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FINAL BIOVENTING TEST WORK PLAN FOR PETROLEUM OIL AND LUBRICANT TANK FARM SITE ST14 WITH TRANSMITTAL LETTER NAS FORT WORTH TX

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D.B.

Bioventing Test Work Plan for Petroleum, Oil, and Lubricant Tank Farm Site ST14 Carswell AFB, Texas

April 1993

AU380

ENGINEERING-SCIENCE, INC.

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April 26, 1993

Chris Hobbins
Brooks Air Force Base
Bldg 624W, AFCEE/ESRR
San Antonio, Texas 78235

Subject: Bioventing pilot test work plan
Site ST14
Carswell AFB, Texas

Dear Chris:

Enclosed are six copies of the subject final report. We have addressed all comments received in your April 19, 1993, letter. Please notify me of your acceptance of this plan as soon a possible. We are proceeding with plans for field activities.

Please feel free to call me (or Doug Downey at 303-831-8100) if you have any questions regarding the work plan or other aspects of this project.

Sincerely,

J. David Highland, P.E.
Project Manager

xc: Doug Downey, ES-Denver

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Bioventing Test Work Plan for Petroleum, Oil, and Lubricant Tank Farm Site ST14 Carswell AFB, Texas

Contract F41624-92-D-8036

Prepared for

Air Force Center for Environmental Excellence

Brooks AFB, Texas

Prepared by

Engineering-Science, Inc.

Austin, Texas

April 1993

CONTENTS

FIGURES

BIOVENTING TEST WORK PLAN
FOR PETROLEUM, OIL, AND
LUBRICANT TANK FARM - SITE ST14
CARSWELL AFB, TEXAS

1.0 INTRODUCTION

This work plan presents the scope of an *in situ* bioventing pilot test for treatment of fuel-contaminated soils and a subsurface soils investigation at the petroleum, oil, and lubricant (POL) tank farm (site ST14) at Carswell Air Force Base (AFB), Texas. The pilot test has three primary objectives: 1) to assess the potential for supplying oxygen throughout the contaminated soil interval; 2) to determine the rate at which indigenous microorganisms will degrade fuel when stimulated by oxygen-rich soil gas; and 3) to evaluate the potential for sustaining these rates of biodegradation until fuel contamination is remediated to concentrations below regulatory limits. The objective of the subsurface soils investigation is to delineate the extent of contamination at the site.

The pilot test will be conducted in two phases. Vent wells (VWs) and monitoring points (MPs) will be installed during site investigation activities. The initial stage will also include an *in situ* respiration test and an air permeability test. This initial testing is expected to take approximately 2 weeks. If successful, ES will proceed directly into the second phase of testing. During the second phase, a bioventing system will be installed and monitored over a 1-year period.

If bioventing proves to be feasible, pilot test data could be used to design a full-scale remediation system and to estimate the time required for site cleanup. The soils investigation will provide additional data on subsurface contamination to guide design of the full-scale bioventing system at this site. An added benefit of the pilot testing at the POL tank farm is that a significant amount of the fuel contamination should biodegrade during the 1-year pilot test, as the testing will take place within known contaminated soils at the site.

Additional background information on the development and recent success of the bioventing technology is found in the *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Hinchee et al., 1992). This protocol document will also serve as the primary reference for pilot test well designs and detailed procedures which will be used during the test.

2.0 SITE DESCRIPTION

2.1 Site Location and History

The POL tank farm, also referred to as site ST14, is located in the eastern portion of the base, near the Carswell AFB main gate. The tank farm portion of the site consists of two aboveground fuel storage tanks. The site also includes the fuel loading facility located on the east side of Knights Lake Road, across the street from the tank farm. Figure 2.1 shows the locations of existing tanks, general site features, and monitoring wells within and adjacent to the areas identified with fuel contamination. Soil gas survey results indicate probable subsurface soils contamination in the vicinity of the aboveground tanks and near the monitoring well, ST14-17M (Radian, 1991a). Free-floating product was encountered in this monitoring well during a 1990 Investigation Restoration Program (IRP) investigation event. It is suspected that subsurface soils in the fuel loading facility were contaminated through leaking underground pipes. A French drain system was reportedly installed downgradient of the site to collect and discharge oily wastes through an oil-water separator located at the base.

