AIR SPARGING/SOIL VAPOR EXTRACTION TREATABILITY STUDY WORK PLAN FOR BUILDING 189 TRUMAN ANNEX NAS KEY WEST FL

5/19/2000

TETRA TECH NUS

7846-3.5-26

0013

Air Sparging/Soil Vapor Extraction (AS/SVE) Treatability Study Work Plan

Building 189, Truman Annex Naval Air Station Key West Key West, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888
Contract Task Order 0059

May 2000

7846-3.5-26

TETRA TECH NUS, INC.
794 S. Military Trail ■ Deerfield Beach, Florida 33442
(954) 570-5885 ■ FAX (954) 570-5974 ■ www.tetratech.com

TtNUS/DFB-00-110/7846/3.2

18 May, 2000

Project Number 7846

Commander
Southern Division
Naval Facilities Engineering Command
ATTN: Ms. Byas Glover (Code 1841)
Remedial Project Manager
2155 Eagle Drive, P.O. Box 190010
North Charleston, South Carolina 29419-9010

Reference: Clean Contract No. N62467-94-D0888
Contract Task Order No. 0059

Subject: Treatability Study Work Plan for
Building 189, Truman Annex
Naval Air Station Key West, Florida

Dear Mr. Glover:

Tetra Tech NUS, Inc. is pleased to submit the Treatability Study Work Plan for the referenced site.

TtNUS anticipates mobilizing to the site during the week of May 29, 2000 to install the system equipment and to oversee the drilling subcontractor.

If you have any questions regarding this plan or require further information, please contact me at (954) 570-5885 extension 250.

Very truly yours,

Rick Ofsanko
Task Order Manager

RO/jj

Enclosures (1)

c: Ms. D. Wroblewski (w/o enclosure)
Mr. Mike Stanka, NAS Key West
Mr. Jorge Caspary, FDEP

AIR SPARGING/VAPOR EXTRACTION TREATABILITY STUDY WORK PLAN

FOR

BUILDING 189, TRUMAN ANNEX
NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0059

MAY 2000

PREPARED UNDER THE SUPERVISION OF:

Richard Ofsanko

RICHARD OFSANKO
TASK ORDER MANAGER
TETRA TECH NUS, INC.
DEERFIELD BEACH, FLORIDA

APPROVED FOR SUBMITTAL BY:

Debra Wroblewski

DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 PURPOSE/SCOPE 1-1
1.2 TREATABILITY STUDY OBJECTIVES 1-1
1.3 SITE DESCRIPTION 1-1
1.4 WORK PLAN ORGANIZATION 1-2
2.0 SITE HISTORY 2-1
2.1 PREVIOUS INVESTIGATIONS 2-1
2.1.1 Geologic and Hydrogeologic Characteristics 2-3
2.1.2 Contamination Assessment 2-4
3.0 SYSTEM DESIGN AND INSTALLATION 3-1
3.1 PERMITS 3-2
3.2 INSTALLATION OF PILOT-SCALE SYSTEM 3-2
3.2.1 Well Installation 3-3
3.2.2 Air Sparging/Soil Vapor Extraction Equipment 3-7
3.2.3 Piping 3-7
3.2.4 Investigation-Derived Waste (IDW) 3-7
4.0 SYSTEM OPERATION AND TESTING 4-1
4.1 PHASE I TESTING 4-1
4.2 PHASE II TESTING 4-2
5.0 FIELD SAMPLING 5-1
5.1 AIR SAMPLING 5-1
5.1.1 Field VOC Analysis 5-1
5.1.2 Fixed-Based Laboratory Soil Vapor Sampling 5-1
5.2 QUALITY ASSURANCE 5-5
5.2.1 Field Documentation Responsibilities 5-5
5.2.2 Field Measurement 5-6
5.2.3 Field Analysis 5-6
5.2.4 Laboratory Analysis 5-6
5.2.5 Sample Handling and Preservation, Custody, and Shipment 5-6
5.2.6 Quality Control Samples 5-9
5.3 BOTTLEWARE 5-9
5.4 SAMPLE IDENTIFICATION SYSTEM 5-9
5.5 RECORD KEEPING 5-10
6.0 REPORTING 6-1

REFERENCES R-1

APPENDICES

A AS/SVE TEST PROCEDURES AND FORMS A-1

TABLE OF CONTENTS (Con't)

TABLES

NUMBER		PAGE
5-1	Proposed Analytical Testing for AS/SVE Pilot Test	5-3
5-2	AS/SVE Pilot-Scale System	5-7
5-3	Holding time and Bottleware Requirements	5-8

FIGURES

NUMBER		PAGE
1-1	Site Topographic Map	1-3
1-2	Site Location Map	1-4
1-3	Site Map	1-5
2-1	Site Utilities Map	2-2
2-2	Potentiometric Surface Map	2-5
2-3	Areal Extent of Free Product Plume	2-7
3-1	AS/SVE System Layout	3-4
3-2	Well Construction Details	3-5
3-3	Trailer Mounted AS/SVE Pilot Test Unit Equipment Layout	3-7

ACRONYMS

AS/SVE	Air Sparging/Soil Vapor Extraction
bls	Below land surface
CAR	Contamination Assessment Report
CARA	Contamination Assessment Report Addendum
cfm	Cubic feet per minute
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	Contaminants of Concern
CO_2	Carbon Dioxide
CTO	Contract Task Order
DO	Dissolved Oxygen
DOT	Department of Transportation
FDEP	Florida Department of Environmental Protection
FID	Flame-ionization Detector
FOL	Field Operations Leader
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
MOP	Monitoring Only Plan
msl	Mean Sea Level
NAS	Naval Air Station
NSF	National Sanitation Foundation
O_2	Oxygen
O & M	Operation and maintenance
OVA	Organic Vapor Analyzer
ppm	Parts per million
PSI	Pounds per square inch
PVC	Poly vinyl chloride
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedures
TOM	Task Order Manager
TRPH	Total Recoverable Petroleum Hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

1.1 PURPOSE/SCOPE

This Treatability Study Work Plan has been prepared by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-term Environmental Action Navy (CLEAN) Contract No. N62467-94-D-0888. Contract Task Order (CTO) 0059. This Work Plan has been prepared to describe field work which will determine if Air Sparging/Soil Vapor Extraction (AS/SVE) is an appropriate remedial technology for Building 189, Truman Annex at the Naval Air Station (NAS) Key West, Key West, Florida. The Treatability Study will also provide information necessary for the design, installation, and operation of an AS/SVE Treatability Study System. The scope of this Treatability Study is limited to the soils and groundwater that have been affected by previous activities at the site.

This Work Plan summarizes information presented in the Contamination Assessment Report Addendum (ABB Environmental Services November 1993) and Remedial Action Plan (ABB Environmental Services August 1994) to provide site history. This Work Plan also provides procedures for the installation, operation, and evaluation of a pilot-scale AS/SVE system.

1.2 TREATABILITY STUDY OBJECTIVES

The following are the remedial action objectives for Building 189, Truman Annex, Key West:

- Remediate free product in the soil adjacent to MW-2 by removing soils in the immediate vicinity of the well.
- Remediate free product in the groundwater in the vicinity of monitoring well MW-2 to below detectable levels.
- Remediate any dissolved hydrocarbons in the groundwater to concentrations below the State of Florida's Groundwater Cleanup Target Levels.

1.3 SITE DESCRIPTION

NAS Key West is located approximately 150 miles southwest of Miami in Monroe County, Florida. The site can be found on the Key West, Florida United States Geological Survey (USGS) Topographic Quadrangle (7.5 Minute Series). A copy of the topographic map for the site is included as Figure 1-1. NAS Key West consists of a complex of properties located in a number of areas of the lower Florida Keys and encompasses approximately 5,000 acres. The majority of these properties are concentrated on Boca

Chica Key and Key West. The mission of NAS Key West is to maintain and operate facilities and provide services and materials to support operations of aviation activities and units designated by the Chief of Naval Operations.

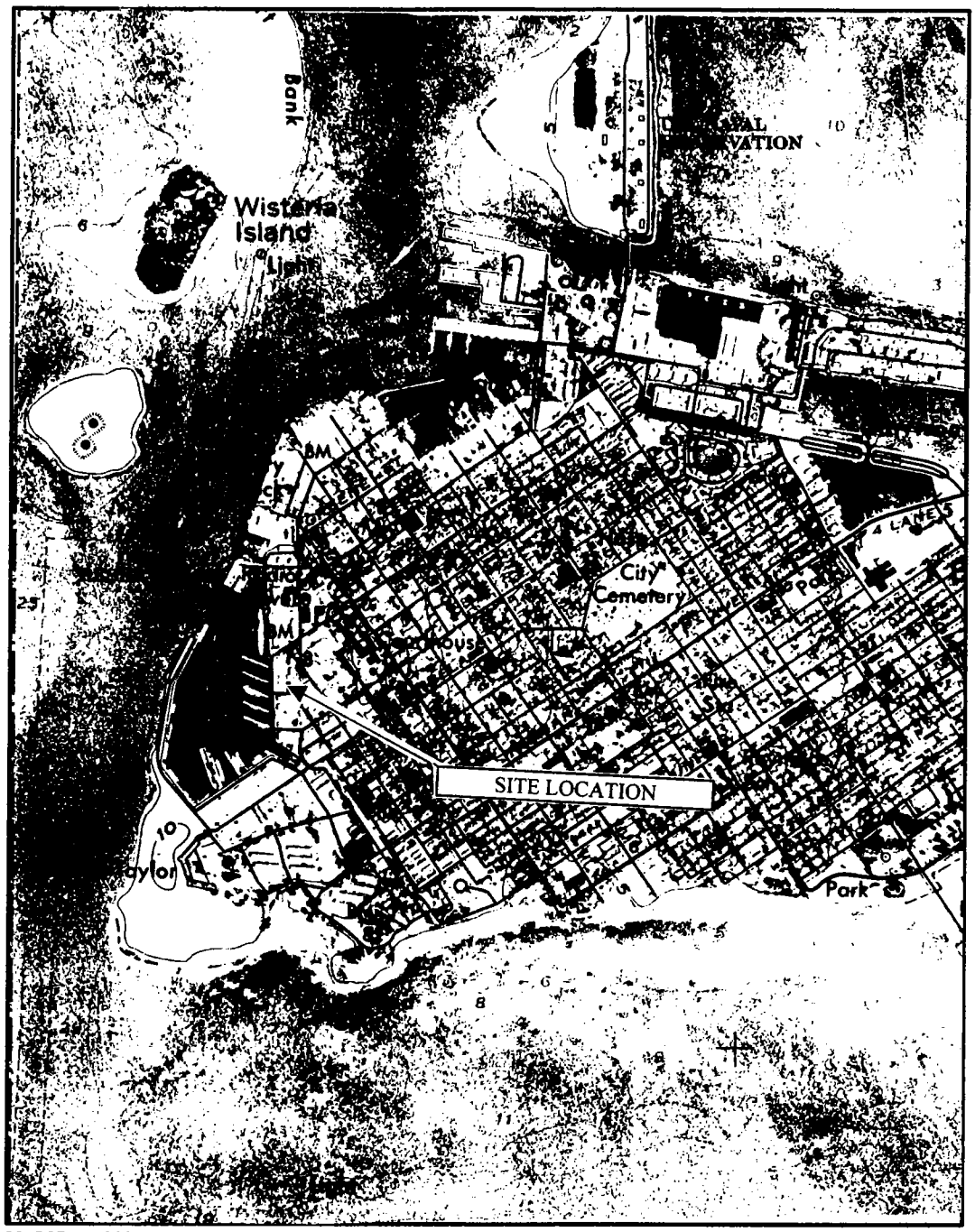
The turning basin, where ships are docked and serviced, is located within the Truman Annex in the western part of the station. Building 189 is located adjacent to the bulkhead along the eastern part of the turning basin (Figure 1-2). There are three structures at the site: Building 159, Building 189, and Motor Generator (MG) House 3. Building 159 and 189 are located near the southern edge of the site. MG House 3 is located in the wharf area on the western part of the site. Much of the area east of the wharf and north of Building 159 and 189 is unpaved. East of the site, a fence separates a residential area from the facility. The Berthing Wharf is located along the western margin of the site. The wharf area is approximately 65 feet wide and is paved with concrete. The western edge of the site is the reinforced concrete capped, steel sheet-pile seawall, which is oriented in a north/south direction. The seawall extends to a depth of approximately 53 feet below mean sea level (msl) and forms the eastern side of the turning basin. A site map is presented as Figure 1-3.

