tested. Leaks in a sampling train and the vapor probe surface seal can result in dilution of the soil vapor samples with ambient air resulting in low biased reported values. There are two types of leak tests: 1) a tightness test which checks the tightness of the sampling train and 2) a tracer test which measures the presence/absence of a compound introduced near the vapor probe surface seal. The design of the system used to perform a leak test will depend upon the installation design of the vapor probe.

The design of the tightness test should include isolating the sample train from the soil vapor probe and drawing a vacuum on the sampling train. The applied vacuum should hold for at least 60 seconds. If the vacuum does not hold, retighten connections of the sampling train and perform tightness test again.

There are two options for performing the tracer test: 1) *surface seal testing*, where the tracer compound (i.e., isopropanol) is applied to an absorbing material and placed on the vapor probe surface seal *or* a tracer gas (i.e., helium or difluoroethane) is introduced into a small shroud which is placed over the vapor probe surface seal; and 2) *whole apparatus testing*, where a tracer gas is introduced into a shroud which covers the entire sampling apparatus.

Of the two options, the surface seal testing is the easiest to implement and uses less tracer material. Feed-back on the integrity of the vapor point is immediate if helium is used as the tracer gas because presence of helium can be tested for in the field with a hand-held helium detector. The whole apparatus tracer test option can be implemented if the integrity testing of the entire sampling apparatus is required. Selection of the option used for leak testing should be agreed upon by all stakeholders.

There are multiple tracer compounds that can be used for leak testing. Three of the commonly used compounds are isopropanol, helium and difluoroethane. Each has advantages and disadvantages. The advantages of using isopropanol and difluoroethane, are that they are both inexpensive, readily available, and isopropanol does not require a shroud. There are several disadvantages of using these tracer compounds: 1) there are no available field meters that are selective for these compounds, so the presence of a leak is not known until the samples are analyzed by the laboratory; 2) if the compounds are present in high concentrations in the sample, they may interfere with laboratory analysis and elevate reporting levels above project action levels; and 3) the quantification of a leak can only be estimated because the initial concentration of the compounds in the field are unknown. The advantage of using helium is that it can be detected and quantified in the field. As a result, leaks at the sampling point can be determined immediately and the size of the leak can be quantified if the sample is tested for helium in the laboratory and the concentration of helium under the shroud maintained for the duration of the sampling period.

5.5.6 Prepare Summa Canister (Whole Gas Sampling)

Prior to sampling, verify the evacuated pressure of the canister (typically 30 inches of mercury). Do not use the canister if the pressure is less than 25 inches of mercury (or as appropriate for canister volume) and contact canister supplier. Record the initial pressure on the sample chain of custody (COC).

For grab sampling, verify the canister valve is closed and attach particulate filter. For time integrated sampling, close canister valve and assemble the canister, flow controller and pressure gauge. Close assembly by capping the sample inlet. Check for leaks in assembly by opening and quickly closing the canister valve. If the needle on the vacuum gauge drops the assembly is not air tight. Refit and/or tighten connection until the needle on the vacuum gauge remains steady. Do not use assembly if it is not air tight.

5.5.7 Prepare the Sorbent Tube (Sorbent Tube Sampling)

Prior to sampling, tubes should be kept in their storage and transportation container and allowed to equilibrate with ambient temperature. The flow rates should be set using a dummy tube of identical construction. Using clean gloves, the sample tubes should be removed from the container and attached to the sampling lines. Any flow rate adjustments should be made quickly to avoid sampling errors. Then the flow rate should be monitored throughout the sampling process.

5.5.8 Collect Soil Gas

To begin, open canister valve at a half turn or start vacuum pump for the sorbent tube assembly. Record start date and time. Periodically monitor the progress of the air sampling by verifying sufficient vacuum pressure remains for entire sampling period for canister sampling. Monitor and record the flow rate periodically stable over the sampling period for sorbent tube sampling.

For canister sampling, the final vacuum pressure should preferably be 5 inches of mercury but are acceptable between 2 to 10 inches of mercury. If the vacuum is less than 1 inch of mercury, the air sample integrity may have been compromised. Record the final pressure and end date and time as well as the canister, controller and gauge serial numbers.

