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WORKPLAN ADDENDUM

EXPANDED SOIL VAPOR EXTRACTION PILOT TEST AT OPERABLE UNIT 2 NATIONAL AERONAUTICS AND SPACE ADMINISTRATION JET PROPULSION LABORATORY PASADENA, CALIFORNIA

Contract Number N68711-97-D-8702
Delivery Order No. 0048

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LIST OF ACRONYMS AND ABBREVIATIONS

APWA:	American Public Works Association
bgs:	below ground surface
CalTech:	California Institute of Technology
CCl_4:	carbon tetrachloride
CCR:	California Code of Regulations
CERCLA:	Comprehensive Environmental Response, Compensation, and Liability Act
cfm:	cubic feet per minute
CFR:	Code of Federal Regulations
FS:	feasibility study
FWEC:	Foster Wheeler Environmental Corporation
GAC:	granular activated carbon
GEOFON:	GEOFON, Incorporated
ID:	inside diameter
JPL:	Jet Propulsion Laboratory
NASA:	National Aeronautics and Space Administration
NMO:	NASA Management Office
OU:	operable unit
OVA:	organic vapor analyzer
PCB:	polychlorinated biphenyls
P&ID:	piping and instrumentation diagram
psi:	pounds per square inch
PVC:	polyvinyl chloride
RAO:	remedial action objective
RD:	remedial design
RI:	remedial investigation
ROD:	Record of Decision
ROI:	radius of influence
RPM:	Remedial Project Manager
RWQCB:	Regional Water Quality Control Board
SCAQMD:	South Coast Air Quality Management District
SH&SP:	Site Health and Safety Plan
SVE:	soil vapor extraction
TCE:	trichloroethene
USA:	Underground Services Alert
USEPA:	United States Environmental Protection Agency
VOCs:	volatile organic compounds
VSLs:	vapor screening levels

1.0 INTRODUCTION

This workplan addendum has been prepared by GEOFON, Inc. (GEOFON) to describe additional field activities associated with an expanded soil vapor extraction (SVE) pilot test for Operable Unit 2 (OU-2) at the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) located in Pasadena, California. This addendum has been prepared to augment the original workplan (GEOFON, 2000) for the continued operation of a SVE system at pilot test well VE-01. The location and boundaries of the JPL site are shown on Figure 1 – Site Location Map. A map of the facility is provided as Figure 2 – Site Facility Map. Site background information, regional and local setting, SVE equipment descriptions, and other information presented in the original workplan or the remedial investigation (RI) and feasibility study (FS) documents will not be repeated in this addendum.

NASA is currently finalizing a Record of Decision (ROD) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) that presents the remedy selected for OU-2 (on-facility vadose zone soil). NASA has also initiated the preparation of a Remedial Design (RD) Workplan that will present detailed information regarding the engineered design, equipment, and implementation of the selected remedy described in the ROD. Until the ROD and the RD Workplan have been finalized, NASA plans to expand the existing SVE pilot test at the site.

The SVE pilot study at JPL was initiated at pilot test well VE-01 in April 1998 and conducted through June 1998. Based on the results of the initial pilot study, operation of the SVE system was continued from November 1998 to September 1999, and from April 2000 to August 2000. Detailed results of the SVE pilot test are presented in the FS report (FEWC, 2000). The SVE system was re-started in January 2001 and was active through May 2001, and from December 2001 to the present, as part of the extended pilot study of the site. The SVE system is estimated to have removed over 200 pounds of volatile organic compounds (VOCs) during the pilot study period.

Additional work involved with the expanded pilot test will include the following:

- Drilling and installation of three additional vapor extraction wells (VE-02 through VE-04),
- Disconnecting the existing SVE equipment at Location 1 (VE-01) and transporting the equipment to Location 2 (VE-02),
- Equipment and utility connections at Location 2,

- SVE system operation at Location 2 for up to six (6) months, and
- Continued soil vapor monitoring following an established sampling frequency protocol.

Data generated during this expanded pilot study will be used to evaluate the effectiveness of SVE operations on removing VOCs detected at the perimeter of the soil vapor monitoring network, and to help determine optimal operating conditions for future locations. The work performed during this expanded SVE pilot study will be incorporated into the full-scale remedial action for OU-2 after the ROD and the RD Workplan have been finalized and approved.

This addendum describes the methods and procedures GEOFON will use to perform the work identified above and will be used, in conjunction with the original workplan (GEOFON, 2000), to guide GEOFON personnel throughout the expanded pilot test.

2.0 INSTALLATION OF NEW SVE WELLS

Based on the results of the periodic soil vapor monitoring program, significant reduction of VOCs has been achieved within the radius of influence (ROI) of extraction well VE-01 since the pilot test was initiated in 1998. The ROI for extraction well VE-01 is estimated to be approximately 350 feet. However, VOCs have been detected outside of the ROI, at the perimeter of the soil vapor monitoring network. In order to remove VOCs from the soil at the perimeter of the soil vapor monitoring network, three new soil vapor extraction wells (VE-02, VE-03, and VE-04) will be installed at locations shown in Figure 3 – Proposed SVE Well Location Map. These locations were selected based on the levels of carbon tetrachloride (CCl_4) and trichloroethene (TCE) that remain above conservative soil vapor screening levels (VSLs) that have been developed for OU-2 (Battelle, 2002). The VSLs, provided in Table 1, were developed based on the method provided in the Los Angeles Regional Water Quality Control Board (RWQCB) 1996 Guidance (Note: VSLs are conservative screening levels only and should not be considered cleanup criteria).

2.1 Pre-Construction Activities

Prior to initiating field activities, GEOFON will request a site visit with Navy and California Institute of Technology (CalTech) personnel to finalize the locations of the three new wells based on the physical constraints present at each area. All utility drawings available at JPL and the City of Pasadena will be reviewed to determine the locations of underground structures in the vicinity of the drilling locations. In addition, GEOFON will coordinate a geophysical survey at each proposed location. The geophysical survey will be performed using ground-penetrating radar to identify any subsurface utilities that may be encountered during drilling activities. Any utilities detected in the field will be labeled with the appropriate color codes.

