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January 21, 2005
PMX# 555-4693-001

Brian Sato, P.E.
Washington State Department of Ecology
3190 160th Avenue S.E.
Bellevue, Washington 98008-5452

Re: Barg French Cleaners; Ecology Site ID 22254391
1925 Third Avenue; Seattle, Washington
Engineering Design Report

Dear Brian:

The "Soil and Groundwater Remediation System Engineering Design Report for the Third Avenue Site" is attached for your review. The report text, tables, figures, and Appendix A (Pilot Study Work Plan) are provided in PDF format. A hard copy of the report, Appendix A, and Appendix B (Equipment Cut Sheets) will be sent to you for your files. Please contact me at your convenience to discuss the report.

Sincerely,

Michael R. Warfel
Project Manager

attachments

Sato, Brian

From: Sato, Brian
Sent: Thursday, January 27, 2005 10:36 AM
To: 'Mike Warfel'
Subject: RE: Barg French Cleaning Engineering Design Report

Mike:

I've reviewed the Engineering Design Report and everything looks in order. I have no comments/edits on this document. Please proceed.

Regards,

Brian
-----Original Message-----
From: Mike Warfel [mailto:warfel@parametrix.com]
Sent: Friday, January 21, 2005 8:29 AM
To: Sato, Brian
Subject: Barg French Cleaning Engineering Design Report

Brian:

The Engineering Design Report is attached. Call me to discuss at your convenience. Thanks.

Parametrix has moved to Bellevue!
My new contact info is:

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Soil and Groundwater Remediation System Engineering Design Report for the Third Avenue Site

Washington State Department of Ecology Site ID 22254391

Prepared for

1925 Third LLC
300 East Pine Street
Seattle, WA 98122

Prepared by

Parametrix
1231 Fryar Avenue
Sumner, WA 98390-1516
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January 2005 | 555-4693-001 (03/10)

CITATION

Parametrix. 2005. Soil and Groundwater Remediation System Engineering Design Report for the Third Avenue Site. Sumner, WA.

CERTIFICATE OF ENGINEER

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

BRANDON R. BALL
STATE OF WASHINGTON
28480
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES: 7/07/06

1/20/05

Prepared by Brandon R. Ball, P.E.

Checked by Kenneth T. Fellows, P.E.

FOR Approved by Michael R. Warfel, LHG

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KEY TERMS

AS/VE	air sparging/vapor extraction
CAP	Cleanup Action Plan
cfm	cubic feet per minute
COCs	chemicals of concern
DNAPL	Dense non-aqueous phase liquid
DPD	Department of Public Development
MTCA	Model Toxics Control Act
PCE	perchloroethylene
PPA	Prospective Purchaser Agreement
PSCAA	Puget Sound Clean Air Agency
VOCs	volatile organic compounds

1. INTRODUCTION

This Soil and Groundwater Remediation System Engineering Design Report for the Third Avenue Site (former location of the Barg French Dry Cleaning business) has been developed by Parametrix to fulfill the requirements of the Model Toxics Control Act (MTCA) (WAC 173-340-400) and the Prospective Purchaser Consent Decree executed on January 15, 2004. The Engineering Design Report includes the following information:

- General project background information.
- Cleanup and performance goals.
- Conceptual description of remediation system.
- Remediation system design criteria and references.
- Expected performance and effectiveness (including results of pilot study).
- Design features to contain hazardous vapors and waste activated carbon.
- Design features to protect building occupants from hazardous vapors and noise.
- Identification of construction and operating permits.
- Reference to construction plans and specifications.
- An operation and maintenance plan for all mechanical components of the system and for waste management of activated carbon.
- Design and construction schedule.
- A general description of construction testing that will be used to assure quality control.
- A general description of compliance monitoring.
- Certification by a professional engineer.

2. GENERAL PROJECT BACKGROUND INFORMATION

The former Barg French Dry Cleaning business was located at 1925 Third Avenue, Seattle, Washington, in a structure originally known as the Heiden Building that was erected in 1914. This building is a three-story structure without a basement, comprised of brick and masonry walls supported on conventional shallow concrete spread footings. The northwestern third of the ground floor was occupied by the dry cleaning operation from 1951 to 2000. The remainder of the ground floor formerly housed a bookstore. The second and third floors have been used as commercial business spaces. All spaces within the building are currently vacant. The building is bounded by Third Avenue to the northeast, a six-story office building to the southeast, a paved alley to the southwest, and a two-story parking structure to the northwest.