1.4 WORK PLAN ORGANIZATION

This Work Plan is organized in the following sections:

Section 1.0	Introduction, Treatability Study objectives, and site description
Section 2.0	Site history
Section 3.0	System design and installation
Section 4.0	System operation and testing
Section 5.0	Field Sampling

S:\NAS Key West\CAD\7846\7846BM01



SOURCE: USGS Key West, Florida 7.5-minute Topographic Quadrangle

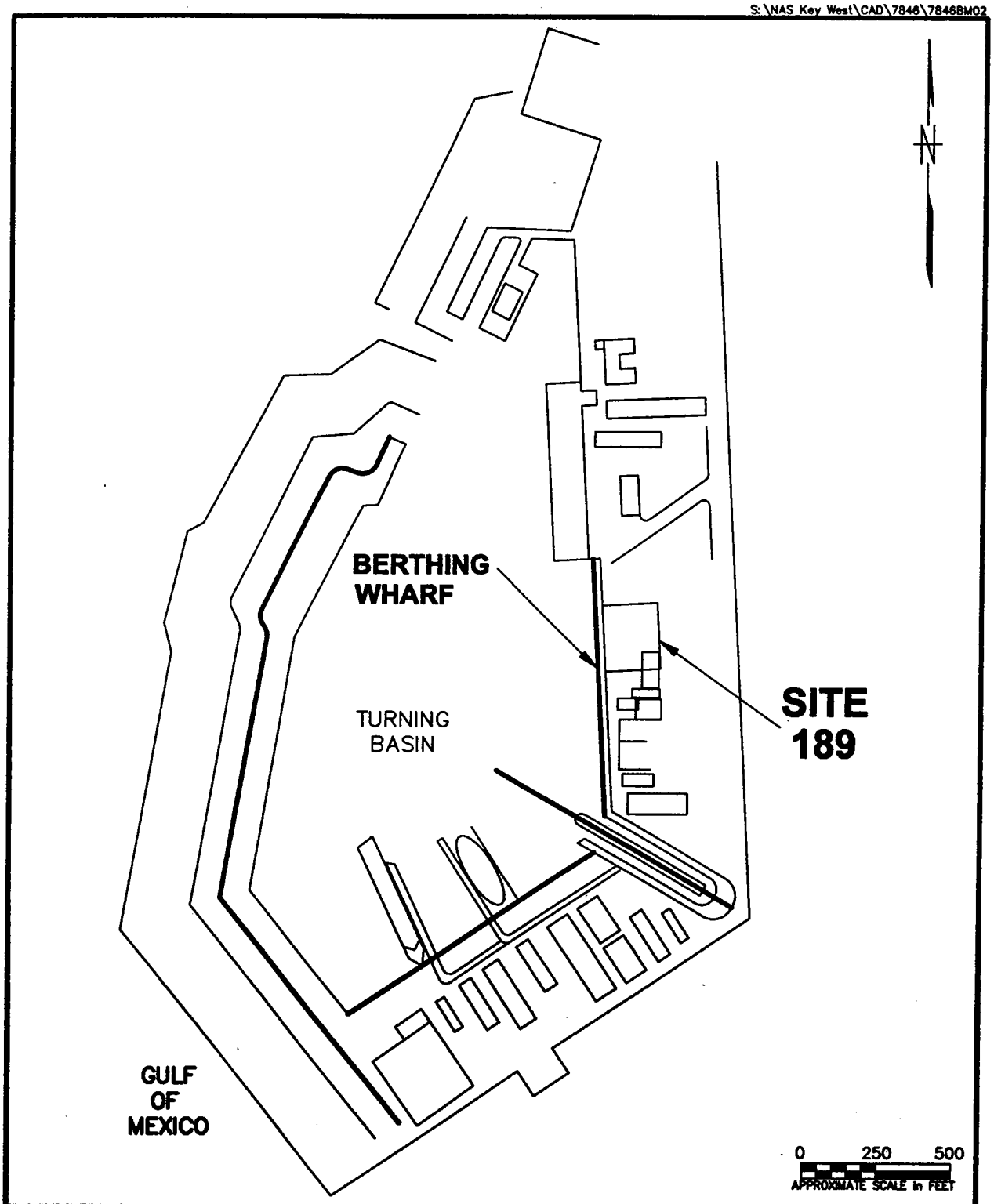
0 1000 2000

APPROXIMATE SCALE in FEET

DRAWN BY LK DATE 4/24/00		SITE TOPOGRAPHIC MAP BUILDING 189 TRUMAN ANNEX NAVAL AIR STATION KEY WEST, FLORIDA	CONTRACT NO. 7846
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-1 REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

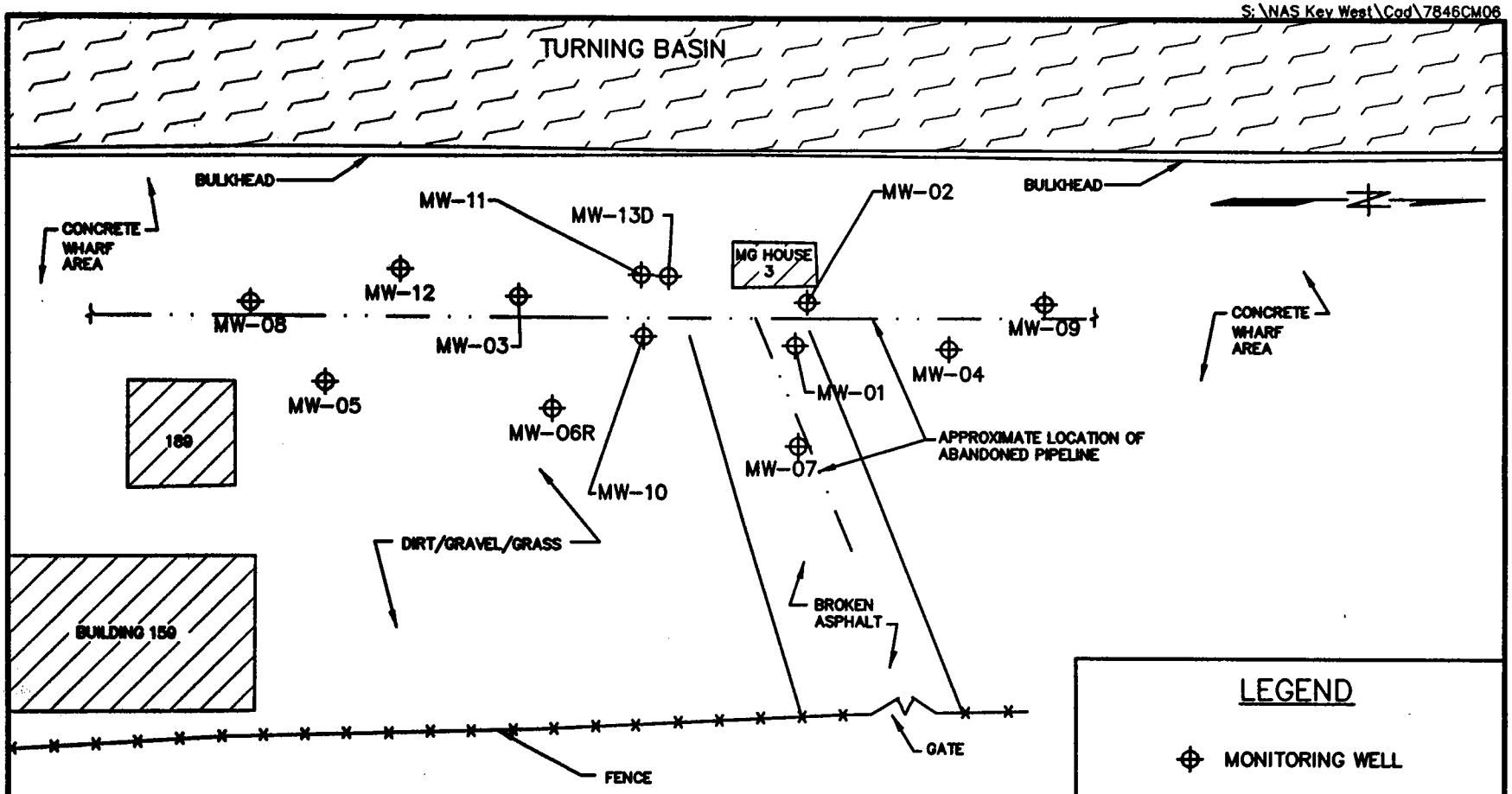
S:\NAS Key West\CAD\7846\7846BM02



DRAWN BY LLK DATE 4/18/00			CONTRACT NO. 7846
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED–AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1–2 REV. 0

SITE LOCATION MAP
BUILDING 189
TRUMAN ANNEX
NAVAL AIR STATION
KEY WEST, FLORIDA

S:\NAS Key West\Cad\7846CM06



DRAWN BY: LLK DATE: 10/6/99	SITE MAP BUILDING 189 TRUMAN ANNEX NAVAL AIR STATION KEY WEST, FLORIDA	CONTRACT NO. 7846	
CHECKED BY: DATE:		APPROVED BY: DATE:	
COST/SCHED-AREA:		APPROVED BY: DATE:	
SCALE: AS NOTED		DRAWING NO. FIGURE 1-3	REV. 0

FORM CADD NO. SDV_AH12.DWG - REV 0 - 1/20/98

2.0 SITE HISTORY

The turning basin was formerly used to dock naval vessels. The present seawall at Building 189 is an addition to the original turning basin seawall. The original 1,200-foot section of the wharf was extended 30 feet into the turning basin in the late 1980's. The seawall is constructed of a single wall of sheet piling, capped with a three-inch thick concrete encasement. The piles were driven to various depths, generally extending to 53 feet below msl. The dredge depth is approximately 33 feet below msl. The original seawall was driven to various depths, generally extending to 23 feet below msl, with a dredged depth of about 13 feet below msl.