The proposed well locations will be marked with water-soluble or chalk based white paint or other suitable markings such as flags or stakes. Underground Services Alert (USA) will be notified two full weeks prior to drilling per Section 1, Chapter 3.1 “Protection of Underground Infrastructure”, Article 2 of California Code 4216 through 4216.0. If the USA members have utilities within the working area, they will mark them, prior to the start of drilling activities, using the American Public Works Association (APWA) utility color code; if not, GEOFON will be notified that there is no conflict.

Because the pilot test at OU-2 is being performed under CERCLA, state and local permits will not be required for the installation of additional SVE wells on the facility. However, the wells

will be installed in accordance with the substantive requirements and guidelines relating to the County of Los Angeles, Department of Health Services well construction permit.

2.2 Drilling Method

The vapor extraction wells will be installed using the roto-sonic drilling method. The roto-sonic drilling method produces a much smaller quantity of drill cuttings than other drilling methods and allows continuous cores of the subsurface materials to be collected. A roto-sonic drill rig looks and operates much like any conventional top-drive rotary or auger rig. The main difference is that a roto-sonic drill rig has a specially designed, hydraulically powered, drill head or oscillator that generates adjustable high frequency vibrational forces. The oscillator uses two eccentric, counter rotating balance weights, or rollers that are timed to direct 100 percent of the vibration at 0 degrees and 180 degrees. There is an air spring in the drill head that insulates the vibration from the drill rig.

The vibrational frequency is controlled to suit operating conditions and to achieve optimum drilling rates. When the vibrations coincide with the natural resonate frequency of the steel drill rod or casing, a natural phenomenon called resonance occurs. This phenomenon allows the rig to transfer timed vibrational energy into the top of drill string, utilizing the natural stored energy of the steel, to cause the drill string to act like a flywheel or a spring delivering tremendous amounts of energy directly to the bit face.

The sonic drill head is attached directly to the core barrel, drill pipe or outer casing, sending the high frequency vibrations (between 50 and 150 hertz or cycles per second) down through the drill pipe to the face of the drill bit. Advancement of the borehole occurs due to fracturing, shearing, or displacement of the subsurface, depending on the material being drilled. Drilling through cobbles, boulders, and rock is achieved by fracturing of the material by the inertial moment of the drill bit. Shearing takes place in dense silts, clay and shales, provided that the amplitude of the drill bit is high enough to overcome the elasticity of the formation material. Displacement occurs when unconsolidated formation material is moved away from the drill bit.

When required, the drill pipe or casing can be rotated to evenly distribute the energy and the wear on the drill bit face. Because of the high force developed by the vibrating drill head (up to more than 200,000 pounds) and applied vertical load, the drill string fluidizes and displaces excess formation material into the boring wall and core resulting in no excess cuttings being generated during the drilling operations. Continuous cores of the materials penetrated are retrieved by using a wire-line core barrel, a dual-rod system, or by telescoping drill pipe and casing with different diameters. The system requires neither the addition of air nor drilling fluids for penetrating soil materials.

The outer casing is advanced after the core barrel has moved ahead to collect the core sample and then pulled out of the borehole. This procedure leaves a cavity to collect the cuttings that are "shaved" from the borehole wall as the outer casing is being advanced and minimizes soil compression and friction with the surrounding soil materials. These cuttings are then removed from inside the casing before the next length of core is collected. Borehole integrity is maintained by the casing after the drill sting is pulled from the hole and during placement of extraction well components.

2.3 Soil Sampling and Analysis

Soil samples will be collected for perchlorate analysis during the drilling of each proposed vapor extraction well. Grab samples of the continuous soil core at each drilling location will be collected at 20-foot intervals, at major changes in lithology (i.e., confining layers), and immediately above the observed groundwater table. All soil samples will be shipped to the project laboratory under proper chain-of-custody protocol. At a minimum, soil samples collected at depths of 20 feet bgs, and every 40-foot-interval thereafter, will be analyzed for perchlorate using USEPA Method 314. Additional soil samples collected above major changes in lithology and above the observed groundwater table will also be analyzed. The remaining soil samples will be archived for possible perchlorate analysis, if deemed necessary based on the results of the initial analyses. Soil sampling procedures are provided in Section 4.1.1 of the revised Field Sampling Plan (FSP) (Appendix A).

2.4 SVE Well Installation Procedures

The proposed vapor extraction wells will be constructed in a manner similar to VE-01, with multiple 50- to 55-foot-long screened intervals extending to depths equaling the lowest recorded groundwater elevation at each proposed drilling location. This well design will allow the deepest screened interval to be utilized intermittently and as appropriate, to recover VOCs in the capillary fringe and/or smear zone, during periods when the groundwater elevation is low. The PneuLog™ testing results (Praxis, 2002) indicate that the construction of VE-01 is appropriate and that the VOC-producing soil layers have been adequately targeted.

Each vapor extraction well will consist of multiple discrete screened intervals (i.e., multiple separate casings in the same borehole) with a bentonite seal between screens. The screens will be designated from shallowest to deepest as Screen A, Screen B, and Screen C, etc. Each well will be constructed of 2-inch inside diameter (ID) Schedule 80 polyvinyl chloride (PVC) blank casing with 50- to 55-foot-long sections of 0.020-inch slotted Schedule 80 PVC casing at the screened intervals. The screened intervals will be backfilled with Lonestar RMC No. 3 sand (or

equivalent) and separated by 10-foot thick seals of Enviroplug No. 16 bentonite granules. Enviroplug No. 16 bentonite granules will also be used as backfill above the top of the screen to the surface completion. Well construction details for proposed SVE wells VE-02, VE-03, and VE-04 are presented as Figures 4, 5, and 6, respectively.

The provisions of multiple discrete screened intervals will allow minimization of vacuum losses within the well. If the entire depth requiring extraction from each well were to be addressed with a single screen, vacuum losses in the well itself may allow the bulk of the flow to come from only the shallower portions of the screen. This can be avoided by using the multiple screened intervals, as described above. The depths of the screens and the separation between them have been selected to maximize the flow towards the extraction well. Hence, a 10-foot separation between the screens was selected to keep the short-circuiting to a minimum.