A limited Phase II site assessment conducted in 1999 detected the presence of perchloroethylene (PCE), a dry cleaning solvent, in shallow soil beneath the floor of the dry cleaning space. Subsequent subsurface investigations completed from 1999 through 2001 included installation of more than 30 subsurface explorations consisting of soil probes, soil vapor extraction points, and monitoring wells. The results of prior investigations with respect to the nature and extent of contamination are summarized as follows:

- PCE was the principal component of the dry cleaning fluids released at the site and best represents the impacts of the dry cleaning fluid release on the environment at the site. TCE is a degradation product of PCE and was also detected at the site. PCE and TCE behave similarly in the environment and are remediated using the same remedial technologies. PCE and TCE are selected as the chemicals of concern (COCs) at the former Barg French dry cleaning site.
- PCE in soils was encountered at concentrations up to 8.9 mg/kg, generally decreasing with increasing the distance from the cement pad upon which the dry cleaning machine was mounted.
- Concentrations of PCE in the shallow perched water table were reported up to 4,200 mg/ℓ beneath the concrete pad, with decreasing concentrations as distance from the pad increased.
- Dense non-aqueous phase liquid (DNAPL) was not observed in any of the soil or groundwater samples collected at the site.
- In 2001, SECOR tested the air in the former dry cleaning area of the building and found concentrations of PCE above the Method B formula cleanup level. Concentrations of TCE did not exceed the Method B cleanup level.
- The contamination identified at the site does not present risk to ecological receptors because the groundwater, soil, and air contamination are contained beneath and within the existing building. There are no known discharges from this site of contaminated groundwater to ground surfaces or surface water bodies.
- Data from the site investigations conducted to date have sufficiently defined the nature and extent of contamination from the PCE release. The data was collected in accordance with procedures specified in the MTCA regulations, supports the selection of the cleanup action, and meets the substantive requirements of a remedial investigation per the MTCA regulations.

These site-specific sampling results served as the basis for preparation of a Cleanup Action Plan (CAP) submitted for review by Ecology. The CAP included screening of remedial alternatives and selection of an air sparging and soil vapor extraction system as the preferred alternative. The draft CAP was prepared as an attachment to a draft Prospective Purchaser Agreement (PPA) Consent Decree, which was submitted in November 2003 for public review. The final PPA Consent Decree (with attached final CAP) was executed on January 15, 2004.

3. CLEANUP AND PERFORMANCE GOALS

Cleanup goals for the Barg French Dry Cleaning site were specified in the CAP and are summarized below.

3.1 SOIL

The MTCA Method B cleanup level for PCE in soil is 19.6 mg/kg and is based upon direct human contact. This is the appropriate soil cleanup level to apply, since shallow groundwater beneath the site is not potable (as documented in the CAP). Per WAC 173-340-740(6)(c), the point of compliance for soil is the soil throughout the site from the ground surface to the uppermost groundwater saturated zone.

3.2 GROUNDWATER

Groundwater beneath the site that has been impacted by PCE occurs in a shallow perched water-bearing zone within 20 feet of ground surface. Geologic data from the site and nearby properties indicate that the perched groundwater is laterally discontinuous, low-yielding (less than 0.5 gallon per minute), not a current or potential future source of drinking water, and separated from potential drinking water aquifers by a well-documented confining unit consisting of dense silt and clay. For these reasons, the perched zone beneath the site is classified as non-potable groundwater, per the requirements of WAC 173-340-720(2).

Given that the perched groundwater beneath the site is non-potable, cleanup of groundwater is only required to the extent that concentrations of PCE in groundwater cause unacceptable risks to potential receptors via pathways other than potable groundwater. Prior calculations by SECOR in 2001 resulted in the following Method B groundwater cleanup levels for the site:

Type of Protection	Calculated Groundwater Cleanup Levels (mg/ℓ)	
	PCE	TCE
Indoor Ambient Air	0.485	0.247
Outdoor Air	19.469	9.468
Excavation Workers	0.196	1.277

The lowest calculated cleanup levels are selected as the groundwater cleanup levels for the site. These levels are 0.196 mg/ℓ for PCE and 0.247 mg/ℓ for TCE.

According to WAC 173-340-720(8)(b), the point of compliance for groundwater will be groundwater throughout the site from the uppermost level of the saturated zone extending vertically to the lowermost depth, which could potentially be affected by the site. The hydrogeologic information collected for the site indicates that the shallow perched water table is bounded below and separated from the regional water table by the dense silt unit.

3.3 AIR

The MTCA regulations do not specify Method A cleanup levels for air; therefore, Method B cleanup levels are appropriate for the former Barg French Dry Cleaning site. SEACOR (2003) calculated the following Method B cleanup levels for air: 4.31 $\mu g/m^3$ for PCE and 0.515 $\mu g/m^3$ for TCE.

4. CONCEPTUAL DESCRIPTION OF REMEDIATION SYSTEM

An air sparging/vapor extraction (AS/VE) system is proposed as the selected cleanup action for the former Barg French dry cleaning site consistent with the approved CAP. This technology uses air sparging to volatilize PCE and other volatile organic compounds (VOCs) in the groundwater layer. VOCs released from the groundwater, as well as PCE present at low levels in the unsaturated soil column, are recovered in a vacuum extraction system. Extracted vapors are removed from the soil and then adsorbed in activated carbon canisters. Treated air is then discharged to the atmosphere through a building duct.

The vapor extraction system consists of vertical wells screened in the unsaturated soil zone. As an added level of protection, vapor extraction pipes are also located horizontally, just below the floor slab, to prevent vapors from entering the building space. All piping is routed beneath the building floor slab and into a mechanical room where equipment and instrumentation are housed.

The remediation system is compatible with the building renovation, and will be operated and monitored as the building is occupied. When the cleanup has been completed, the system will be decommissioned with a minimum of disturbance to the occupied building space.