During reconstruction of the wharf in 1989, a north to south oriented Bunker C fuel oil pipeline was discovered approximately 25 feet west of Building 189. The pipeline was broken prior to or during the wharf reconstruction activities, resulting in the release of petroleum. An east to west oriented spur of the pipeline was also discovered east of MG House 3 in an area paved with asphalt.

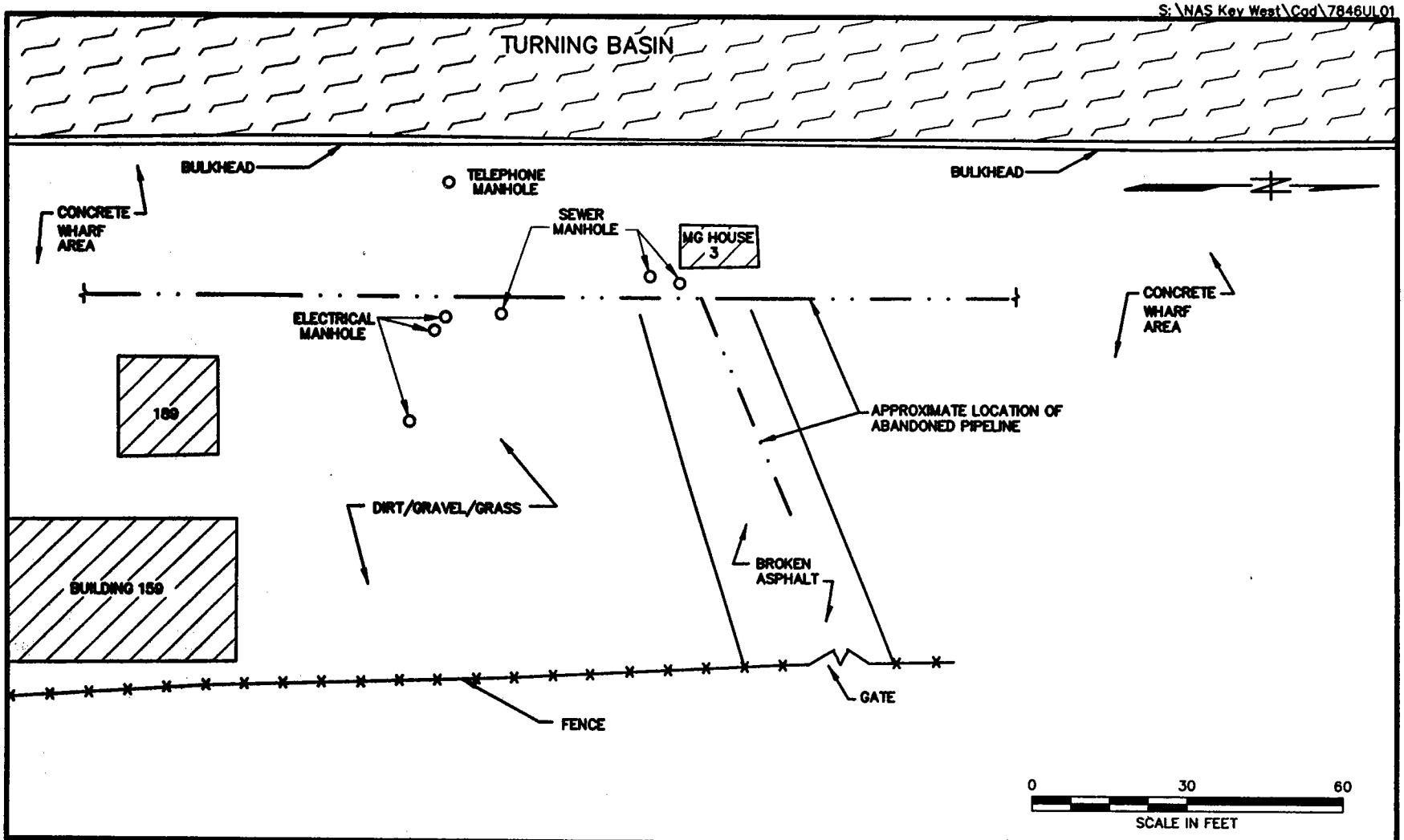
The section of the pipeline discovered at the site and much of the contaminated soil were removed during wharf reconstruction activities. NAS Key West Public Works Department personnel were unable to provide information regarding where the excavated soil and pipeline materials were transported. The area where the former north to south pipeline was discovered was resurfaced with concrete. The area where the former east to west spur was found is now covered by broken asphalt.

There are existing underground utilities and ship service connections throughout the wharf area. The approximate location and distribution density of the known utilities is illustrated in Figure 2-1. These utilities and service connections include fuel and oily waste pipelines, electrical, stormwater, sanitary sewer, potable water, compressed air, and steam lines.

2.1 PREVIOUS INVESTIGATIONS

Following the observation of contamination during the wharf reconstruction in 1989, a contamination assessment was conducted in July and August 1991 and supplemented in March and June 1993. A Contamination Assessment Report (CAR) was submitted in February 1992 to the Florida Department of Environmental Protection (FDEP). The CAR recommended a monitoring only plan (MOP) be implemented. However since free product was present in the wells at the site, the FDEP required that the product be manually recovered. Also at the request of the FDEP, supplemental field investigative activities were conducted at the site. The activity objectives were to identify petroleum contaminants and their likely sources at the site, assess the degree and extent of petroleum contamination in the soil

S:\NAS Key West\Cad\7846UL01



DRAWN BY LLK DATE 4/18/00		SITE UTILITIES MAP BUILDING 189 TRUMAN ANNEX NAVAL AIR STATION KEY WEST, FLORIDA	CONTRACT NO. 7846
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED–AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2–1 REV. 0

FORM CADD NO. SDV_AH12.DWG – REV 0 – 1/20/98

and groundwater, and recommend remedial actions. These activities were conducted from June 1993 through August 1993 and a Contamination Assessment Report Addendum (CARA) was submitted November 1993.

A total of 17 soil borings, one sediment sample, 12 shallow monitoring wells, and 1 deep monitoring well were advanced or installed at the site. Soil and groundwater quality samples were analyzed for constituents of the kerosene and mixed products analytical group as defined in Chapter 17-770, FAC. Free product was observed in two monitoring wells. The free product was a viscous, tarry substance that resembles Bunker C fuel. Total recoverable petroleum hydrocarbons (TRPH) and pyrene were the only contaminants detected in the groundwater samples collected in June 1993. Contaminants were not detected in the sample collected from the vertical extent monitoring well MW-13D, which was screened from 30 to 35 feet below land surface (bls).

The hydrogeologic investigation included lithologic descriptions of the subsurface, monitoring well installation, and groundwater level measurements.

2.1.1 Geologic and Hydrogeologic Characteristics

2.1.1.1 Regional Geology and Hydrogeology

The lower Keys, which are within the southern geomorphic division of Florida, were formed during the Pleistocene era. The Keys are known as the "Oolitic Keys", a reference to the Oolitic Member of the Miami Limestone. The Oolitic Member consists of variably sandy, fossiliferous limestone composed primarily of ooids. The Oolitic Member is divided into two lithofacies: an ooid calcarenite and an oomoldic-recrystalline facies. The Key Largo Limestone underlies the Miami Limestone. The Key Largo Limestone is a light gray to light yellow coralline limestone comprised of coral heads encased in a matrix of cacarenite. In the Key West area, the Miami Limestone is approximately 27 feet thick and the Key Largo limestone is greater than 270 feet thick.

The surficial aquifer system present in the lower Keys in an unconfined, porous, highly permeable solution-ridden unit, as described above. Rainfall recharge seeps quickly into the ocean and saltwater intrusion is common. The water table ranges in depth from less than 1-foot to approximately 2.5 feet below msl and fluctuates diurnally due to tidal effects. The surficial aquifer is non-potable and classified G-III due to its high total dissolved solid content.

2.1.1.2 Local Geology

The soils at the site are primarily fill material, composed of tan to brown calcareous sand with limestone cobbles to a depth of 5 to 6 feet bls. The fill material is underlain by tan to light gray to white weathered limestone. Other major soil groups at Key West consist of gravelly sand and calcareous clay, marl, and weathered bedrock.

2.1.1.3 Local Hydrogeology

Hydrogeologic conditions of the shallow aquifer were determined from well installations, water-level measurements, and field testing of hydraulic properties. The depth to groundwater at the site varies from 4 to 6 feet bls. Groundwater flow direction is predominantly to the west. A tidal influence study indicated that tidal fluctuations cause groundwater elevation change of up to 1 foot and reverse the groundwater flow direction at the site during high tide. Static groundwater level measurements on November 25, 1999 were used to develop the map of the potentiometric surface shown in Figure 2-2.