2.5 Soil Boring Cuttings Disposal

Upon completion of drilling and assimilation of soil cuttings into roll-off bins, representative soil samples will be collected and submitted, under standard chain-of-custody control, to a State of California-certified laboratory for chemical analysis. The soil samples will be analyzed for VOCs, polychlorinated biphenyls (PCB), pesticides, metals, and hexavalent chromium. Based on the laboratory results, the soil will be classified as hazardous or non-hazardous waste in accordance with the Code of Federal Regulations (40 CFR 261.31 to 261.33 and 261.21 to 261.24) and the California Code of Regulations (22 CCR). An appropriate United States Environmental Protection Agency (USEPA)-certified waste disposal facility will be selected and a licensed transporter will haul the soil off-site for disposal. All waste transported off-site will be accompanied by the appropriate hazardous or non-hazardous waste manifest, signed by a NASA-approved representative from CalTech.

3.0 SVE EQUIPMENT DISCONNECTION, TRANSPORTATION AND SETUP

The existing SVE unit at Location 1 (VE-01) was installed on a mobile trailer in November 2001, to facilitate movement of the equipment to other locations at JPL. After the new SVE wells are completed, the piping and utilities will be disconnected from the trailer-mounted SVE unit and the equipment will be prepared for mobilization to Location 2 (VE-02). The SVE equipment compound at Location 1 will be preserved for future use during SVE well cycling that may be performed as part of the full-scale remedial action for OU-2.

The trailer-mounted equipment and the four 2,000-pound granular activated carbon (GAC) vessels will be transported to a location adjacent to VE-02. The actual location of the SVE system and utility connections will be coordinated with the proper Navy, NASA, and CalTech representatives prior to the move to minimize impacts to the facility operations.

The trailer mounted SVE unit will be connected to the three well screens at VE-02 with 2-inch ID Schedule 80 PVC piping connected to a 4-inch ID Schedule 80 PVC manifold. The SVE unit will be connected to the GAC vessels with a 4-inch ID Schedule 80 PVC trunk line connected to 4-inch ID flexible vapor hoses. All SVE piping will be tested for leaks at the time of installation using a pressure test conducted at 25 pounds per square inch (psi) for a minimum of 30 minutes.

All of the equipment will be enclosed by a 6-foot-tall chain link fence with an access gate. The SVE system compound will be locked when the system is unattended. A typical SVE system and piping layout diagram is provided in Figure 7. A piping and instrumentation diagram (P&ID) is provided in Figure 8.

4.0 SVE SYSTEM OPERATION

This section includes the strategy and procedures for performing operation, maintenance, and monitoring of the SVE system at Location 2. Since the same SVE unit used for the SVE pilot test at vapor extraction well VE-01 will also be used at additional locations at JPL, a new South Coast Air Quality Management District (SCAQMD) permit will not be required for the expanded pilot test. A copy of the existing SCAQMD permit is presented as Appendix B.

4.1 Start-Up Procedures

The following are the step-by-step procedures for initiating SVE operation at Location 2:

1. Ensure all plumbing and electrical equipment has been installed and connected properly in accordance with the manufacture's recommendations.
2. Check the electrical equipment for proper operation in accordance with the manufacture's recommendations.
3. Leak check the process piping in accordance with the following steps:
   i. Ensure the extraction well valves are shut.
   ii. Ensure the sample ports are shut.
   iii. Check the blower dilution valve in the open position.
   iv. Move the electrical disconnect to the "ON" position (Figure 8).
   v. Start-up the process blower and allow to run on dilution air for 5 to 10 minutes until amperage readings are collected.
   vi. Record blower amperage readings to establish a baseline.
   vii. Leak check all joints and connections from the wellheads to the SVE system by application of a soap and water solution.
   viii. Record successful completion of the leak check in the field log.
4. Following the leak check, slowly open the vapor extraction well valves and shut the process dilution air until desired results are attained. The well valves will be opened to allow maximum flow at each screened interval without pulling an excessive amount of moisture out of the well.
5. Measure and record vacuum readings for each screened interval and total vacuum; flow rates for each screened interval and the combined influent; differential pressure; and OVA readings from each individual screened interval of the vapor extraction well, the combined influent, and the combined effluent. Section 4.2.1 through Section 4.2.4 provide a description of the data collection activities that will be performed during system start-up. All field data will be recorded on daily SVE monitoring forms (Appendix C).

6. Perform PneuLog® testing at the SVE well to evaluate the efficiency of the SVE system and to help determine if additional vapor monitoring points are necessary.

4.2 Operation and Maintenance Procedures

Prior to start-up of the SVE system, GEOFON will implement a schedule for site visits in order to comply with SCAQMD permit conditions, a preventive maintenance schedule, and system adjustment for optimization. The typical operation and maintenance schedule is as follows:

4.2.1 System Influent and Effluent OVA Data Collection

SVE system influent and effluent (stack) vapor samples will be collected in accordance with the SCAQMD permit conditions. Each sample will be analyzed for VOCs using an OVA. A vacuum pump will be used to extract a vapor sample from both the influent and effluent air streams. Prior to extracting each sample, the tubing, which attaches to both the pump and sample port, will be replaced. Each sample will be collected in a Tedlar™ bag contained in a sampling chamber. The OVA will then extract the sample from the Tedlar™ bag and measure the overall VOC level. OVA readings between GAC vessels will also be measured for carbon break-through. The locations of the sample ports that will be used for the collection of vapor samples are shown in Figure 8.

4.2.2 Record System Flow Rate

The air flow rate into the system will be recorded twice during each visit. The first will be taken upon arrival. The second reading will be recorded at the time of departure, after all system or well adjustments are made. The flow will be measured using either an anubar (averaging tube), which is inserted into the airstream and records the average flow rate across the process air line, or an anemometer. The anubar will be connected to a differential pressure gauge, which reads in inches of water. A flow conversion chart will be used to determine cubic feet per minute (cfm).