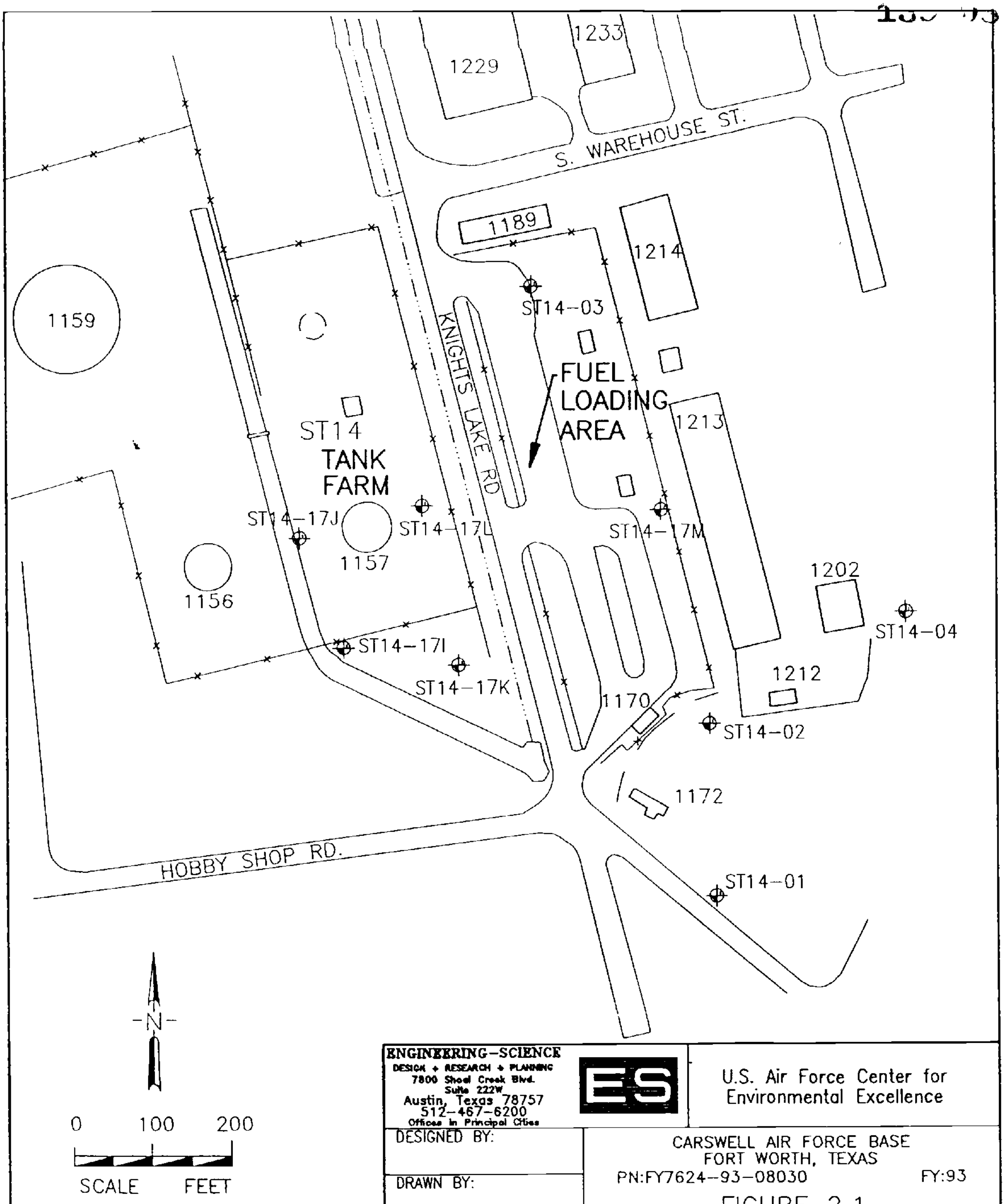
2.2 Site Geology

According to information obtained during installation of the nine monitoring wells and drilling of eight soil borings in and around the site vicinity, the upper zone in the POL tank farm area consists of approximately 10 feet of gray to tan clay (Radian, 1991a). The clay was reported to contain pebbles and freshwater gastropod shells. This upper zone is underlain by another 5 to 10 feet of fine-grained greyish-green or tan sand and gravel, increasing in gravel content with depth. The gravel ranges from pea size to over an inch in diameter. Beneath this sand and gravel layer lies the underlying bedrock surface of the Goodland Limestone Formation. The depth to the Goodland limestone beneath the site ranges from 16 to 20 feet below ground level (BGL) (Radian, 1991a).

A water-level survey performed on wells in June 1990 at the site indicated the depth to water varied from approximately 8 to 16 feet BGL (Radian, 1991a). This suggests that the top of the water table corresponds fairly closely to the top of the sand and gravel layer. In monitoring well ST14-17M, located near the proposed vent well, groundwater was encountered at approximately 10 feet BGL.

2.3 Site Contaminants

The primary contaminants at this site are believed to be petroleum hydrocarbons, which have been detected in groundwater samples collected at site ST14 (Radian, 1991b). These petroleum components are benzene, ethyl benzene, chlorobenzene, toluene, and xylenes. Of these, ethyl benzene was the most common, having been detected in six of the nine monitoring wells at the site. Benzene was the only volatile organic compound detected at a concentration exceeding its maximum contaminant level (MCL). Analytical results reveal the highest benzene concentrations in the groundwater sample collected from monitoring well ST14-17M in the fuel loading facility. More than 2 feet of free-



LEGEND

ST14-02 MONITOR WELL

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DESIGNED BY:	CARSWELL AIR FORCE BASE FORT WORTH, TEXAS PN:FY7624-93-08030 FY:93
DRAWN BY:	FIGURE 2.1
REVIEWED BY: B.R. VANDERGLAS	SITE LAYOUT WITH EXISTING
SUBMITTED BY: J.D. HIGHLAND	MONITORING WELL LOCATIONS SITE ST14

PLOT SCALE: AS NOTED	DWG. CODE:	CONTRACT DATE: APRIL 30,1992	SHEET REFERENCE NUMBER
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phase hydrocarbon was also encountered floating on top of the water in this monitoring well during the 1990 sampling event. The highest levels of chlorobenzene, toluene, and total xylenes were also detected in the sample collected from this well.

The results of a soil gas survey conducted in December 1987 at the site also indicated the probable presence of hydrocarbon-contaminated subsurface soils in two separate areas beneath the site (Radian, 1991a). The largest vapor plume was reported underlying the vicinity of tanks 1156 and 1157 and encompassing an area approximately 100 feet wide and 300 feet long. A smaller plume was encountered in the fuel loading facility area located near monitoring well ST14-17M, which exhibited free-floating product during the 1990 groundwater sampling activities.

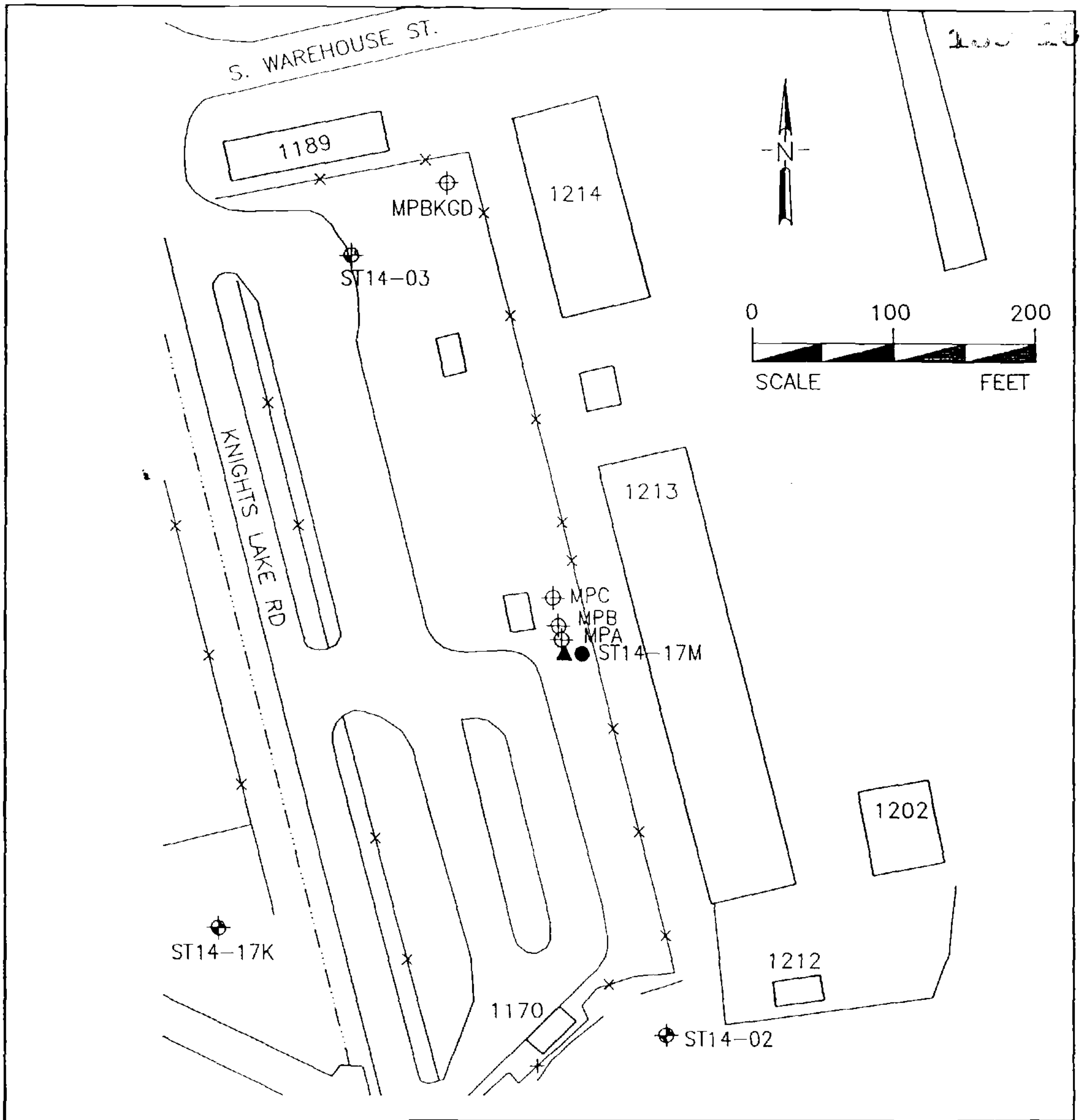
The results of any soil sampling activities which may have taken place are not available. As discussed in section 5.0, soil sampling is planned to fill in this data gap.