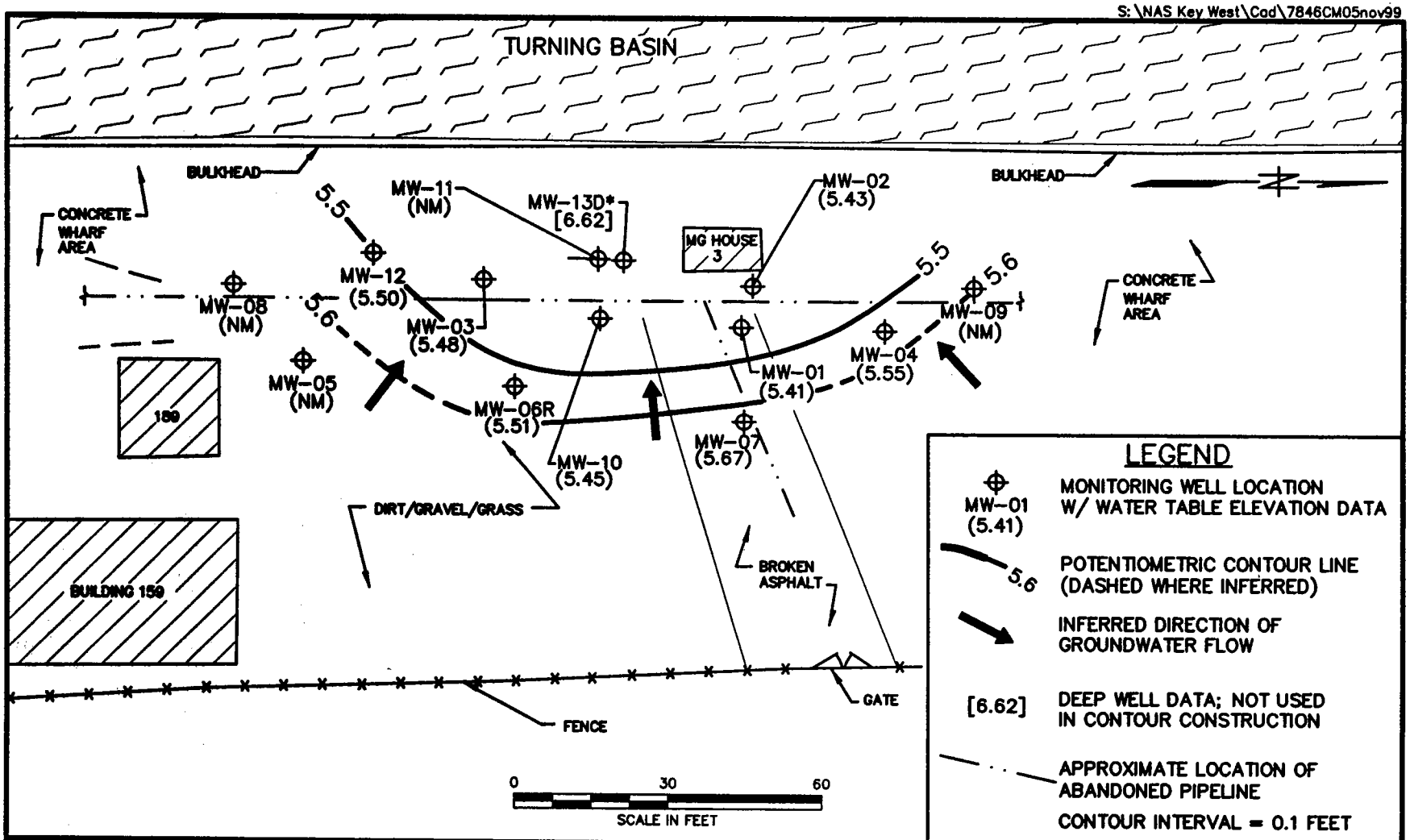
2.1.2 Contamination Assessment

The proposed AS/SVE system will address subsurface soil and groundwater contaminated with dissolved and free-phased petroleum compounds. The following is a general discussion of the site contaminants.

2.1.2.1 Soils

Soils in the site area were screened with an Organic Vapor Analyzer (OVA) to determine the presence of contaminated soil during the CARA conducted in August 1993. Results of the screening did not reveal the presence of excessively contaminated soils. OVA readings greater than 10 parts per million (ppm) were identified in two soil borings. Petroleum contaminants were identified in the sediment sample collected from the floor of the turning basin adjacent to the seawall at the site. However these results were attributed to former Naval activities in the turning basin.

S:\NAS Key West\Cad\7846CM05nov99



LEGEND

- MW-01 (5.41) — MONITORING WELL LOCATION W/ WATER TABLE ELEVATION DATA
- 5.6 — POTENTIOMETRIC CONTOUR LINE (DASHED WHERE INFERRED)
- INFERRED DIRECTION OF GROUNDWATER FLOW
- [6.62] — DEEP WELL DATA; NOT USED IN CONTOUR CONSTRUCTION
- APPROXIMATE LOCATION OF ABANDONED PIPELINE
- CONTOUR INTERVAL = 0.1 FEET

DRAWN BY / DATE	LLK 12/30/99
CHECKED BY / DATE	
COST/SCHED--AREA	
SCALE	AS NOTED

POTENTIOMETRIC SURFACE MAP
NOVEMBER 25, 1999
BUILDING 189
TRUMAN ANNEX
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO.	7846
APPROVED BY / DATE	
APPROVED BY / DATE	
DRAWING NO.	FIGURE 2-2
REV.	0

FORM CADD NO. SDV_AH12.DWG - REV 0 - 1/20/98

2.1.2.2 Groundwater

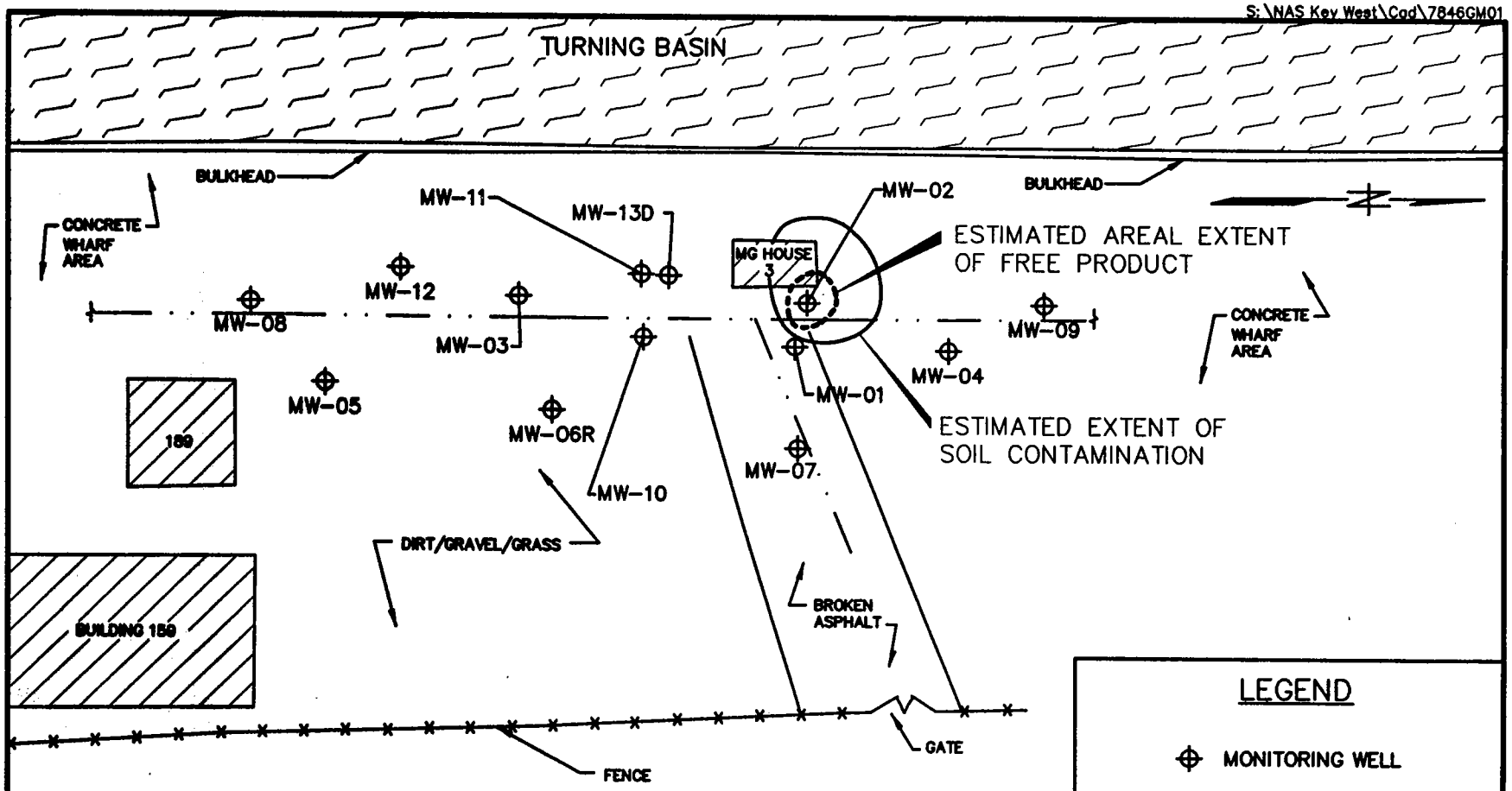
During the CARA conducted in August 1993, groundwater samples were collected from all existing wells. Free product was observed in monitoring wells MW-1 and MW-3. The free product was a viscous, tarry substance that resembles Bunker C fuel. TRPH and pyrene were the only contaminants detected in groundwater samples collected in June 1993. TRPH concentrations exceeded the state target levels for G-III groundwater.

Monitoring at the site resumed in 1998 on a quarterly basis. The objectives of the quarterly monitoring program was to evaluate the contaminant plume stability and monitor product recovery efforts until cleanup levels are achieved. The monitoring program was conducted for a total of six quarters, and the final quarter was completed in November 1999. At the end of this quarter hydrocarbon levels in all wells were below detection limits. Free product was present only in monitoring well MW-2 at a thickness of <0.01 feet. The product could not be recovered any further as its viscous nature prevented it from entering the bailer. The areal extent of the remaining free product layer is shown on Figure 2-3.

2.1.2.3 Contaminants of Concern

The contaminants of concern (COC) in the groundwater, based on the first two quarterly monitoring events, were Benzo(a)anthracene, Benzo(a)pyrene and Indeno(1,2,3-cd)pyrene. These compounds were detected in monitoring wells MW-2 and MW-3. Free product consisting of tarry Bunker C fuel oil is present in the vicinity of MW-2.

S:\NAS Key West\Cad\7846GM01



DRAWN BY: LLK	DATE: 4/18/00	SOIL AND FREE PRODUCT DISTRIBUTION BUILDING 189 TRUMAN ANNEX NAVAL AIR STATION KEY WEST, FLORIDA	CONTRACT NO. 7846
CHECKED BY	DATE		APPROVED BY / DATE
COST/SCHED-AREA			APPROVED BY / DATE
SCALE: AS NOTED			DRAWING NO. FIGURE 2-3 / REV. 0

FORM CADD NO. SDV_AH12.DWG - REV 0 - 1/20/98

3.0 SYSTEM DESIGN AND INSTALLATION

An AS/SVE Treatability Study will be initiated at the site. The Treatability Study will determine the applicability of AS/SVE for removing volatile organic compounds (VOCs) present in the soil and groundwater via volatilization and stimulation/enhancement of bioremediation. The AS/SVE system will inject air into the groundwater via two injection wells and extract vapors from the vadose zone via one extraction well.