4.2.3 Record Vacuum/Pressure Measurements

Vacuum and pressure measurements from various points of the SVE system will be recorded 4 days per week for the duration of the SVE system operation. The measurement points will include upstream and downstream of the GAC vessels and the blower suction and discharge. The purpose for these measurements is to ensure that maximum vacuum is applied and there is no reduction in efficiency caused by the system.

4.2.4 Individual Well Screen Interval Data Collection

Vacuum, vapor flow rate, and VOC concentrations at each individual screened interval will be recorded. This data will be used to determine the mass loading at each screened interval and which interval yields more flow and/or higher rates of VOC removal.

4.2.5 Soil Vapor Monitoring Well Data Collection

Vacuum responses in soil vapor monitoring wells will be recorded using magnehelic gauges and manometers. Using the vacuum response data collected from the soil vapor monitoring wells, the maximum ROI and effective ROI will be calculated.

4.2.6 System Adjustments and Optimization

During SVE system operation, appropriate system optimization will be implemented to improve the efficiency of the SVE system. Startup activities associated with the operation of the SVE system at Location 2 will involve a focused evaluation of the vacuum, flowrate, and VOC concentrations at each screened interval. This information will allow determination of mass loading at each screened interval and which interval yields more flow and/or higher rates of VOC removal. In addition, each new SVE well will be evaluated using the PneuLog® technology. The optimal operating condition will then be selected based on maximizing mass removal. The operating conditions will be adjusted as appropriate based on the results of vapor sampling conducted at individual screened intervals. Cycling of individual screened intervals (i.e., close one screened interval and open the other two and vice versa) will be performed based on the VOC concentrations in each screened interval. The cycling of individual screened intervals will allow the application of more vacuum on specific screens, resulting in increased extraction flow rates.

4.2.7 Waste Management Practices

The only waste from the SVE system operation will be liquid collected by the moisture separator of the vacuum blower. This liquid will be stored in labeled 55-gallon drums at a secure on-site location. Samples of the liquids will be collected and analyzed in accordance with the procedures described in the revised Field Sampling Plan (Appendix A). GEOFON will prepare all required waste profiles and manifests for the waste. The profiles and manifests will be submitted to the NASA Management Office (NMO) - JPL On-site Liaison Office, NFESC Remedial Project manager for review and signature five working days prior to scheduled disposal of the waste. The waste will be disposed of as non-hazardous waste by a licensed waste disposal contractor and coordinated by GEOFON. The disposal of waste will be in accordance with Federal, State, and local laws, regulations and instructions.

4.2.8 Site Safety and Security Provisions

All GEOFON personnel, subcontractors, and others who will participate in SVE system operations will meet the training requirements outlined in OSHA standard 29 CFR 1910.120 and California Code of Regulations (CCR) Title 8, Section 5192 covering Hazardous Waste

Operations and Emergency Response. It is GEOFON's intent to provide a safe and healthful work environment for employees, government personnel and subcontractors. All field activities will be conducted in accordance with the revised Site Health and Safety Plan (SH&SP) (Appendix D) prepared specifically for this project.

Entrance to the JPL facility is regulated by a security gate, with a 24-hour security guard. All parties involved in remedial action activities will follow the following security procedures:

- Badges, site-passes, and work permits should be obtained when required. Due to the nature of the facility operations, special precautions should be taken when working "after hours" (past 5:00 p.m., weekends, or holidays);
- Daily notification to the Project Manager or the Site Health and Safety Officer of intended work tasks;
- Daily notification to the JPL Security Station of location and approximate time period of work;
- Notification of JPL security immediately of any suspicious hazards or persons;
- Implementing the adage "If It's Not Safe, Don't Do It";
- Fire extinguishers, hydrants, and alarms will be provided at strategic locations;
- Warning signs will be posted at potential fire hazard locations;
- The emergency services (local police and fire) telephone numbers will be posted at these locations; and
- Full compliance of SH&SP requirements.

4.3 Replacement Schedule for Equipment and Installed Components

Carbon in the primary GAC vessels will be replaced when the CCl_4 concentrations at the outlet of the primary GAC vessels exceed 0.5 ppmv (i.e., when break-through of the carbon occurs). Carbon in all four GAC vessels will be replaced if the CCl_4 concentrations at the outlet of the secondary GAC vessels exceed 0.5 ppmv. The GAC adsorption system is expected to be used 6 months, 7 days/week, 24 hours/day. No other replacement of equipment and installed components is anticipated.

4.4 System Monitoring

GEOFON personnel will perform routine monitoring during the operation of the SVE system to

comply with SCAQMD permit conditions. The following parameters will be monitored:

- CCl_4 concentration at the outlet of the secondary GAC vessels (not to exceed 0.5 ppmv)
- Flow Rate (not to exceed 500 CFM)
- Check for leaks between the blower outlet and the outlet of the GAC vessels.

4.5 Vapor Sampling

Vapor samples will be collected during the operation of the SVE system to monitor the VOC concentrations in the treatment system influent and effluent, to determine the destruction efficiency of the system, and to determine emission rates for chemicals of concern. Results of the vapor sampling will be used to calculate VOC mass removal achieved by the system and mass loading for individual screened intervals.

Although the SCAQMD permit does not specifically require laboratory analysis of the vapor samples, it does contain a maximum concentration requirement of 0.5 ppmv for CCl_4 emissions. SVE system influent and effluent vapor samples will be collected once every two weeks over the duration of the SVE operation for laboratory analysis. The laboratory results will be used for selecting optimal operating conditions, system optimization, and evaluation of shutdown criteria. The samples will be analyzed for VOCs by USEPA test Method TO-14.