For sorbent tube sampling, turn off pump at pre-defined times, and seal sorbent tubes. Record the final flow rate, end date and end time, and the sorbent serial number.

5.5.9 Analytical Methods

The analytical method for soil gas samples collected using a sorbent cartridge is EPA Method TO-17 (EPA 1999). The analytical method for soil gas samples collected using a Summa canister depends upon the project objectives. For projects requiring indoor air risk drivers is typically analyzed by EPA Method TO-15 GC/MS SIM. For soil-gas data, EPA TO-14 or TO-15 should be sufficient. However, ultimately, the analytical method used, will depend upon the project specific needs. Consult the analytical laboratory for recommended analytical method to use.

5.5.10 Active Soil Gas Sampling Field Quality Control Samples

Duplicate soil vapor samples must be collected from the same sample location, using the same equipment and procedure as used for the original. The percentage of duplicates submitted for laboratory analysis depends on project-specific objectives and regulatory specifications that shall be defined in the WP. Purge the pump between sampling locations and check for residual VOC contamination by collecting field blanks for analysis.

5.5.11 Active Soil Gas Sampling Equipment Decontamination

Soil gas samples should not contact potentially sorbing materials such as the pump diaphragm or soft tubing. Check all components of the sampling system randomly for contamination by drawing atmospheric air through the system, subjecting it to analysis, and comparing the resulting chromatogram with that of ambient air. Use pre-cleaned probes for each sampling location in order to minimize the possibility of cross-contamination among sampling locations.

Clean sampling components, such as the probes, using steam or pressurized water and detergent at the conclusion of each day and clean immediately after use with a portable sprayer as described in Procedure I-F, *Equipment Decontamination*. Sampling syringes can be decontaminated and reused only if GC analyses indicate no residual contamination is present. Drive points placed at the ends of the steel sampling tubes are dedicated to one sampling location. Note that this procedure assumes that syringe sampling will be conducted. If other sampling techniques are preferred or required, document them in the project-specific WP.

5.5.12 Active Soil Gas Analytical Quality Control Samples

Blanks shall be run at least once for every 20 samples and after “hot” samples with concentrations outside the calibration range. A quality control standard containing concentrations in the middle range of those expected at the site shall be run at least once for every 20 samples, or at a minimum of once per day. In addition, a minimum of two ambient air samples shall be collected over the course of each day and analyzed for background concentrations of target compounds.

6. Documentation/Records

The subcontractor shall document each soil gas sampling event in a bound logbook or appropriate field log sheets. The following information will be recorded for each soil gas sampling event:

- Sample number
- Project name and number
- Sampling location and depth
- Date and time
- Name(s) of sampling personnel
- Site location
- Miscellaneous observations
- Analytical equipment utilized (e.g., GC, column, detector)

Other documentation will be recorded on a daily basis in the bound field notebook, and will include:

- Calibration results
- Blank measurement results

The original field records will be placed in the project files immediately upon completion of fieldwork. Subcontractors will prepare a detailed report summarizing the methodologies used during the survey, the results obtained, and an interpretation of the results. This report will be incorporated into the site characterization report or equivalent document.

7. Health and Safety

Field Personnel shall perform work in accordance with the current (or as contractually obligated) United States Army Corps of Engineers Safety and Health Requirements Manual EM-385-1-1 (USACE 2008) and site-specific health and safety plan.

8. References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of Health, State of Hawaii (DOH). 2009. *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*. Interim Final. Honolulu: Office of Hazard Evaluation and Emergency Response. 21 June. <http://www.hawaiidoh.org/tgm.aspx>.

Department of the Navy (DON). 2010. Ammunition and Explosives Safety Ashore. NAVSEA OP 5 Volume 1, 7th Revision, Change 11. 0640-LP-108-5790. Commander, Naval Sea Systems Command. July 1.

———.2014. *Environmental Readiness Program Manual*. OPNAV Instruction 5090.1D. 10 January.

Environmental Protection Agency, United States (EPA). 1999. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. 2nd ed. EPA-625/R-96-010b. Center for Environmental Research Information. January.