The pilot-scale system operation, and associated sampling and analysis activities, are divided into two phases: a short-term test to evaluate the physical components for the long-term system, and a long-term evaluation phase (Phase I and Phase II) to evaluate effectiveness. The results from the Phase I system operation will be used to determine the AS/SVE equipment settings for the long-term evaluation. Phase I operation of the pilot-scale system will also be used to determine the effective radii of influence, off-gas treatment requirement, flow rate requirements, vacuum and injection pressures, and removal efficiencies. The pilot-scale system can be designed such that the system is expanded or modified as needed for Phase II operation.

Phase I will use two injection wells and one extraction point and will employ a temporary, trailer-mounted pilot test unit to test the subsurface characteristics for AS/SVE suitability. During Phase I, four off-gas samples for VOCs, oxygen (O_2), and carbon dioxide (CO_2) will be collected from the discharge of the vapor extraction blower. Dissolved oxygen (DO) and CO_2 in groundwater will be collected in four monitoring wells using field test kits. The system will then be shut down while initial results including radii of influence, estimated flow rates, pressures, vacuums, horsepower, and electrical requirements will be evaluated. Phase I operation is anticipated to last approximately 2 days.

If Phase I results identify that site conditions are suitable for AS/SVE, then adjustments to the system for Phase II operation will be determined. Evaluation of the system to determine its effectiveness to remediate the dissolved and free-phased petroleum contamination will be conducted during Phase II. TtNUS does not anticipate the need to install additional injection and extraction wells prior to Phase II. For estimating purposes, the radius of influence of 20-feet was used for the injection wells. Depending on off-gas concentrations, treatment may or may not be required. It is assumed that two 350-lb activated carbon units will be used to treat the off-gas prior to release to the atmosphere during Phase I and II. It is anticipated that Phase II will last approximately 12 months.

Low permeability vapor barriers are often placed over a site to increase the size of the impact area of each well. Part of the site's surface is paved with concrete, however the area 15-feet east of the detection of the highest contamination is unpaved. Phase I will evaluate AS/VE without the use of a vapor barrier. However, if Phase I indicates that excessive short-circuiting from above-ground is occurring, then a vapor barrier may be added as part of Phase II.

The native material underlying the site, mainly fill material and limestone, is expected to provide good transmission of forced air and soil vapor which is necessary for this technology. Typical air injection and extraction rates for an individual well are 6 to 10 cubic feet per minute (cfm) and 9 to 15 cfm, respectively. Given the conditions at the site, these typical air flow rates may be obtained with relatively low pressures or vacuums.

3.1 PERMITS

It is believed that the AS/SVE system will not require any permits unless off gas emissions exceed 13.7 lbs/day of VOCs (EPA OSWER Directive [9355.0-28]).

It is anticipated that a permit will not be required for Phase I because the tests will be conducted approximately 8 hours per day at a source of relatively low VOC concentrations. The pilot test unit will be equipped with a 350-lb vapor phase carbon drum to treat the extracted air. This will ensure that emissions will be less than the regulated quantity. Concentrations of VOCs in the extracted soil vapor will be evaluated during Phase I using both real time measurements and fixed-based laboratory results to determine if treatment of off gas will be required during Phase II.

3.2 INSTALLATION OF PILOT-SCALE SYSTEM

The Phase I pilot-scale system will consist of an air injection system, a soil vapor extraction system, and soil vapor groundwater monitoring points. Prior to, during, and after the pilot-scale system operation, samples of groundwater and soil gas will be collected and analyzed. (See Section 5.0 for further discussion of monitoring and sampling activities).

Standard Operating Procedures (SOPs) applicable to the field work associated with this project can be found in the FDEP SOP (FDEP, 1992)

TtNUS will prepare specifications and obtain subcontractors for well drilling, investigation-derived waste (IDW), and laboratory analytical services. All field team members will review this Work Plan and the updated Health and Safety Plan (HASP) prior to mobilization.

A bound, weatherproof site logbook shall be maintained by the Field Operations Leader (FOL). The requirements of the site logbook are outlined in TtNUS SOP SA-6.3, Sections 5 and 7. This book will contain summaries of each day's activities.

3.2.1 Well Installation

Two 2-inch diameter air sparging wells (AS-1 and AS-2) will be installed to the north and south of MW-2 and used as the injection points. Monitoring well MW-2 will be replaced with a 5-inch diameter well, which will be used as the vapor extraction well (SVE-1). The soil vapor extraction well (SVE-1) will be screened from 1-16 ft bgs. The extraction well will serve two purposes, to extract vapors from the vadose zone, and to act as a collection point for the recovery of free-phased product

To monitor the effects of AS/SVE on the subsurface, one 2-inch observation well (OW-1) will be installed approximately 20 ft from SVE-1 and from AS-1 and AS-2 in the downgradient direction. Two other existing wells, MW-1 and MW-4 located approximately 10 ft and 30 ft from SVE-1 will also be used as observation wells. Observation well OW-1 will be installed with 5 ft of screen above the water table and 5 ft screen below the water table. The depth to water table in the proposed location is approximately 5 to 6 ft bls. Therefore, the wells will be screened from 1 ft to 10 ft bls. The locations of the proposed vapor extraction, injection wells and observation well are shown on Figure 3-1.

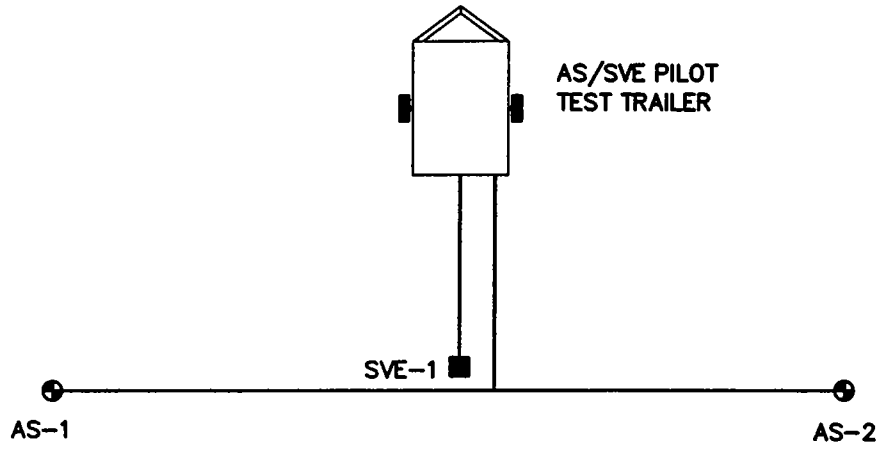
The well boring for the SVE-1 well will be advanced using a minimum 8.25-inch inside diameter hollow-stem auger and the injection wells and the observation well will be installed using a minimum 6.25-inch inside diameter hollow-stem auger. All wells, except for SVE-1, will be constructed of Schedule 40, flush-joint, 2-inch diameter, National Sanitation Foundation (NSF) approved poly vinyl chloride (PVC) well screen and riser pipe. SVE-1 will be constructed with 5-inch diameter Schedule 40 PVC. The well screens will have a slot size of 0.01 inches and supplied with a PVC end cap.

Once the screen and riser pipe are in place, the annulus of the boring will be backfilled with clean 20/30 U.S. standard sieve size silica sand from the bottom of the boring to two feet above the top of the well screen in all of the wells except SVE-1. Sand will always be maintained several inches inside of the augers during installation to ensure an adequate sand pack around the well. A one-foot thick layer of 30/65 U.S. standard sieve size silica sand will be installed on top of the sand pack and will serve as a seal. The thickness of the sand pack and seal will be constantly monitored using a weighted stainless steel or plastic tape. The remainder of the annulus of the borehole (from the seal to the ground surface)

will be grouted with neat cement grout through a tremie pipe. Well construction details are depicted on Figure 3-2.

The new system and observation wells will be developed a minimum of 24 hours after installation to allow the cement grout to cure. The wells will be developed to remove sediments in the wells by bailing and surging and/or by pumping using a submersible pump in accordance with TtNUS SOP SA-1.1. Measurements of pH, temperature, specific conductance, and turbidity will be collected after each well casing volume until pH, temperature, and specific conductance are within +/- 5 percent. If these criteria cannot be met (+/- 5 percent), the well will be developed until the purged water is clear and sediment-free by visual determination.

S:\NAS KEY WEST\CAD\7846\7846CM02



LEGEND

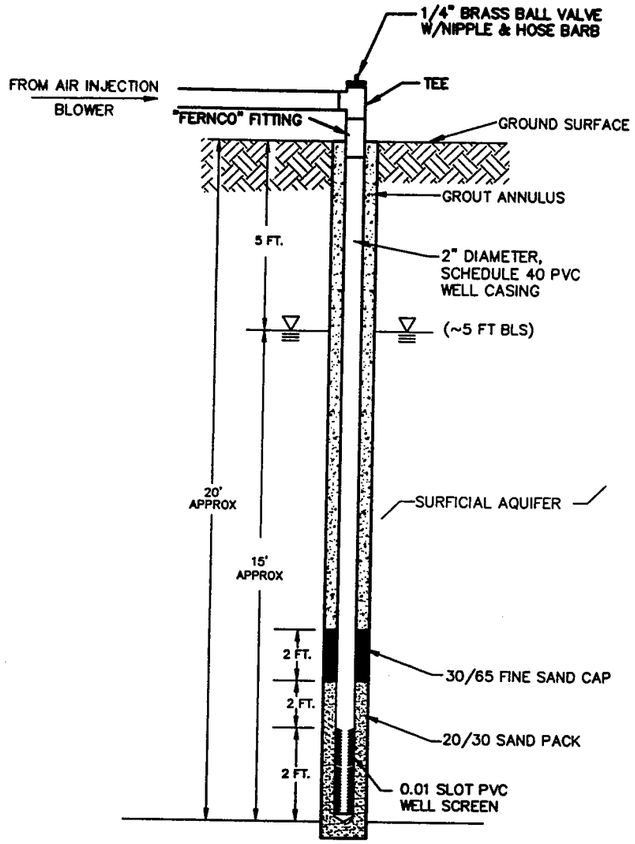
- SOIL VAPOR EXTRACTION WELL
- AIR SPARGING WELL
- OBSERVATION WELL

0 10 20

SCALE IN FEET

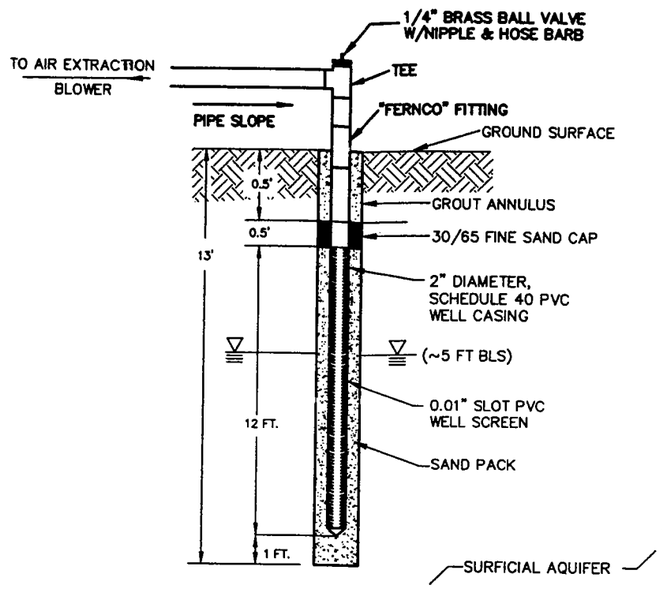
DRAWN BY LLK DATE 4/18/00		AS/SVE SYSTEM LAYOUT BUILDING 189 TRUMAN ANNEX NAVAL AIR STATION KEY WEST, FLORIDA	CONTRACT NO. 7846
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3-1 / REV. 0