In order to evaluate initial VOC concentrations during startup and to select the optimal operating conditions, the following sampling program will be implemented at Location 2:

Week 1

Day 1: Vapor sampling for laboratory analysis at system influent, individual screens, and effluent

Day 2: Vapor sampling for laboratory analysis at system influent, individual screens, and effluent

Day 3: Vapor sampling for laboratory analysis at system influent, individual screens, and effluent

Day 4: Vapor sampling for laboratory analysis at system influent, individual screens, and effluent

Week 2 through 26

Bi-Weekly: Vapor sampling for laboratory analysis at system influent and effluent on Monday of every other week

Sampling procedures and methods are presented in the Field Sampling Plan (Appendix A).

5.0 DATA ANALYSIS AND REPORTING

The data collected during the SVE operation will be analyzed to calculate the destruction efficiency of the treatment system, VOC mass removal rates, mass loading for individual screened intervals, ROI, carbon usage rates, and liquid removal rates. Results of influent and effluent vapor samples will be used to verify that the SVE system met SCAQMD permit requirements during the operation.

GEOFON will evaluate the field data generated at Location 2 and will submit a bi-weekly SVE Pilot Test Memorandum that will contain conclusions and recommendations concerning system optimization and continued operation. In addition, GEOFON will prepare Monthly SVE System Operation Progress Reports. At a minimum, the Monthly Progress Report will include the following:

- Cumulative Mass Removal Curve
- Cost Per Pound of VOCs Removed Graph
- Recommendations for the Following Month's Operations

6.0 SVE SYSTEM SHUTDOWN CRITERIA

The SVE system at Location 2 will be operated continuously until performance objectives (i.e., VOC concentration reduction, asymptotic mass removal, and cost effectiveness) have been achieved or for approximately six (6) months (whichever occurs first). Six months of operation will provide time to extract approximately 6 to 8 pore volumes. The performance of the SVE system will be evaluated on a continuing basis and the information regarding the amount of VOCs removed will be reported to the regulator agencies as needed to effectively evaluate system performance objectives. The performance objectives include the following:

1. ***VOC Concentration Reduction*** – Reduction of overall VOC concentrations at the vapor monitoring points and extraction wells compared to baseline levels. This includes fate and transport modeling to evaluate leaching to groundwater (using RWQCB guidance [RWQCB, 1996] and VLEACH™) and groundwater mixing.
2. ***Asymptotic Mass Removal*** – Asymptotic mass removal achieved after temporary shutdown periods and appropriate optimization of the SVE system. Asymptotic conditions will have been reached at a given SVE well when the upper limb of the cumulative mass removal curve is substantially linear and the slope of the curve approaches zero. In addition, rebound of chemical concentrations will be evaluated during the temporary shutdown periods. A general asymptotic decreasing trend in rebound of chemical concentrations in the soil vapor monitoring points will be demonstrated. Time series plots of VOC concentrations at each soil gas monitoring point will be prepared to assist in evaluation of rebound.
3. ***Cost Effectiveness*** – Operate only as long as system is cost-effective. The SVE system will no longer be cost effective when operating costs per unit of VOC mass removed from the vadose zone indicate that the additional cost of continuing to operate the SVE system is not warranted and/or when shutdown of the SVE system is not anticipated to significantly increase the cost of the groundwater remedy or significantly prolong the time to achieve groundwater cleanup.

The existing vapor monitoring network will be used to monitor changes in the lateral and vertical distribution of VOCs and the effectiveness of the cleanup. PneuLog® testing will also be performed on each of the proposed SVE wells to evaluate VOC concentrations across the vertical profile. The results of the PneuLog® testing, along with SVE performance data, will be used to determine if additional vapor monitoring points are necessary. In addition, the existing groundwater monitoring network will be used as part of the evaluation of SVE effectiveness.

When performance objectives have been achieved, NASA will request shutdown of the SVE system. Fate and transport modeling results and other data used to evaluate performance objectives will be provided to the regulatory agencies for review and approval prior to initiating actions to terminate operation of the SVE system. NASA will shut down the SVE system once approval has been granted by the USEPA, DTSC, and RWQCB.

7.0 PERIODIC SOIL VAPOR MONITORING PROGRAM

The ongoing soil vapor monitoring program, which consists of periodic sampling of nested soil vapor wells, will be used to assess changes in contaminant concentrations and extent over time. The frequency of soil vapor sampling will be reduced as the uncertainty regarding the soil vapor plume behavior is reduced. The sampling frequency for each soil vapor well (VP-1 through VP-39) will be determined in accordance with the flowchart presented in Figure 9. Table 2 presents the soil vapor sampling frequencies, based on the most recent monitoring data. Soil vapor monitoring well sampling procedures are provided in Section 4.1.2 of the revised FSP (Appendix A). The locations of soil vapor monitoring wells are shown in Figure 10.

Soil vapor sampling results will be used to determine the extent of VOC reduction, if operations should be adjusted, or if a new approach must be taken at some point in the remediation. Potential adjustments to the SVE system include shutting down extraction wells or altering extraction well locations. When operation of the SVE system is no longer cost-effective and/or necessary to mitigate migration of VOCs to groundwater, the SVE system will be shutdown and soil vapor monitoring will be implemented to evaluate progress toward meeting the remedial action objective (RAO). The soil vapor monitoring program will be continued until the RAO is achieved. The RAO for OU-2, on-facility vadose zone soil at JPL is to prevent, to the extent practicable, further migration of VOCs at potential levels of concern from the vadose zone to groundwater to protect an existing drinking-water source.

8.0 PROJECT SCHEDULE

The proposed schedule for implementing the expanded SVE pilot test tasks identified in this Workplan Addendum is presented as Figure 11. The schedule indicates the major tasks described in this Workplan, their anticipated duration and Navy deliverable deadlines.

Following approval of the Workplan Addendum, GEOFON will request a project kick-off meeting to discuss project scheduling and mobilization activities. The sequence of the field activities at the JPL site will be coordinated through the SWDIV Remedial Project Manager (RPM) and the NMO - JPL On-Site Liaison Office prior to site mobilization.

9.0 REFERENCE SOURCES

Battelle, 2002. Technical Memorandum, Design, Construction, Operation, Optimization, and Monitoring Recommendations for the Soil Vapor Extraction (SVE) System, Operable Unit 2 (OU-2), Jet Propulsion Laboratory. March.