3.0 PILOT TEST ACTIVITIES

The purpose of this section is to describe the work that will be performed by Engineering-Science, Inc. (ES), at site ST14 (POL tank farm) during the bioventing pilot test. ES will perform siting and construction of a central air injection VW and three vapor MPs; an *in situ* respiration test; an air permeability test; and installation of a long-term bioventing pilot test system. Soil borings will also be drilled to more fully characterize and delineate the soil contamination of the vadose zone in the vicinity of the POL tank farm. If significant fuel contamination is encountered during soil boring activities, then additional VWs may be constructed in the contaminated borehole for potential use in full-scale remediation, depending on pilot test results. Pilot test activities performed on any additional wells will be limited to field screening of soil gas samples. Soil and gas sampling procedures and the blower configuration that will be used to inject air (oxygen) into contaminated soils through the central VW are also discussed in this section. The soil sampling plan for the vadose zone contamination investigation is described in section 5. No dewatering will take place during the pilot test. Pilot test activities will be confined to unsaturated soils remediation. Existing monitoring wells will not be used as primary air injection wells. However, monitoring wells which have a portion of their screened interval above the water table may be used as vapor MPs or to measure the composition of background soil gas.

3.1 Site Layout

Criteria for siting a central VW and vapor MPs are described in the protocol document (Hinchee et al., 1992). Figure 3.1 illustrates the proposed locations of the central VW and the MPs at this site. The final locations may vary slightly from the proposed locations if significant fuel contamination is not observed in the boring for the VW. Based on existing site investigation data, the central VW should be located



LEGEND

▲	PROPOSED CENTRAL VENT WELL (AIR INJECTION)
ST14-17M ●	EXISTING MONITORING WELLS
MPC ⊕	PROPOSED VAPOR MONITORING POINT
—×—×—	FENCE
1213	BUILDING

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DRAWN BY:

REVIEWED BY: B.R. VANDERGLAS

SUBMITTED BY: J.D. HIGHLAND

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FIGURE 3.1
PROPOSED VENT WELL/VAPOR MONITORING POINT LOCATIONS
SITE ST14

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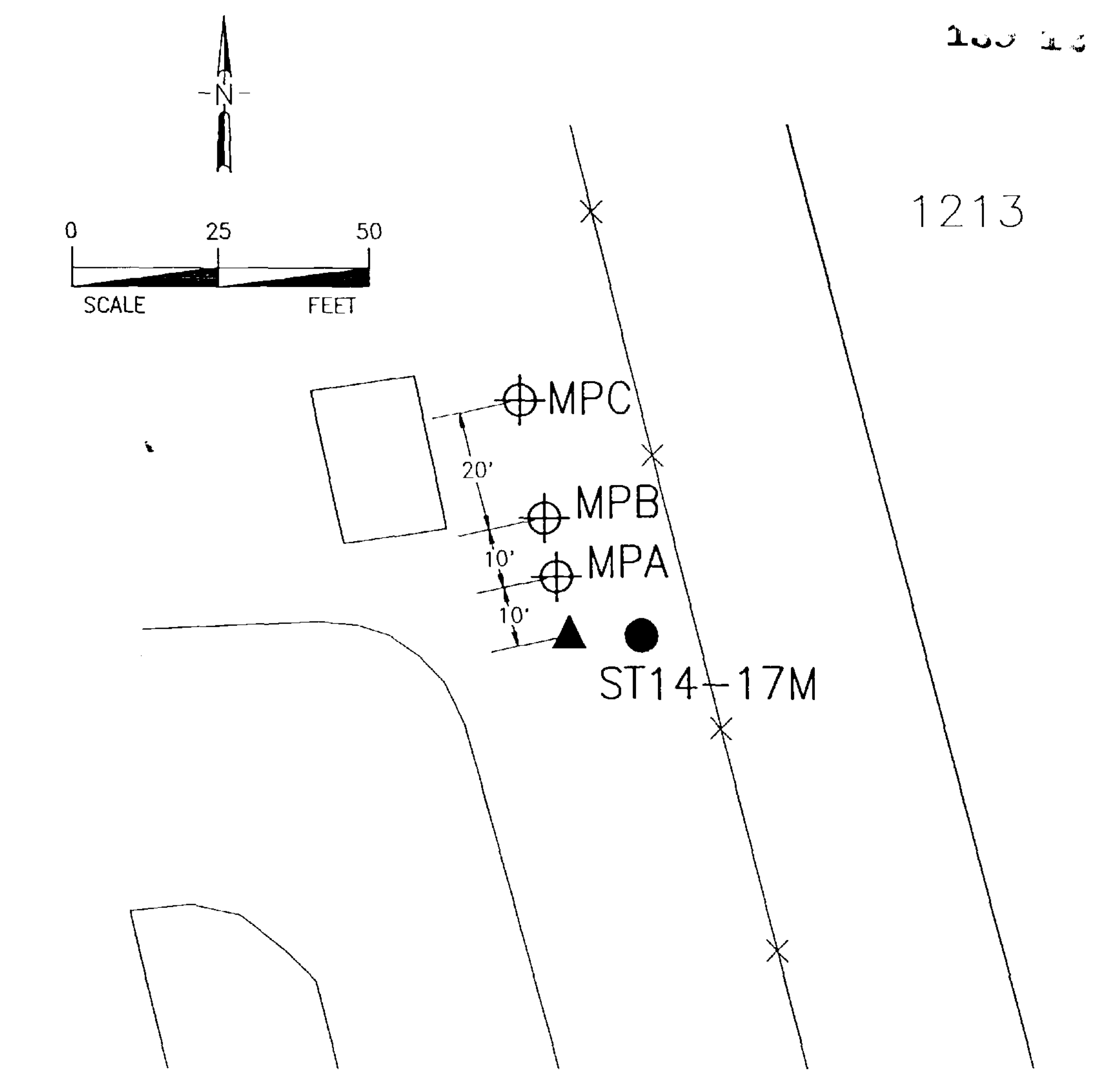
near, and west of, monitoring well ST14-17M. Soils in this area are expected to be oxygen depleted (<2 percent) by high hydrocarbon levels, and increased biological activity should be stimulated by oxygen-rich soil gas ventilation during pilot test operations.