S:\NAS KEY WEST\CAD\7846\7846CD01



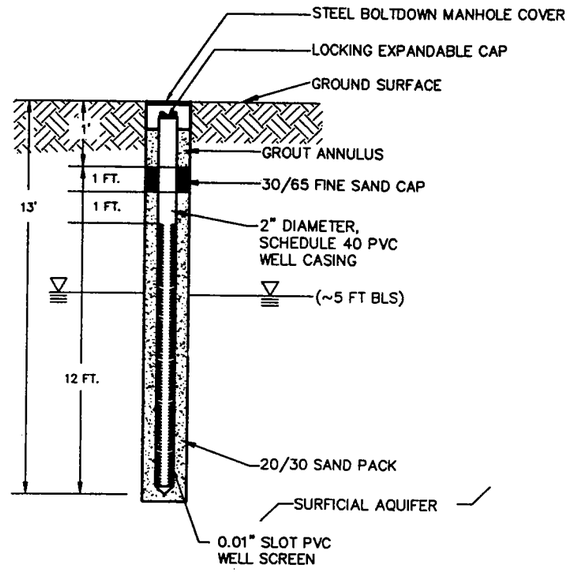
INJECTION WELL DETAIL

NOT TO SCALE



EXTRACTION WELL DETAIL
PROPOSED SVE1

NOT TO SCALE



OBSERVATION WELL DETAIL (TYPICAL)
OW1, OW2, OW3

NOT TO SCALE

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 4/21/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

WELL CONSTRUCTION DETAILS
BUILDING 189
TRUMAN ANNEX
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 7846
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 3-2
REV. 0

3.2.2 Air Sparging/Soil Vapor Extraction Equipment

The pilot test unit is trailer mounted and consists of two rotary, positive displacement blowers, one for injection and one for extraction. A single, 3-phase, 5 horsepower motor drives both blowers via a belt system. The injection blower is capable of 12 pounds per square inch (psi) at 56 cfm and the extraction blower is capable of 14 inches of mercury vacuum at 52 cfm. The desired pressure or vacuum will be regulated by throttling system valves. The injection blower will be capable of evacuating the water column in the injection well (approximately 8 psi) plus overcome head losses due to friction in the transfer line. The pilot test unit also includes a moisture separator, activated carbon canister for off-gas treatment, flow meters, gauges, sampling ports, and a noise silencer. Electrical service will be obtained from an existing power supply at the pier area. A plan view of the pilot test unit is illustrated in Figure 3-3.

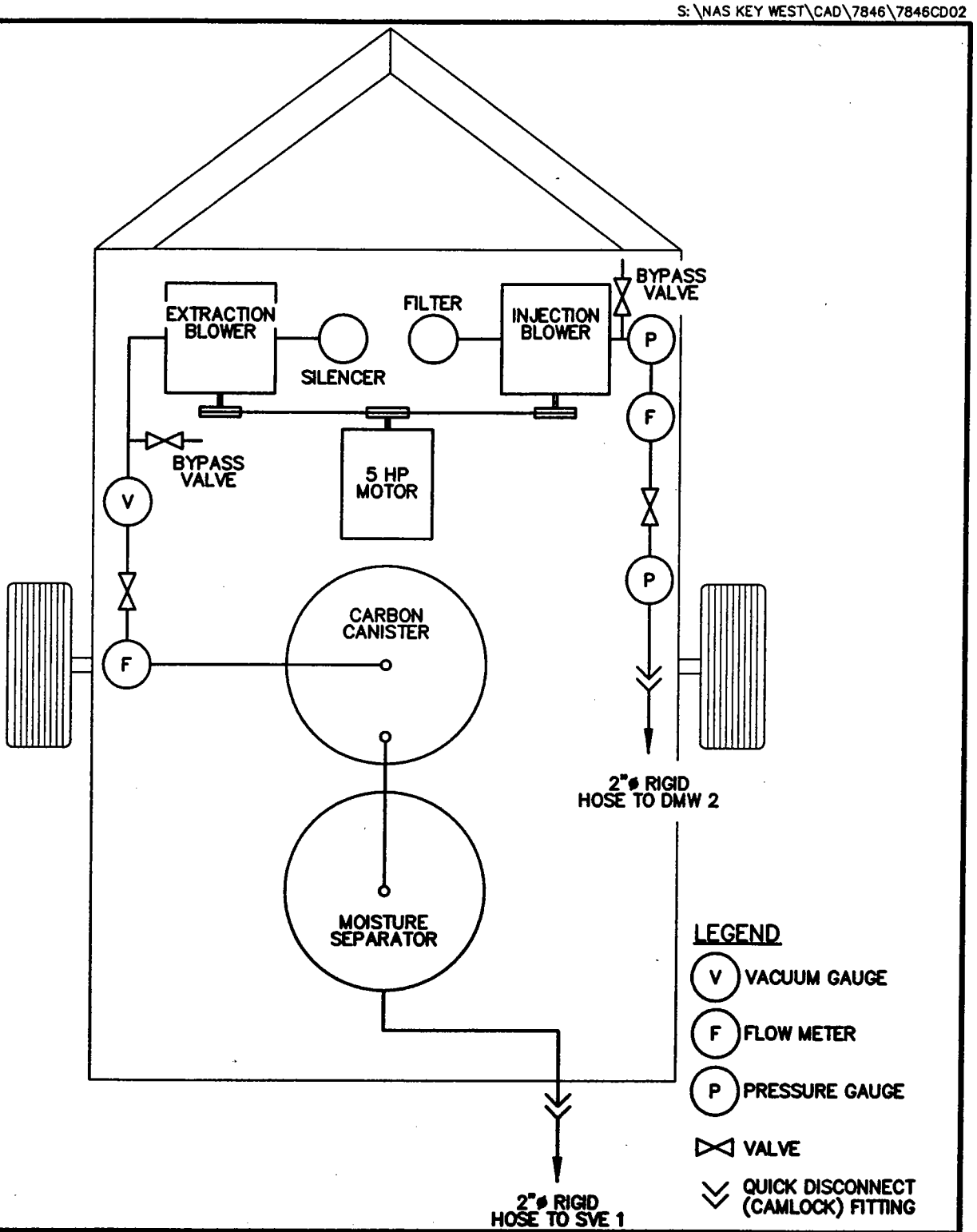
3.2.3 Piping

Air transfer piping between the blowers and the injection and extraction wells will be installed above ground using 2-inch diameter schedule 40 PVC. The PVC pipes will be connected to the blowers using 2-inch hoses equipped with quick-disconnect camlocks.

3.2.4 Investigation-Derived Waste (IDW)

Drill-cuttings produced during well installation will be containerized in 55-gallon, Department of Transportation (DOT) approved metal drums. Development water, purge water, and decontamination water will also be containerized in separate similar drums. All drums will be labeled with the following: contents, date, and source. All IDW will be handled in accordance with the United States Environmental Protection Agency (USEPA) guidance document "Management of Investigation-Derived Wastes During Site Inspections", (USEPA , 1991).

S:\NAS KEY WEST\CAD\7846\7846CD02



DRAWN BY LLK DATE 4/21/00		TRAILER MOUNTED AS/SVE PILOT TEST UNIT EQUIPMENT LAYOUT BUILDING 189 TRUMAN ANNEX NAVAL AIR STATION KEY WEST, FLORIDA	CONTRACT NO. 7846
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 3-3 REV. 0

4.0 SYSTEM OPERATION AND TESTING

The objectives of the treatability study are:

- Determine the effective radius of influence and physical operating parameters of the vapor extraction system, air injection system, and combined vapor extraction and air injection systems in the soil and groundwater.

- Determine the suitability of AS/SVE to remediate site contaminants and given site conditions, and to expand the system to determine the long-term effects of the AS/SVE on the subsurface conditions.

Phase I will be conducted following well and system installation. During this time, the vapor extraction and air injection systems will be operated separately and together. Phase II operation will begin once the modifications to the existing layout are installed. Once the final well configuration is obtained, the system will be operated with monthly evaluations of system effectiveness. Groundwater samples will be collected by the TtNUS field team over the term of the treatability study according to the procedures outlined in the Field Sampling Plan (Section 5.0).

4.1 PHASE I TESTING

Phase I will include the installation of one extraction, one observation, and two injection wells; installation of the pilot test unit to the extraction and injection wells; and baseline sampling and analysis.

Subsequent to the well and piping installation, Phase I will be conducted in three separate tests: soil vapor extraction only, air sparging only, and combined AS/SVE. Test procedures and forms for collecting the data are provided in Appendix A.

The data obtained during Phase I will be used to determine the respective radii of influence and physical operating parameters for the AS/SVE systems. The results of the analysis will help in evaluating the initial effectiveness of this remedial technology for this site. The results of the off-gas analyses will be used to determine if off-gas treatment will be necessary during Phase II. The determined radii of influence will be used to evaluate the number of additional remediation wells required to fully influence the contamination plume during Phase II.

Forms for recording pertinent Operation and Maintenance (O&M) data will be developed and included in the Technical Report prior to the implementation of the Phase II testing. These forms will include a list of

the necessary activities required, and their schedule to properly maintain the AS/SVE system in operating condition.