Foster Wheeler, 1999. Final Remedial Investigation Report for Operable Unit 2: Potential On-Site Contaminant Source Areas, National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California. November.

Foster Wheeler, 2000. Draft Final Feasibility Report for Operable Unit 2: Potential On-Site Contaminant Source Areas, National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California. July.

GEOFON, 2000. Work Plan Soil Vapor Extraction (SVE) Pilot Test at the National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California. December.

GEOFON, 2001. Summary Report Soil Vapor Extraction Pilot Test, (January 8 to May 24, 2001), Operable Unit 2, National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California. November.

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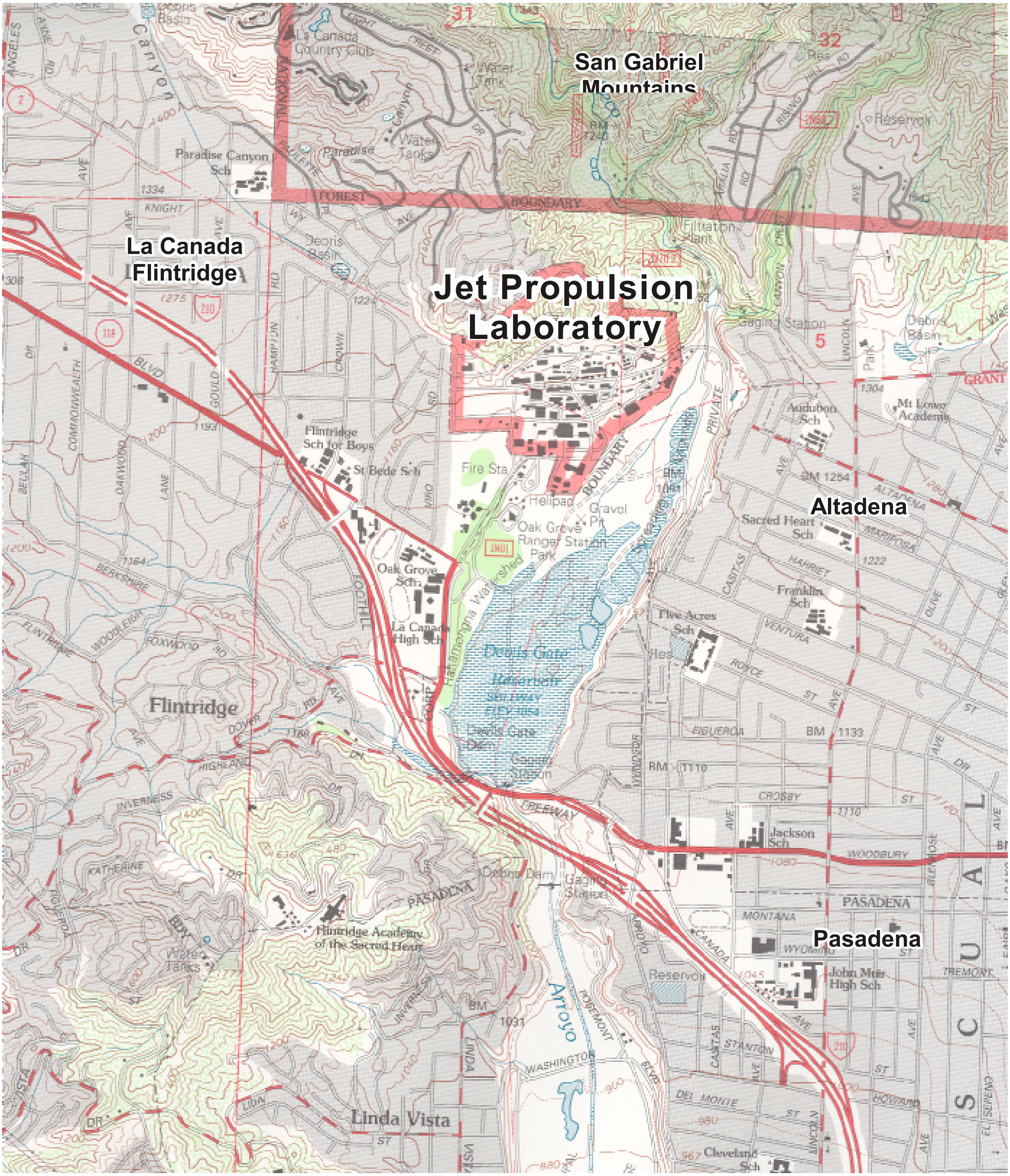
Praxis, 2002. PneuLog™ Evaluation of Well VE1, Jet Propulsion Laboratory, Pasadena, CA. February.