Given the relatively shallow depth of contamination at this site and the experience that ES has had with similar soil types, the potential radius of venting influence around the central air injection well is expected to be 35 to 40 feet. Three vapor MPs (referred to as MPA, MPB, and MPC) will be located within a 40-foot radial distance of the central VW. The spacing of the monitoring points in relation to the vent well is shown on Figure 3.2. A fourth MP will be located away from the site in clean soils and will be used to measure background levels of oxygen and carbon dioxide and to determine if natural carbon sources are contributing to oxygen uptake during the *in situ* respiration test. This background MP is tentatively located on Figure 3.1. However, ES will request the assistance of base personnel in identifying an uncontaminated area for background sampling.

3.2 Vent Well

One central VW will be installed at the site. The central VW will be used, for pilot testing purposes and will be constructed of 4-inch-inside-diameter (ID) schedule 40 polyvinyl chloride (PVC), with a 10-foot interval of 0.04-inch slotted screen set at 5 to 15 feet BGL. Flush-threaded PVC casing and screen will be used with no organic solvents or glues. The filter pack will be clean, well-rounded silica sand with a grain size of 6 to 9, and will be placed in the annular space of the screened interval. A 2-foot layer of bentonite pellets, hydrated in place with potable water, will be placed directly over the filter pack. This layer of pellets will prevent the addition of bentonite slurry from saturating the filter pack. A bentonite-cement grout will then be tremied into the remaining annular space above the bentonite pellets to produce an airtight seal above the screened interval. A complete seal is critical to prevent injected air from short-circuiting to the surface during the bioventing test. Figure 3.3 illustrates the proposed central VW construction for this site.

Although contaminated soils may exist above 5 feet BGL, the 5-foot depth was chosen for the top of the screened interval to reduce short-circuiting of injected air to the surface, a common problem at sites with shallow contamination and tight soils. It is felt that oxygen can still be delivered to the shallow soils by vertical flow and diffusion. The bottom of the screened interval 15 feet BGL will be 5 feet below the interface of silty-clay and sand, which is approximately 10 feet BGL. Water is anticipated to be present in the top of the sand zone at approximately 11 feet BGL. The June 1990 water level reported for monitoring well ST14-17 was 10.9 feet below the measuring point. Placing the screened interval well into the water table will allow oxygenation of soils in this zone if the water table subsides during the life of the pilot system.



LEGEND

▲ PROPOSED CENTRAL VENT WELL (AIR INJECTION)

ST14–17M ● EXISTING MONITORING WELLS

MPC ⊕ PROPOSED VAPOR MONITORING POINT

—×—×— FENCE

[1213] BUILDING

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FIGURE 3.2
PROPOSED VENT WELL/VAPOR MONITORING POINT SPACING

SITE ST14

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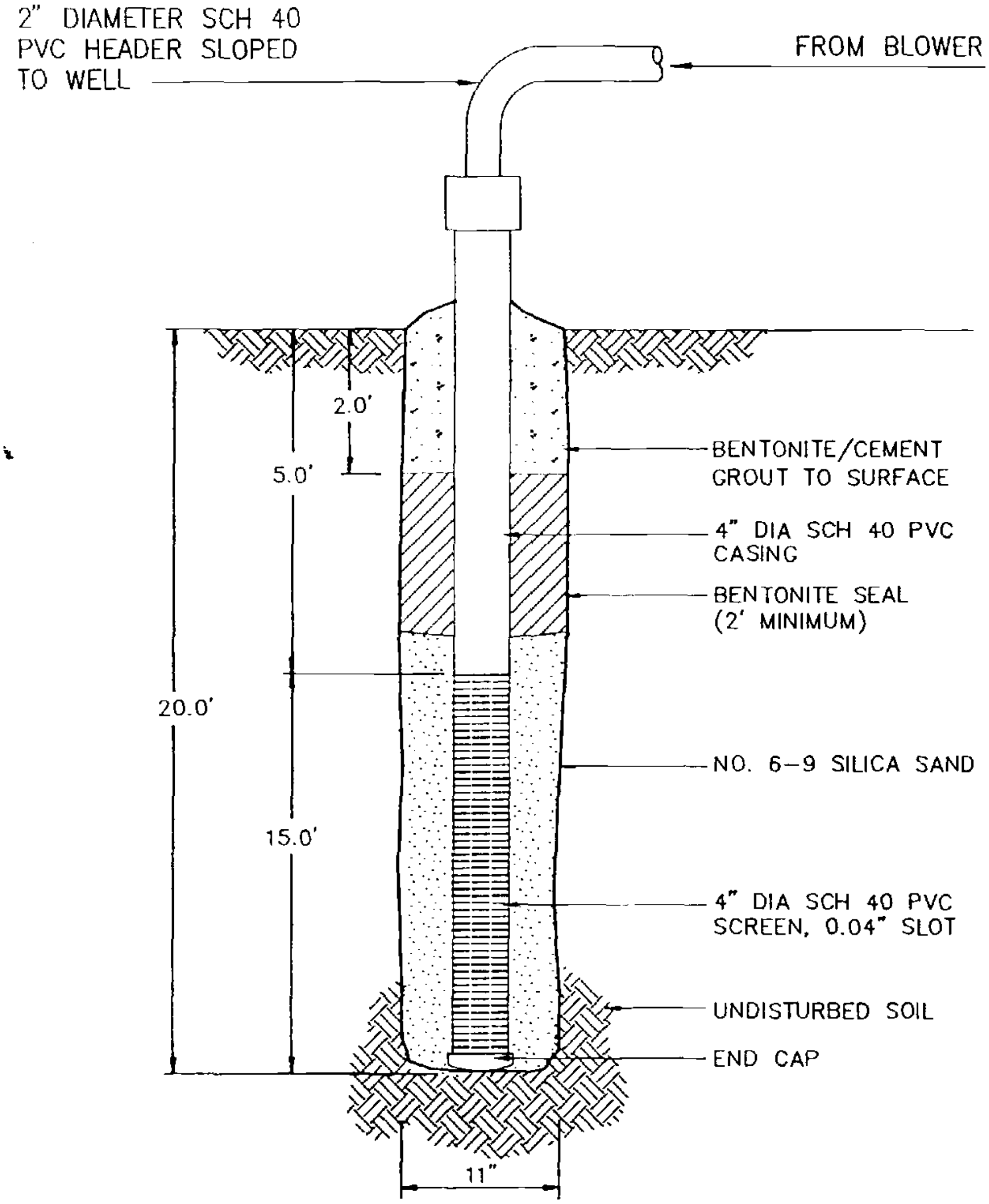

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DRAWN BY:	FIGURE 3.3
REVIEWED BY: B.R. VANDERGLAS	INJECTION VENT WELL CONSTRUCTION DETAIL
SUBMITTED BY: J.D. HIGHLAND	SITE ST14

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3.3 Monitoring Points

A typical multidepth vapor MP construction for this site is shown in Figure 3.4. Soil gas oxygen and carbon dioxide concentrations will be monitored at depths of 4 feet, 7 feet, and 10 feet at each location. Where the water table is less than 10 feet BGL, only two MPs may be constructed. Multidepth monitoring will confirm that the entire soil profile is receiving oxygen, and will serve to measure fuel biodegradation rates at each depth. The depths or number of monitoring points will be adjusted in the event the water table is encountered at depths shallower than 10 feet, such that the deepest monitoring point screen is a minimum of 1 foot above the water table. The spaces between monitoring intervals will be sealed with bentonite to isolate the intervals. As with the central VW, several inches of hydrated bentonite pellets will be used to shield the filter pack from rapid infiltration of bentonite slurry additions. Soil temperature will be monitored using thermocouples installed at depths of 4 feet and 10 feet BGL in the monitoring point closest to the vent well (MPA). Additional details on VW and MP construction are found in section 4 of the protocol document.