4.2 PHASE II TESTING

The activities associated with Phase II include installation of a semi-permanent power source to the equipment, expansion of the Phase I system as necessary, and O & M of the system for a 12-month period. The O & M of the system will include monthly upkeep of the equipment and periodic air and groundwater sampling. A quarterly evaluation of the system will be used to determine if system operation is progressing toward the Treatability Study Objectives. If it is identified that the goals have been achieved and the system has effectively reduced the levels of free-phased product, then this phase of the study will be considered complete.

5.0 FIELD SAMPLING

Field sampling will include collection of air and groundwater samples during the installation, start-up, and operation of the pilot-scale AS/SVE system. The proposed analytical testing for the pilot-scale operations is summarized in Table 5-1. Dissolved hydrocarbons have not been detected in the source area over the past year of groundwater monitoring at the site, therefore groundwater samples will not be collected as a means for evaluating the effectiveness of the treatability study.

The sampling activities to be conducted in conjunction with this treatability study are outlined below.

5.1 AIR SAMPLING

5.1.1 Field VOC Analysis

An OVA equipped with a flame-ionization detector (FID) will be used for VOC analysis during Phase I. VOC samples during SVE, AS, and AS/SVE tests will be collected at the frequency recommended in Table 5-1.

Soil vapor samples will be collected from the exhaust of the SVE blower during the SVE and AS/SVE tests and in the observation wells during the AS test. The air samples collected from the exhaust give an indication of the effectiveness of SVE and AS/SVE in cleaning up impacted soils and groundwater, and the need for offgas treatment. The air samples collected from the observation wells during the AS test can also be used to estimate the radius of influence of the AS test (Mobil U.S. Marketing Division, 1993).

Soil vapor samples will be obtained by attaching one end of a flexible hose to an inline sampling port and attaching the other end of the hose to a tedlar sample bag. With the sampling port opened, air under positive pressure is allowed to purge ambient air in the hose. As soon as the Tedlar bag is connected to the hose, the valve on the tedlar bag is opened to allow it to be filled. Once full, the bag's valve is closed and connected to the OVA via a similar tube for analysis. The tedlar bag will be purged with clean air three times prior to reuse.

5.1.2 Fixed-Based Laboratory Soil Vapor Sampling

During Phase I and Phase II, soil vapor samples for laboratory analysis will be collected. During Phase I, untreated and undiluted air samples (without carbon treatment and with the air makeup valve closed) will

be collected in tedlar bags from the vacuum pump exhaust during the SVE-only test and during the AS/SVE test.

TABLE 5-1

PROPOSED ANALYTICAL TESTING FOR AS/SVE PILOT TEST
NAS KEY WEST
KEY WEST, FLORIDA
PAGE 2 OF 2

PHASE I

Task	Event	Media	Location	No. of Samples	Fixed-based Laboratory Analysis	Field Analysis
Groundwater monitoring	Prior to any Test	Groundwater	OW-1, MW-1 and MW-4 and SVE-1	1 per event	N/A	DO, CO_2 , free product thickness
SVE Test	After vacuum readings become asymptotic (+/- 10%), or every 10 minutes	Soil Vapor	SVE-1 (collect from SVE prior to bleed air)	1 per event		OVA/FID
AS Test	Start-up, every 15 minutes for the first hour, and every 30 minutes thereafter (or until DO, VOC and pressure readings become stable (+/- 10%)	Groundwater	OW-1, MW-1, MW-4, and SVE-1	4 per event		DO, OVA/FID headspace in well
AS/SVE Test	After vacuum readings become asymptotic with extraction pump only operating	Soil Vapor	SVE-1	1 per event	VOCs	
AS/SVE Test	Start-up, every 15 minutes for the first hour, and every 30 minutes thereafter (or until DO, VOC and pressure readings become stable	Groundwater	OW1, MW-1, and MW-4	3 per event		DO, O_2

TABLE 5-1

PROPOSED ANALYTICAL TESTING FOR AS/SVE PILOT TEST
NAS KEY WEST
KEY WEST, FLORIDA
PAGE 2 OF 2

Task	Event	Media	Location	No. of Samples	Fixed-based Laboratory Analysis	Field Analysis
AS/SVE Test	Start-up, every 15 minutes for the first hour, and every 30 minutes thereafter (or until DO, VOC and pressure readings become stable	Soil Vapor	Vacuum pump exhaust	1 per event		OVA/FID
AS/SVE Test	After pressure/vacuum readings in the observation wells become stable	Soil Vapor	Vacuum pump exhaust	1 per event	VOCs	

PHASE II

Task	Activity	Media	Location	No. of Samples	Fixed-based Laboratory Analysis	Field Analysis
Start up	Initial sampling	Soil vapor(untreated and undiluted)	Vacuum pump exhaust	1 sample	VOCs, O_2, CO_2	OVA/FID reading from vapor stream
Start up	Initial sampling	Air (treated)	After first carbon drum	1 plus 1 blank	VOCs, O_2, CO_2	OVA/FID reading
O & M	Monthly (until emission requirements are met)	Soil vapor (untreated and undiluted)	Vacuum pump exhaust	1 sample	VOCs, O_2, CO_2	OVA/FID reading
O & M	Monthly (until emission requirements are met)	Soil Vapor	After first carbon drum	1 sample	VOCs, O_2, CO_2	OVA/FID reading

Note: If the first carbon drum indicates breakthrough, the second drum will be installed in place of the first drum and a new drum installed in place of the second drum.

The samples will be analyzed at a fixed-based laboratory for VOCs. The results of the analyses will be used to evaluate the method of offgas treatment during Phase II and to help evaluate the potential for natural biodegradation. During Phase II, untreated and treated air samples will be collected for VOC analysis. The untreated air samples will permit calculation of the amount of contaminants extracted and the treated air samples will indicate the effectiveness of the offgas treatment (if required). The results of the analysis will also determine when off-gas treatment may be discontinued. The results of the treated sample will be an indication the effectiveness of the carbon and how the system complies with the discharge requirements.

5.2 QUALITY ASSURANCE

This section identifies required Quality Assurance/Quality Control (QA/QC) measures to be employed during both the short-term and long-term evaluation phases of the pilot scale AS/SVE Treatability Study.

The elements of the QA/QC program in support of the treatability study include the following:

- Field documentation
- Field measurements
- Field analysis
- Laboratory analysis
- Sample collection, handling preservation, and sample Chain of Custody
- QC samples

5.2.1 Field Documentation Responsibilities

It will be the responsibility of the FOL to secure all documents (daily logs, sampling logs, communications, etc.) produced in the field at the end of each work day.

The possession of all records will be documented; however, only the FOL or designee may remove field data from the site for reduction and evaluation.

The analytical data generated using field equipment will be sent to the TtNUS Task Order Manager (TOM) for incorporation into the AS/SVE Quarterly Field Operations Summary Reports.

5.2.2 Field Measurement

Field measurements shall include those associated with the collection of air, soil, and groundwater samples. Measurements such as flow rates, air volume, pressure, temperature, and physical water quality measurements shall be recorded in the field logbook or on the log forms included in Appendix A.

Field measurements shall also include those associated with the completion of soil borings and well installation.

5.2.3 Field Analysis

Field analyses of both air and groundwater samples shall be conducted during the treatability study.

Analysis of air samples for the determination of VOCs shall be conducted using an OVA equipped with a FID. Operation of this equipment shall be conducted in accordance with TtNUS SOPs ME-13.

Field test kits shall be used to determine the concentrations of DO and dissolved CO_2 in groundwater samples. Analysis for both DO and CO_2 using the field test kits shall be conducted upon collection of the sample.

Field equipment used during this project will be calibrated and operated in accordance with the manufacturer's instructions and manuals. A log will be kept documenting the calibration result for each field instrument. The log will include the data standards, personnel, and results of the calibration.

5.2.4 Laboratory Analysis

An analytical laboratory experienced in chemical analysis shall perform analysis on the samples for the determination of VOCs in the soil vapor samples. The analytical methodologies to be used in this study are summarized on Table 5-2.

The samples shall be prepared and analyzed in accordance with method specific requirements.

5.2.5 Sample Handling and Preservation, Custody, and Shipment

Sample handling, preservation, custody, and shipping requirements are described in the following sections.

TABLE 5-2

**AS/SVE PILOT-SCALE SYSTEM
ENVIRONMENTAL SAMPLE SUMMARY
NAS KEY WEST
KEY WEST, FLORIDA**

Analyte	Method	Number of Groundwater Samples	Number of Air Samples	Total Samples
VOCs(1 and 2)	TO-14A (EPA Method 18)		29	29
Dissolved O_2(1)	TEST KITS	4		4
Dissolved CO_2(1)	TEST KITS	4		4
Dissolved O_2(2)	TEST KITS	48		48
Dissolved CO_2(2)	TEST KITS	48		48

(1) Analyses for Phase I (short-term study)

(2) Analyses for Phase II (long-term study)

5.2.5.1 Sample Handling and Preservation

Sample handling includes field-related consideration regarding the selection of sample containers, preservatives, allowable holding times, and requested analyses. Table 5-3 summarizes the sample handling requirements for samples collected.

5.2.5.2 Sample Custody

Samples will be recorded on chain-of-custody records by the FOL. Chain-of-custody records must include the identification numbers of all samples collected on a given day, the time of collection, the names of the samplers, and all others who subsequently held custody of the samples. The chain-of-custody must also include the chemical analyses requested. Chain-of-custody sample forms will be completed to the fullest extent possible prior to sample shipment. The forms must include the following: project name, sample identification number, time collected, source of the sample location, matrix, type of sample, grab or composite, preservative, number and size of bottle, required analysis, and name of the sampler.

Samples collected will be the responsibility of identified persons from the time they are collected until they are transferred. Stringent chain-of-custody procedures will be followed to document sample possession.

The FOL, or appropriate designee, is responsible for the care and custody of the samples collected until they are delivered to the analytical laboratory or entrusted to a carrier. Transfer of custody to another party (e.g. express mail or the laboratory) must be formally documented on the chain-of-custody records.

Sample logs or other records must be signed and dated.

Chain-of-custody forms must be filled out in a legible manner using waterproof ink and will be signed by the sampler. Similar information will be provided on the sample label, which will be securely attached to the sample bottle or container.

Containers used to ship samples must be sealed according to USEPA requirements to maintain sample integrity. All shipments must be accompanied by the chain-of-custody record identifying the contents. The original record will accompany the shipment and the field sampler will retain a copy.