United States Army Corps of Engineers (USACE). 2008. *Consolidated Safety and Health Requirements Manual*. EM-385-1-1. Includes Changes 1–7. 13 July 2012.

Procedure I-F, *Equipment Decontamination*

Procedure I-I, *Land Surveying*.

Procedure I-A-5, *Utility Clearance*.

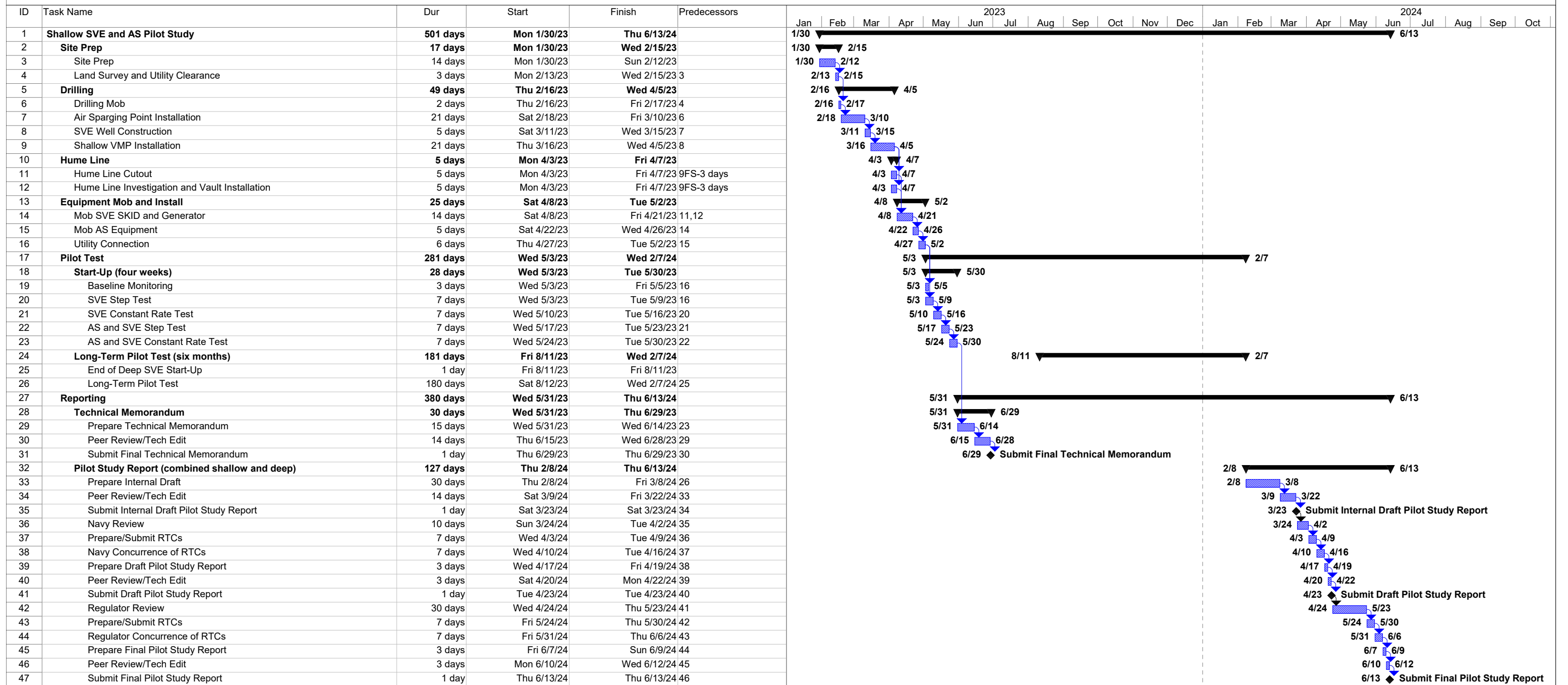
9. Attachments

None.

**Appendix E:
Project Schedule**

Shallow SVE and AS Pilot Study (actual dates are TBD)

Last Updated: Fri 12/2/22



Project: Schedule.mpp

Task Summary Project Summary

Milestone Summary Progress Progress