3.4 Handling Drill Cuttings

Cuttings will be collected in U.S. Department of Transportation (DOT) approved containers. The containers will be labeled and left on base. Drill cuttings will become the responsibility of Carswell AFB or their designated contractor. Thus, Carswell AFB will be responsible for disposal of drill cuttings in accordance with the current procedures for ongoing remedial investigations.

3.5 Soil and Soil Gas Sampling

3.5.1 Soil Samples

Four soil samples will be collected from the pilot test area during installation of the central VW and MPs. Sampling procedures will follow those outlined in the protocol document. One sample will be collected from the most contaminated interval of the central VW boring, and one sample will be collected from the interval of highest apparent contamination in each of the MP soil borings. Soil samples will be analyzed for total recoverable petroleum hydrocarbons (TRPH) using EPA method 418.1; benzene, toluene, ethyl benzene, and xylenes (BTEX) using EPA method SW8020; soil moisture; pH; particle sizing; alkalinity; and nutrients (nitrogen and phosphorus). One sample from the background boring will also be analyzed for total Kjeldahl nitrogen (TKN).

Samples for TRPH and BTEX analysis will be collected using a split-spoon sampler. Samples will be collected by hand with stainless steel sampling spoons or using brass tube liners in the split spoon. Hand collected samples will be immediately placed in glass bottles with Teflon®-lined lids and packed into a cooler for storage. If brass tube liners are used, the soil samples will be immediately trimmed, and the ends of the brass tubes will be sealed with aluminium foil or Teflon fabric held in place by plastic caps. Soil samples collected for all other analyses will be placed into glass sample jars or other appropriate sample containers specified in the soil sampling section of this work plan (section 5). Soil samples will be labeled

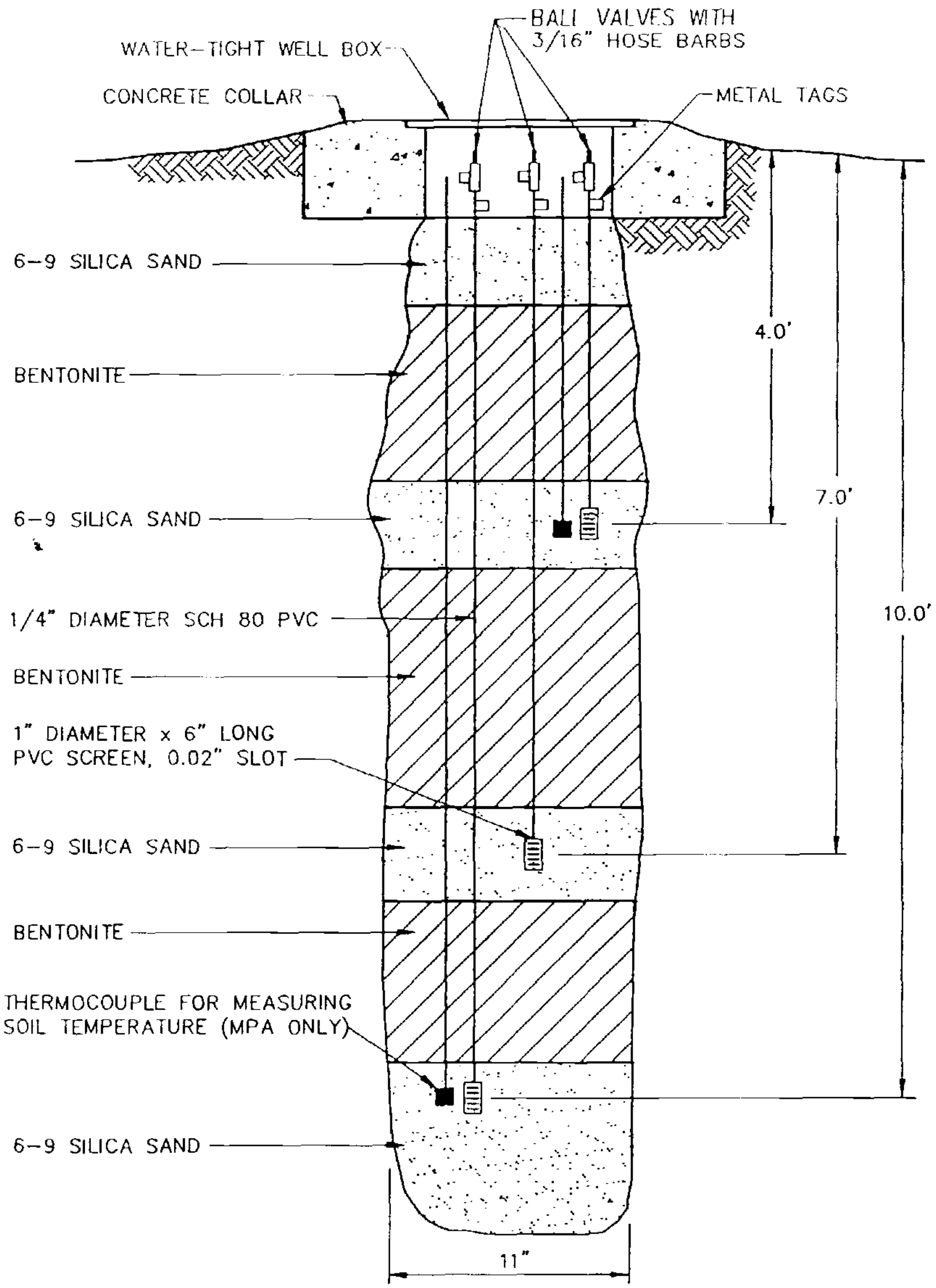

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FIGURE 3.4
MONITORING POINT CONSTRUCTION DETAIL

SITE ST14

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following the nomenclature specified in the protocol document, wrapped in plastic, and placed in a cooler for shipment. A chain-of-custody form will be filled out, and the cooler will be delivered to NDRC Laboratories in Richardson, Texas, for analysis. This laboratory has been audited by the Texas Water Commission (TWC) and meets all quality assurance/quality control (QA/QC) and certification requirements for the State of Texas.

3.5.2 Soil Gas Samples

A total hydrocarbon vapor analyzer will be used during drilling to screen split-spoon samples for intervals of high fuel contamination in the VWs and MPs. Initial soil gas samples from the central VW and from the MPs closest to and furthest from the VW will be collected in SUMMA® canisters in accordance with the bioventing field sampling plan (ES, 1992). Additionally, these soil gas samples will be used to determine the reduction in BTEX and total volatile hydrocarbons (TVH) during the 1-year test, and to detect any migration of these vapors from the source area.

Soil gas sample canisters will be placed in a small cooler and packed with foam pellets to prevent excessive movement during shipment. To prevent condensation of hydrocarbons, samples will not be sent on ice. A chain-of-custody form will be filled out, and the cooler will be shipped to the Air Toxics, Inc., laboratory in Ranch Cordova, California, for analysis.