FIGURES



Scale in Miles

0 0.5 1

N

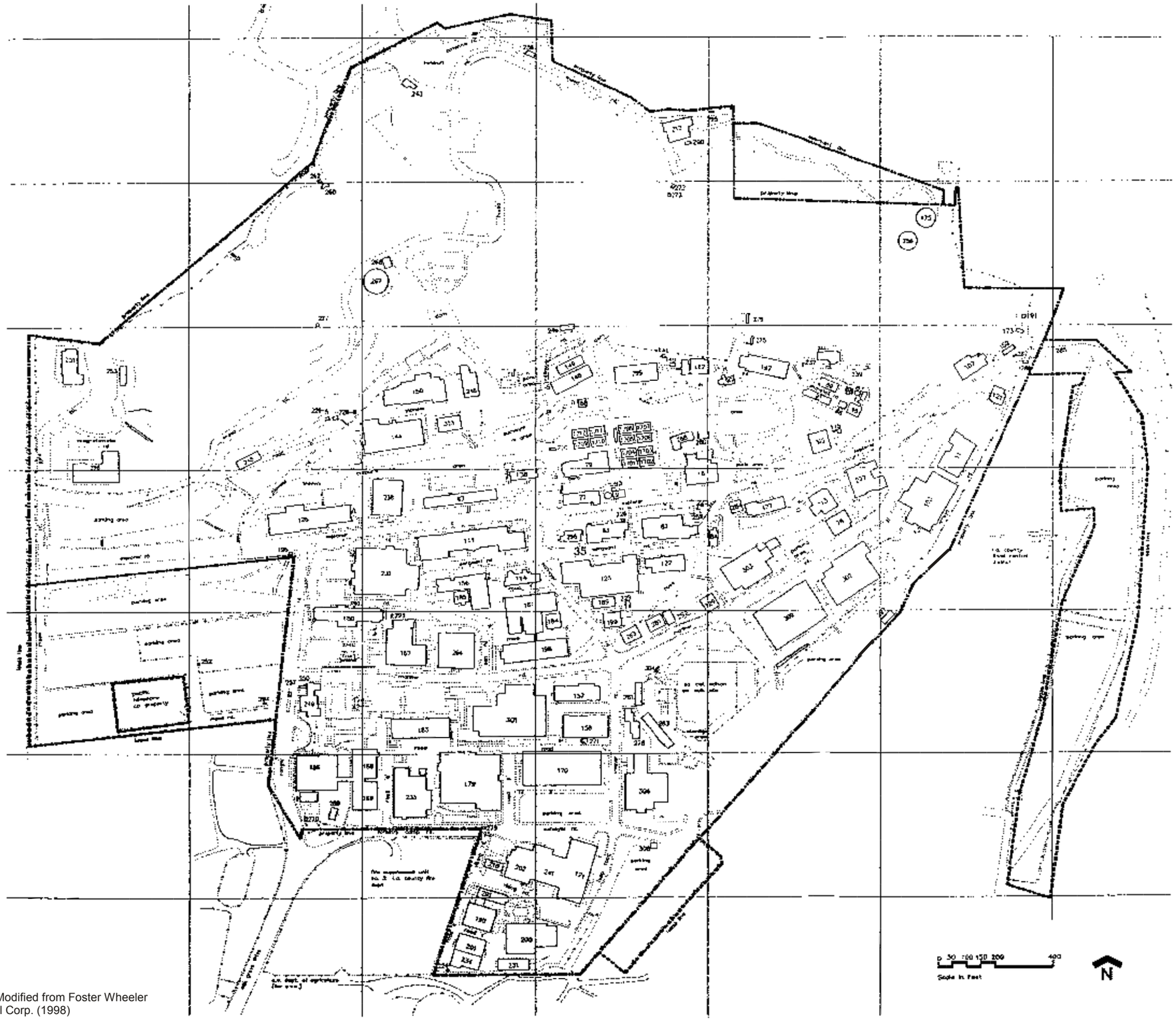
SOURCE: USGS Pasadena 7 1/2-Minute Quad, 1995

SITE LOCATION MAP
FIGURE 1

Jet Propulsion Laboratory
Pasadena, California

GEOFON

Date: May 2002
Contract No.: N68711-97-D-8702
DO No.: 0048



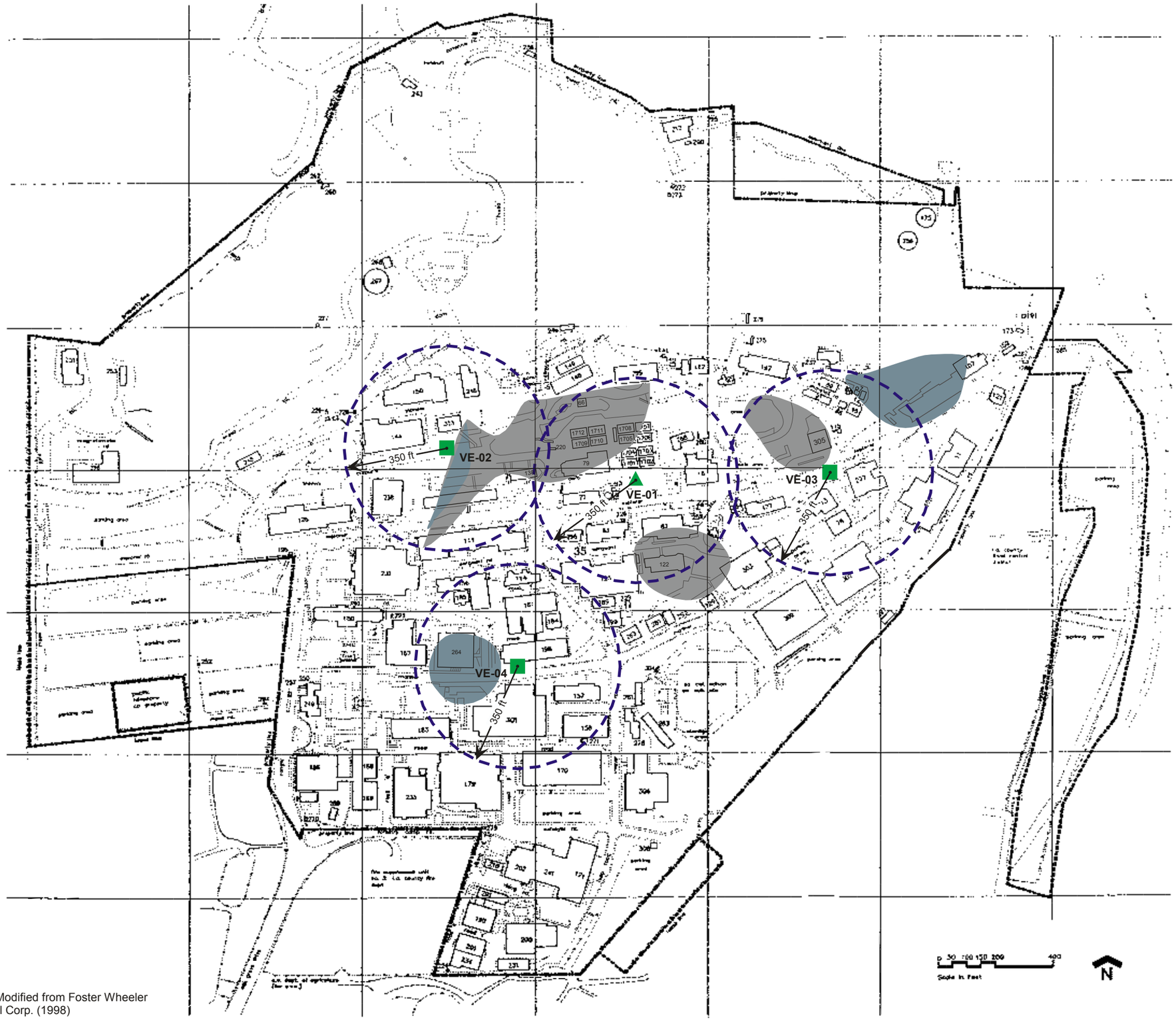
Note: Figure Modified from Foster Wheeler Environmental Corp. (1998)