TABLE 5-3

**HOLDING TIME AND BOTTLEWARE REQUIREMENTS
FOR AS/SVE PILOT TEST
NAS KEY WEST
KEY WEST, FLORIDA**

Matrix	Analysis	Bottleware	Preservation	Holding Time
Air	TCL volatile organic compounds using TO-14A	Tedlar bags	None	3 days from date of collection

5.2.5.3 Sample Shipment Procedures

Samples requiring refrigeration will be promptly chilled with ice to a temperature of 4° C and will be packaged in an insulated cooler for transport to the laboratory. Ice will be sealed in containers to prevent leakage of water. Samples will not be frozen. Air samples will be containerized in a sealed cooler and do not require refrigeration.

Only shipping containers that meet all applicable state and federal standards for safe shipment will be used.

Shipping containers will be sealed with nylon strapping tape, custody seals will be signed, dated, and affixed, in a manner that will allow the receiver to quickly identify any tampering that may have occurred during the transport to the laboratory.

Shipments will be made using an overnight courier. After samples have been collected, they must be sent to the laboratory within 24 hours.

5.2.6 Quality Control Samples

This section identifies required QA/QC samples to be collected during both the short-term and long-term evaluation phases of the pilot scale AS/SVE Treatability Study.

In addition to regular calibration of field equipment and appropriate documentation, QC samples will be collected during the AS/SVE sampling activities. QA/QC samples will not be required for sampling associated with monitoring the treatability system. QC samples include field duplicates and trip blanks. Table 5-2 summarizes the environmental samples by analytical parameter and methodology, media, and associated QC samples.

5.3 BOTTLEWARE

Bottleware and containers are summarized in Table 5-3. Pre-cleaned bottles and lab certified tedlar bags shall be used to collect environmental samples.

5.4 SAMPLE IDENTIFICATION SYSTEM

Each sample submitted to the fixed-base laboratory for chemical analysis will be assigned a unique sample identification number. The sample identification number will consist of a five segment, alphanumeric code, which identifies the site, sample type (medium), sample location, sample depth, and sample period (round).

The alphanumeric coding to be used in the sample identification system is as follows:

Field Samples

(AAA)	-	(AA)	-	(AA) (NN)	-	(NN)	-	(NN)
(Site name)	-	(Sample type)	-	(Sample location)	-	(Sample Depth)	-	Round

Character Type: A - Alphanumeric; N - Numeric

Site Name: NKW - Naval Air Station Key West

Sample Type: AS - Air Sample; GW - Groundwater sample; SB - Soil sample

Sample Location: 02 - Groundwater well (monitoring well) 02.

Sample Depth: Soil - Depth from ground surface to soil sample.
Air and Groundwater- Use none (00).

Sample Round: 01- Round 1

QA Sample Type Designation: TB - Trip Blank
FB - Field Blank
FD- Field Duplicate

QA sample designations will be blind relative to field duplicates. Other pertinent information regarding sample identification will be recorded in the field log books and sample log sheets.

Using this nomenclature scheme, the following is an example for a sample collected from Observation Well No. 1 during round 1: NKW - GW - OW01 - 00 - 01

5.5 RECORD KEEPING

In addition to chain-of-custody forms, certain standard forms will be completed for each sample.. These shall include sample log sheets, boring logs, daily records of subsurface investigation reports and logbooks.

A bound/weatherproof notebook shall be maintained by each sampling event leader. All information related to sampling or field activities will be recorded in the field notebooks. This information will include, but is not limited to sampling time, weather conditions, unusual events, field measurements, descriptions of photographs, etc.

At the completion of field activities, the FOL, shall submit to the TOM, all field relevant records including field notebooks, chain-of-custody receipts, sample log sheets, drilling logs, daily logs, etc.

6.0 REPORTING

Performance data from the long-term AS/SVE evaluation phase will be incorporated into the quarterly Treatability Study Evaluation Reports. These reports will include groundwater flow maps, summary of laboratory analytical results of off-gas sample, free-phased product gauging data, summary of field work performed, and recommendations. Chain-of-custody forms, field forms, field screening results, and analytical reports will be included in the Appendices of the reports.

REFERENCES

ABB Environmental Services, Inc. November 1993. *Contamination Assessment Report Addendum, Berthing Wharf Building 189, Truman Annex, Naval Air Station, Key West Florida*: prepared for Southern Division, Naval Facilities Engineering Command, Charleston, South Carolina.

ABB Environmental Services, Inc. August 1994. *Remedial Action Plan, Berthing Wharf Building 189, Truman Annex, Naval Air Station, Key West Florida*: prepared for Southern Division, Naval Facilities Engineering Command, Charleston, South Carolina.

Florida Department of Environmental Protection (FDEP), 1992. *SOPs for Laboratory Operations and Sample Collection Activities*, DEP - QA-001/92. FDEP, Tallahassee, Florida.

Mobil U.S. Marketing Division, February 1993. *Air Sparging: Criteria for Use, System Design and Operation, and Concerns*

USEPA, 1991. *Management of Investigation - Derived Waste During Site Inspections*. DERR Directive 9345.3.02.

APPENDIX A

AS/SVE PILOT TEST PROCEDURES

Pre-test Preparation

1. Record time and site conditions.
2. Position the pilot study unit as close to the test wells as possible.
3. Measure and record water level, DO and CO_2 in observation wells (OW-1, MW-1, MW-4). Use a YSI flow-through cell (or equivalent) for DO and a HACH Kit (or equivalent) for CO_2.
4. Connect vacuum/pressure gages to the test wells and observation wells. The gauges should be installed as close as possible or at the well heads to minimize recording of friction losses.
5. Install dedicated tubing in each monitoring well. This tubing will be connected to a peristaltic pump for CO_2 sampling.

SVE Only Test

1. Connect SVE-1 to the vacuum pump. A 90-degree piece of PVC pipe with a quick disconnect camlock fitting on one end and a "Fernco" fitting on one end may be used to connect the extraction well to the hose leading to the vacuum pump. Ensure all connections are air-tight.
2. Measure and record distance from SVE-1 to each observation well.
3. Start the vacuum pump. Set the pump with an initial airflow of 10 scfm and record the vacuum at the extraction well.
4. Ensure that each observed vacuum does not deflect the gauge to full scale. Otherwise, replace gauge with the next higher scale. Record vacuum in each observation well every 10 minutes or until asymptotic (within +/- 10%) vacuum readings are observed.
5. Measure untreated off-gas with an OVA.
6. After asymptotic (within +/- 10%) vacuum readings are observed, increase airflow to 20 scfm. Repeat Steps 4 and 5.
7. After asymptotic (within +/- 10%) vacuum readings are observed, increase airflow to 25 scfm. Ensure groundwater is not pumped, otherwise decrease vacuum. Repeat Steps 4 and 5.
8. Shut down pilot test.

AS Only Test

1. Connect AS-1 and AS-2 to the blower. A 90-degree piece of PVC pipe with a quick disconnect camlock fitting on one end and a "Fernco" fitting on one end may be used to connect the extraction well to the hose leading to the blower. Ensure all connections are air-tight.
2. Measure and record distance from AS-1 and AS-2 to each observation well and SVE-1.
3. Calculate injection pressure. Injection pressure should overcome the hydrostatic pressure which equals the height of the column of water in AS-1 and AS-2 from the water table to the top of the screened interval multiplied by 0.43 psi/ft. Additional pressure is required to induce flow through the soils. The total injection pressure should not exceed 0.7 psi/ft or fracturing will result.
4. Start the blower. Set the blower pressure to the previously determined pressure in Step 3. Record flow rate.
5. Ensure that each observed pressure does not deflect the gauge to full scale. Otherwise, replace gauge with the next higher scale.
6. The following must be recorded sequentially at start up, every 15 minutes for the first hour, and 30 minutes thereafter:
   - pressure in AS-1 and AS-2, observation wells, and SVE-1
   - OVA readings in observation wells
   - depth to groundwater
   - DO using YSI probe (or similar) and CO_2 using a HACH kit (or similar) in observation wells.

   Note: The wellhead of each observation well must be removed temporarily to measure depth to groundwater and to measure DO. It has been observed in sites with similar lithology that pressure usually recovers within 5 minutes after a wellhead is sealed.
7. Terminate test after VOC and DO levels and pressure readings in the observation wells become asymptotic (within +/- 10%).
8. Leave set up as-is for the next test.

COMBINED AS/SVE TEST

1. Measure depth to groundwater and DO in each observation well.
2. Recalculate injection pressure with the current depth to groundwater.

3. With the vacuum pump connected to SVE-1, operate SVE at 1.5 to 2 times the flow rate recorded during AS only test.
4. After the vacuum readings in the observation wells become asymptotic (within +/- 10%), measure undiluted and untreated off-gas with an OVA.
5. Collect an undiluted and untreated air sample in a tedlar bag or SVE line from vacuum pump exhaust.
6. Start AS blower and apply the calculated injection pressure.
7. The following must be recorded sequentially at start up, every 15 minutes for the first hour, and 30 minutes thereafter:
    - pressure/vacuum in AS-1 and AS-2 and observation wells
    - OVA readings from the vacuum pump exhaust
    - depth to groundwater
    - DO using YSI probe (or similar) and CO2 using a HACH kit (or similar) in observation wells and MW7.
8. After VOC and DO levels and pressure/vacuum readings in the observation wells become asymptotic (within +/- 10%), collect an undiluted and untreated air sample in a tedlar bag from vacuum pump exhaust.
9. Terminate test.

Phase I SVE Pilot Test

NAS Key West

Time	Pump (" H_2O Vac)	SVE1 (" H_2O Vac)	Flow Rate (scfm)	VOC (ppm)	OW-1 (" H_2O Vac)	MW-1 (" H_2O Vac)	MW-4 (" H_2O Vac)

Start Time: _____

Phase I AS Pilot Test

NAS, Key West

Time	Flow Rate (scfm) SVE1	Blower Pressure (psig)	Injection Press. (psig) AS-1	AS-2	Pressure (" H2O) SVE1	OW1	MW-1	MW-4

Time	Depth to Water (ft) OW1	MW-1	MW-4	GW Dissolved Oxygen (mg/L) OW1	MW-1	MW-4

Start Time: _____

Time	OVA OW1	MW-1	MW-4	CO_2 OW1	MW-1	MW-4

Phase I AS/SVE Pilot Test
NAS Key West

	SVE				AS				
	Pump Vacuum	SVE1 Vacuum	Flow Rate	OVA	Pump Pressure	Pressure		Flow Rate	
						AS-1	AS-2	AS-1	AS-2
Time	(in H2O)	(in H2O)	(scfm)	(ppm)	(psi)	(psi)		(scfm)	

Time	OVA (ppm)			Depth to Water (ft)		
	OW1	MW-1	MW-4	OW1	MW-1	MW-4

Start Time: _____