3.6 Blower System

A 3-horsepower positive-displacement blower capable of injecting air over a wide range of flow rates and pressures will be used to conduct the initial air permeability test and *in situ* respiration test. The maximum power requirement anticipated for this pilot test is 230-volt, single-phase, 30-amp service. Additional details on power supply requirements are described in section 6.0, base support requirements.

3.7 In Situ Respiration Test

The objective of the *in situ* respiration test is to determine the rate at which soil bacteria degrade petroleum hydrocarbons. Respiration tests will be performed at selected depth intervals in MPs where bacteria biodegradation of hydrocarbons is indicated by low oxygen levels and elevated carbon dioxide concentrations in the soil gas. A 1-cubic-foot-per-minute (cfm) pump will be used to inject air into the selected MP depth intervals containing low levels (<2 percent) of oxygen. A 20-hour air injection period will be used to oxygenate local contaminated soils. At the end of the 20-hour air injection period, the air supply will be cut off, and oxygen and carbon dioxide levels will be monitored for the following 48 to 72 hours. The decline in oxygen and increase in carbon dioxide concentrations over time will be used to estimate rates of bacterial degradation of fuel residuals. Helium will also be injected at each MP to account for oxygen loss to diffusion or leakage. Additional details on the *in situ* respiration test are found in section 5.7 of the protocol document (Hinchee et al., 1992).

3.8 Air Permeability Test

The objective of the air permeability test is to determine the extent of the subsurface that can be oxygenated using one air injection VW. Air will be injected into the 4-inch-diameter central VW using the blower unit, and pressure response will be measured at each MP with differential pressure gauges to determine the region influenced by the unit. Oxygen will also be monitored in the MPs to verify that oxygen levels in the soil increase as the result of air injection. One air permeability test lasting approximately 4 to 8 hours will be performed.

3.9 Installation of 1-Year Pilot Test Bioventing System

The decision to proceed with bioventing will be made after completion of the soil gas permeability and the *in situ* respiration tests. If sufficient evidence exists to indicate that the addition of oxygen enhances biodegradation in the contaminated areas, then a long-term bioventing system will also be installed at the POL tank farm area (site ST14) before the field crew leaves the site. The base will be requested to provide power consisting of 230-volt, 30-amp, single-phase service and a breaker box with one 230-volt receptacle and two 110-volt receptacles. Depending on availability, a base electrician or a licensed electrician subcontracted to ES will assist in wiring the blowers to line power. The blower system will be chosen based on the results of the initial respiration and air permeability tests. However, it is anticipated that the long-term blower will be capable of injecting air at 5 pounds per square inch (psi) and 14 cfm and will not exceed 1.5 horsepower. The blower will have vacuum, pressure, and temperature gauges, and an air filter, pressure relief, and flow control valve (see Figure 3.5). The blower will be housed in a small, prefabricated shed to provide protection from the weather. The system will be operated for 1 year, and ES personnel will conduct *in situ* respiration tests after 6 months and at the conclusion of the pilot test (1 year) to monitor the long-term performance of this bioventing system. Weekly system checks will be performed by Carswell AFB personnel. If required, major maintenance of the blower unit will be performed by ES personnel. Detailed blower system information and a maintenance schedule will be included in the operation and maintenance (O&M) manual provided to the base. More detailed information regarding the long-term pilot test procedures can be found in the protocol document.

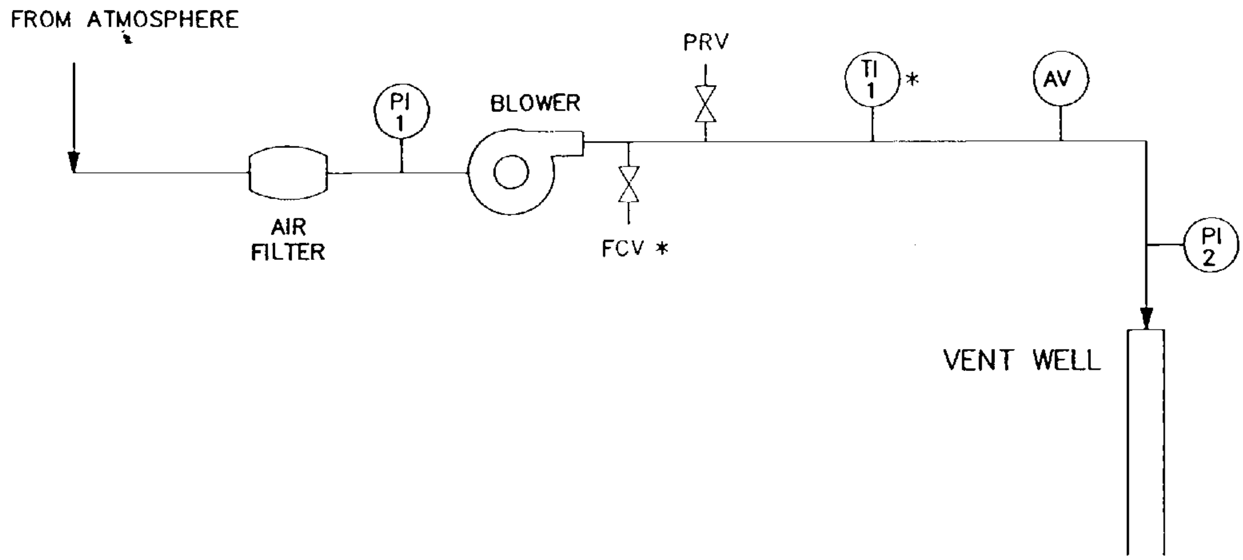
4.0 EXCEPTIONS TO PROTOCOL PROCEDURES

The procedures that will be used to measure the air permeability of the soil and *in situ* respiration rates are described in sections 4 and 5, respectively, of the protocol document (Hinchee et al., 1992). No exceptions to the protocol are anticipated.

5.0 SOIL SAMPLING PLAN

5.1 Preliminaries

Prior to drilling, all federal, state, and local permits will be obtained and all underground pipelines and utilities will be marked. Carswell AFB will be responsible for assisting the ES field team in obtaining all utility clearances. If any of the proposed borehole locations are in a difficult drilling position, such as under a tree,



LEGEND

AV	AIR VELOCITY GAUGE
PI 1	PRESSURE INDICATOR
TI 1	TEMPERATURE INDICATOR
FCV	FLOW CONTROL VALVE
PRV	PRESSURE RELIEF VALVE
*	OPTIONAL

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REVIEWED BY: B.R. VANDERGLAS

SUBMITTED BY: J.D. HIGHLAND

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FIGURE 3.5
BLOWER SYSTEM INSTRUMENTATION DIAGRAM FOR AIR INJECTION SITE ST14

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too close to an overhead power line, or in an unusually soft or wet area, then the borehole will be relocated by the ES field team leader.

To ensure that no contamination is inadvertently introduced into a boring or vent well, all drilling, downhole, and sampling equipment will be decontaminated. The driller on site will have a valid State of Texas monitoring well license.