SITE FACILITY MAP
FIGURE 2

Jet Propulsion Laboratory
Pasadena, California

GEOFON

Date: May 2002
Contract No.: N68711-97-D-8702
DO No.: 0048



EXPLANATION

APPROXIMATE EXTENTS OF CARBON TETRACHLORIDE PLUMES

APPROXIMATE EXTENTS OF TRICHLOROETHENE PLUMES

VE-01 APPROXIMATE LOCATION OF EXISTING SOIL VAPOR EXTRACTION WELL

VE-02 PROPOSED LOCATION OF ADDITIONAL SOIL VAPOR EXTRACTION WELL

ESTIMATED RADIUS OF INFLUENCE

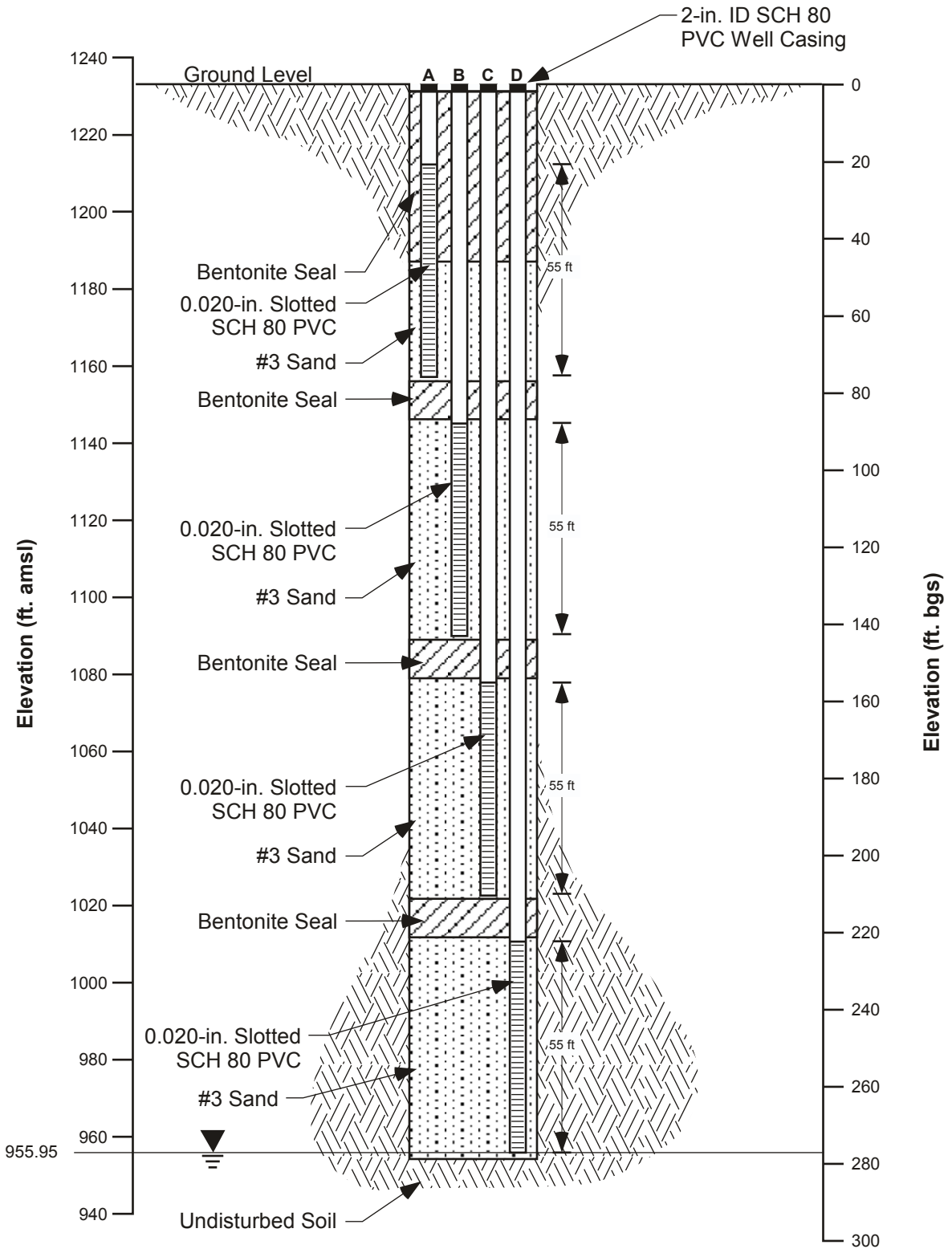
Note: Figure Modified from Foster Wheeler Environmental Corp. (1998)

PROPOSED SVE WELL LOCATION MAP
FIGURE 3

Jet Propulsion Laboratory
Pasadena, California

GEOFON

Date: May 2002
Contract No.: N68711-97-D-8702
DO No.: 0048



Explanation

▼ Lowest Groundwater Elevation Recorded in the Nearest Groundwater Monitoring Well (MW-16)

NOT TO SCALE

PROPOSED SVE WELL CONSTRUCTION DETAIL, VE-02
FIGURE 4

Jet Propulsion Laboratory
Pasadena, California

GEOFON

Date: May 2002
Contract No.: N68711-97-D-8702
DO No.: 0048