To further ensure that there are no underground obstructions, all areas where soil borings and vent wells are to be drilled will be surveyed with a magnetometer (pipe finder) instrument.

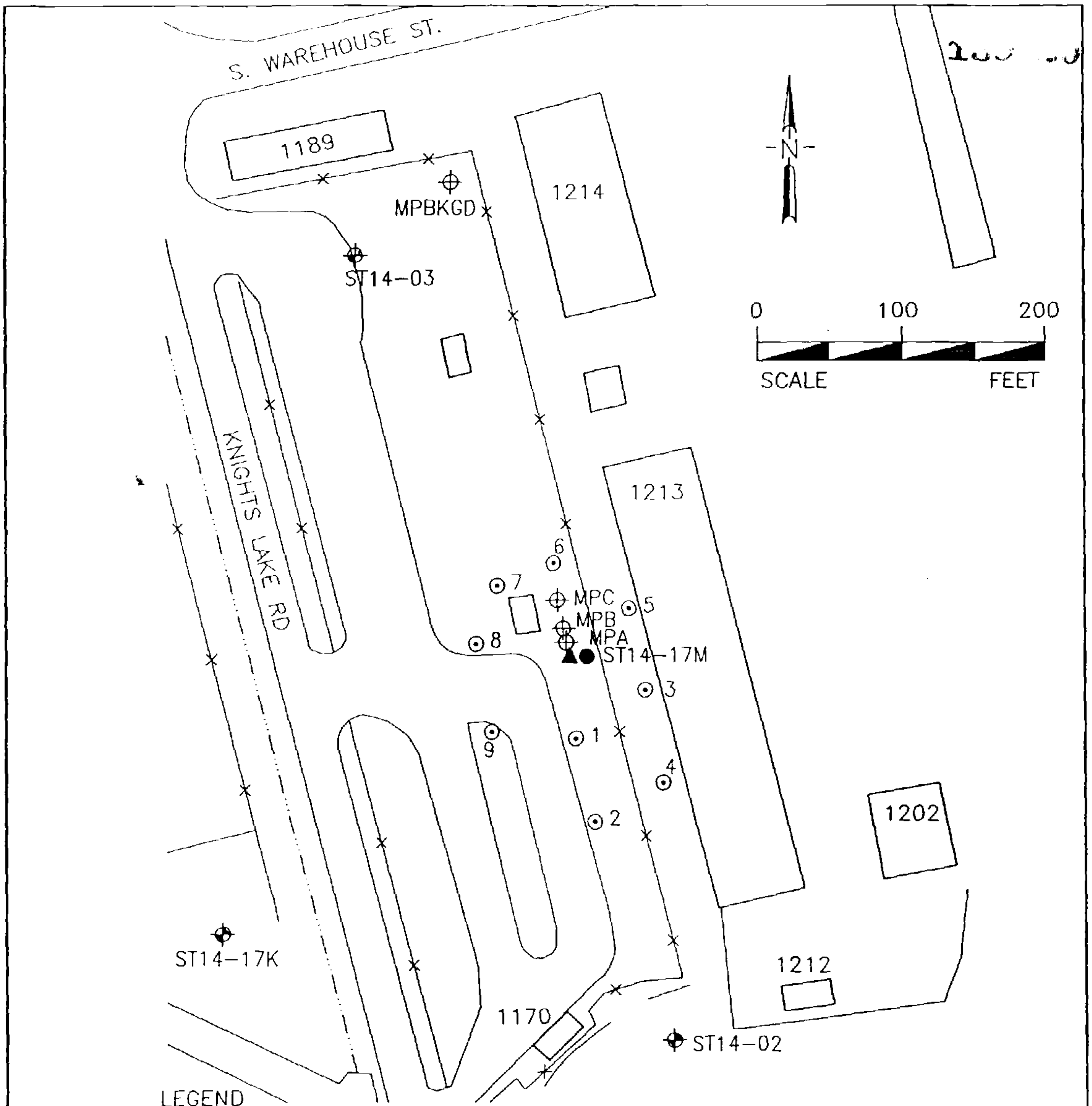
5.2 Drilling

The soil borings will be drilled to a depth of approximately 10 to 15 feet using 8-inch-outer-diameter (OD), continuous-flight, hollow-stem augers. Soil samples will be collected continuously using a split spoon or core barrel. The lithology of each sample will be described in the field logbook.

Once the radius of oxygen influence (ROI) for vent wells at the site is determined from the pilot bioventing test, the soil boring locations can be determined. The borings will be located generally along the buried fuel distribution line. The ROI observed from the pilot system will be used to determine the spacing between soil borings in order to maximize efficiency of a full-scale bioventing system. The proposed locations for the first nine boreholes are shown on Figure 5.1. These locations account for cultural obstructions such as buildings and pavement, but do not consider results obtained during the pilot test. A more accurate soil boring plan with tentative boring locations will be prepared after determining ROI and evaluating analytical data from samples collected from the vent well and monitoring point boreholes. This plan will be submitted as an appendix to the interim bioventing test data report.

The core samples will be screened with an OVA, and at least one sample per boring will be placed into a jar for headspace analysis. If contamination is not found by screening the soil, then no further borings will be drilled. If significant contamination is detected based on headspace readings or saturated visual characteristics, then a vent well will be completed in the borehole for use in the full-scale bioventing system. A second soil boring will be drilled and sampled one and three-fourths ROIs from the first. If contamination is still detected, then additional borings will be drilled until significant contamination is no longer detected. Vent wells will be constructed in each of the borings which exhibit characteristics of significant contamination (i.e., high headspace readings, oily saturated soil, heavy odors).

Soil borings will also be located in a line downgradient of the area of highest contamination based on local groundwater hydrology. The water table is located near a depth of 10 feet, so subsurface soil contamination is likely to occur downstream of the contaminant source since the groundwater is one of the probable migration pathways for contamination. The borings will be spaced according to data provided during the pilot test.



LEGEND

Symbol	Description
▲	PROPOSED CENTRAL VENT WELL (AIR INJECTION)
ST14-17M ●	EXISTING MONITORING WELLS
MPC ⊕	PROPOSED VAPOR MONITORING POINT
—×—×—	FENCE
1213	BUILDING
⊙ 2	PROPOSED SOIL BORING LOCATION

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DESIGNED BY:

DRAWN BY:

REVIEWED BY: B.R. VANDERGLAS

SUBMITTED BY: J.D. HIGHLAND

CARSWELL AIR FORCE BASE
FORT WORTH, TEXAS
PN:FY7624-93-08030 FY:93

FIGURE 5.1
PROPOSED INITIAL BOREHOLE LOCATIONS

SITE ST14

PLOT SCALE: AS NOTED	DWG. CODE:	CONTRACT DATE: APRIL 30,1992	SHEET REFERENCE NUMBER 5.1
DESIGN FILE: SITECARS		CALL ORDER NO.: 0004	
PLOT DATE: 4/26/93	SHEET 1 OF 1	CONTRACT NO.: F41624-92-D-8036	

Once the extent of migration is determined along the pipeline and downgradient of the area of highest contamination, then additional soil borings will be drilled radially from the pilot vent well to determine the extent of contamination in other directions. If the extent of contamination is adequately determined without expending the drilling budget, then some additional soil borings may be located around the POL tank farm area to begin characterization and delineation activities there.

5.3 Sampling

Soil samples will be continuously collected and lithologically described. Samples will also be collected for chemical analysis. Once the samples are retrieved from the augers, the soil will be scanned with a flame ionization detector (FID) to check for contamination. If contamination is suspected, then some of the sample will be placed in a Mason jar and covered with foil for a headspace analysis.

A maximum of two samples will be collected from each boring. One sample will be collected from just above water (about 10 feet below ground) where the highest contamination is anticipated. A second sample will be collected from any other zones which exhibit high contamination based on the screening results, but preferably in the screened interval of the vent wells (5 to 10 feet BGL). The soil samples from each boring will be analyzed for the BTEX and TRPH. It is anticipated that on average one and one-half samples will be collected per boring.

Once the samples have been retrieved from the sampling device, they will be immediately placed in 8-ounce glass jars (if brass tube liners are not used). If brass tubes are used, then the samples will be immediately trimmed, and the ends of the brass tubes will be sealed with aluminum foil or Teflon fabric held in place by plastic caps.

5.4 Chain of Custody

Sample Labels

To prevent misidentification of samples, labels will be affixed to each sample container. The labels will be sufficiently durable to remain legible even when wet and will contain the following types of information:

- Sample identification number
- Name of collector
- Date and time of collection
- Place of collection
- Parameter(s) requested (if space permits).

The sample labels will be filled out with waterproof ink. Clear cellophane tape will be placed over the label for protection.

Sample Seal

In cases where samples may leave the owner-operator's immediate control, such as shipment to a laboratory by a common carrier (e.g., air freight), a seal will be affixed to the shipping container or individual sample bottles to ensure that the samples have not been disturbed during transportation. The seal, which may consist of an adhesive sticker with the date and the sample name written on it, will be placed on the shipping container or bottle in such a way that opening of the container or bottle will cause removal of or damage to the seal.

Field Logbook

A project record book will be maintained by the ES field leader during all field activities at the site. All information (except drill logs and record sheets for respiration and air permeability tests) pertinent to field activities (including instrument calibration data) will be recorded daily in the project-designated field logbooks. These books will be bound, and pages will be consecutively numbered. Entries in the logbook will be made in waterproof ink, and each page will be signed and dated. At a minimum, the following information will be entered in the field logbooks:

- Name and title of author, date and time of entry, and environmental conditions during field activity
- Location of sampling activity
- Name and title of field crew
- Sample medium (i.e., soil)
- Sample collection method
- Number and volume of sample(s) taken and sample identification numbers
- Date and time of collection
- Sample distribution (i.e., laboratory)
- Field observations
- Health and safety information such as air monitoring, heat or cold stress monitoring data, upgrades or downgrades of personal protective equipment, and the reasons for such upgrades or downgrades.

In addition, the following observations about each sample collected will be recorded in the logbooks as appropriate:

- Sample depth
- Color and texture
- Physical description
- Type(s) of laboratory analyses requested
- Any changes in sampling locations (also to be indicated on annotated maps).

In summary, sufficient information will be recorded in the field logbooks during field activities to permit reconstruction of the sampling event without reliance on the collector's memory.

If an error is made on an accountable document assigned to one individual, the individual will make all corrections simply by crossing a line through the error and entering the correct information. The erroneous information will not be obliterated. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All subsequent corrections must be initialed and dated.

Chain-of-Custody Record

To establish the documentation necessary to trace sample possession from time of collection, a chain-of-custody record will be filled out and will accompany every sample. The record will contain the following types of information:

- Sample number
- Signature of collector
- Date and time of collection
- Sample type
- Identification of boring
- Number of containers
- Parameters requested for analysis
- Signature of person(s) involved in the chain of possession
- Inclusive dates of possession.

6.0 BASE SUPPORT REQUIREMENTS

The following base support is needed prior to the arrival of the drilling subcontractor and the ES pilot test team:

- Confirmation of regulatory approval of work plan before proceeding.
- Assistance in obtaining drilling and digging permits.
- Confirmation of available power source, specifically 230-volt, 30-amp, single-phase service and a breaker box with one 230-volt receptacle and two 110-volt receptacles. The breaker box should be located as close as practical to the VW location (Figure 3.1), preferably outside the fenced area.
- Provision of any paperwork required to obtain gate passes and security badges for approximately three ES employees, two drillers, and an electrician (if a base electrician is not available). Vehicle passes will be needed for one truck and trailer and a drill rig.

During the initial testing, the following base support is needed:

- Twelve square feet of desk space and a telephone in a building located as close to the site as practical
- Assistance in locating area (not likely to be affected by petroleum contamination) for background soil boring

- The use of the base wastewater treatment facility or other discharge for disposal of decontamination liquids
- Acceptance by Carswell AFB of responsibility for drill cuttings from VW and MP borings, including any drum sampling to determine hazardous waste status. (If ES is to transfer custody of barrels to another contractor working on the base, assistance in arranging this transfer will also be needed.)

During the 1-year extended pilot test, base personnel will be required to perform the following activities:

- Check the blower system once per week to ensure that it is operating and to record the air injection pressure. ES will provide a brief training session on this procedure.
- If the blower stops working, notify David Highland or Brian Vanderglas of ES Austin (512/467-6200); or Chris Hobbins of the Air Force Center for Environmental Excellence (AFCEE) (210/536-5261).
- Arrange site access for an ES technician to conduct *in situ* respiration tests approximately 6 months and 1 year after the initial pilot test.

7.0 PROJECT AND DELIVERABLES AND SCHEDULE

The following schedule is contingent upon approval of this pilot test work plan and fulfillment of base support requirements.

Event	Date Completed
Draft pilot test work plan to AFCEE/Carswell AFB	22 April 1993
Begin initial pilot test	17 May 1993
Analytical report	20 July 1993
Scientific test	20 July 1993
Technical report	11 August 1993

Upon receipt of laboratory results, ES will prepare and submit an analytical report (referred to as data item A003 in the statement of work) consisting of the project analytical data and appropriate observations and explanations. A scientific report (referred to as data item A004 in the statement of work) will be submitted presenting the draft pilot test report. Upon AFCEE approval of the scientific report, ES will complete the full-scale conceptual design of the bioventing system and will submit this design, along with the final pilot test report, in the final technical report (referred to as data item A005 in the statement of work).

8.0 POINTS OF CONTACT

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817/782-6250

Chris Hobbins
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Brooks AFB, TX 78235
210/536-5261

David Highland/Brian Vanderglas
Engineering-Science, Inc.
7800 Shoal Creek Blvd., Suite 222W
Austin, TX 78757

9.0 REFERENCES

ES, 1992. Field sampling plan for AFCEE bioventing. Engineering-Science, Inc., Denver, Colorado.

Hinchee et al., 1992. Test plan and technical protocol for a field treatability test for bioventing, by R.E. Hinchee, S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. January.

Radian Corporation, 1991a. Remedial investigation for the East Area, draft report for Carswell Air Force Base, Texas. Austin, Texas, April 1991.

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FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE

FINAL PAGE

ADMINISTRATIVE RECORD

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