5. EXPECTED PERFORMANCE AND EFFECTIVENESS (RESULTS OF FIELD PILOT STUDY)

A field-scale pilot study of the AS/VE system was completed during the months of April through September 2004. The pilot test design was based on prior experience and on information contained in the following guidance documents for design and operation of AS/VE systems:

- NAVFAC. 1999. Air sparging application guidance tools. Naval Facilities Engineering Service Center, Port Hueneme, CA. <http://www.nfesc.navy.mil>.
- Leeson, A., et al., 2002. Air Sparging Design Paradigm. Battelle, Columbus, OH.
- Rast, Richard R. 2002. Environmental remediation estimating methods. RS Means, 2nd Edition. Kingston, MA.

A work plan for the pilot study is included in Appendix A. A list of activities prior to and during pilot testing is shown in Table 5-1. In preparation for pilot testing, a total of four new air sparging wells were installed and screened in the groundwater table. Additional vapor extraction wells were also installed. The newly installed AS and VE wells were designed to serve the needs of the pilot study as well as to be utilized in the final remediation system. Design details for the AS and VE wells are provided in Section 6. The locations of the new wells (designated as AS and VE) are shown in Figure 5-1. The figure also shows the results of baseline groundwater testing conducted before the start of pilot testing. The pilot study also utilized existing soil vapor extraction wells (designated SVE on Figure 5-1). These wells are screened primarily in the vadose zone, between approximately 2 and 20 feet below ground surface.

Table 5-1. Summary of Activities Prior to and During AS/VE Pilot Testing

Date	Description of Activity	Significant Results
4/13/04	Completed first round of drilling of VE and AS wells.	A number of AS wells were attempted but had to be abandoned and repositioned due to lack of suitable saturated and permeable media.
4/19/04	Started constructing pilot VE system. Installed electrical and connected fittings, blowers, and activated carbon.	

(Table Continues)

Table 5-1. Summary of Activities Prior to and During AS/VE Pilot Testing (Continued)

Date	Description of Activity	Significant Results
4/20/04	Continued with installation of VE system and started installation of air sparging system piping, compressor, and flow meters.	
4/21/04	Completed installation of AS and VE pilot systems.	
4/22/04	Pressure tested AS-2 with sparging air. Vacuum tested VE-2. Pressure tested AS-1 with sparging air.	Deadheaded AS-2 well at 60 psi. Well is apparently clogged and needs to be redeveloped. VE-2 passed flow and vacuum tests. AS-1 equilibrated at 5.6 cfm and 16 psi. Bubbling noise and PCE odor observed at SVE-4 located about 10 feet away during sparging of AS-1.
4/23/04	Vacuum tested VE-4. Vacuum tested VE 3. Pressure tested AS-4.	Capacity of VE-4 and VE-3 wells is approximately 60 cfm. AS-4 equilibrated at 6.2 cfm and 10 psi.
5/26/04	Started up the vapor extraction system and began to pull PCE (dry-cleaning solvent) vapors out of the soil. Connected blower in most contaminated region using wells SVE-5, SVE-7, and SVE-4.	The purpose of running the pilot system in an extended mode is to remove as much PCE from the soil as possible prior to demolition of the existing floor in Bay 3 (former dry cleaner location).
5/27/04	Performed daily PCE monitoring of the inlet and outlets (upper outlet and lower outlet) using Drager tubes and a Photovac PID.	Drager colorimetric tubes for the inlet was 5 ppm and outlets <2 ppm (ND). PID readings for inlet stabilized at 4.5 ppm, peaking at 4.6 ppm.
5/27/04–6/6/04	Operated soil vapor extraction system continuously over 2-week period to pull PCE vapors out of soil. Performed daily monitoring and inspection.	Based on an average inlet air flow rate of 100 cfm and inlet PCE of 4 ppm, the initial daily mass removal rate of PCE is 0.24 lbs per day. The total estimated mass of PCE in the shallow soils is 3.5 lbs. Therefore, it is expected that a significant percentage of soil-bound PCE was removed over the 2-week period.
6/9/04	Installed additional AS well (AS-3) in center of PCE plum.	Additional well was necessary due to limited success of previous well drilling to find areas with suitable saturated layer thickness and sufficiently permeable media.
6/10/04	Redeveloped AS-2 and tested with He tracer. Sparging air flow = 6 cfm, air pressure = 10 psi, He = 5%.	Results on attached figure for AS Test #1 show that AS-2 has a radius and ROI of approximately 10 feet. This is suitable for full-scale system design.
6/10/04	Tested AS-3 with helium tracer. Sparging air flow = 3 cfm, air pressure = 9 psi.	Results on attached figure for AS Test #2 show that AS-3 has a radius and ROI of approximately 12 feet. This is suitable for full-scale system design. The results also show that the PID readings of surrounding vapor extraction wells were very high (800 ppm in SVE-4, for example), indicating that effective stripping of PCE from the groundwater was occurring.

(Table Continues)

Table 5-1. Summary of Activities Prior to and During AS/VE Pilot Testing (Continued)

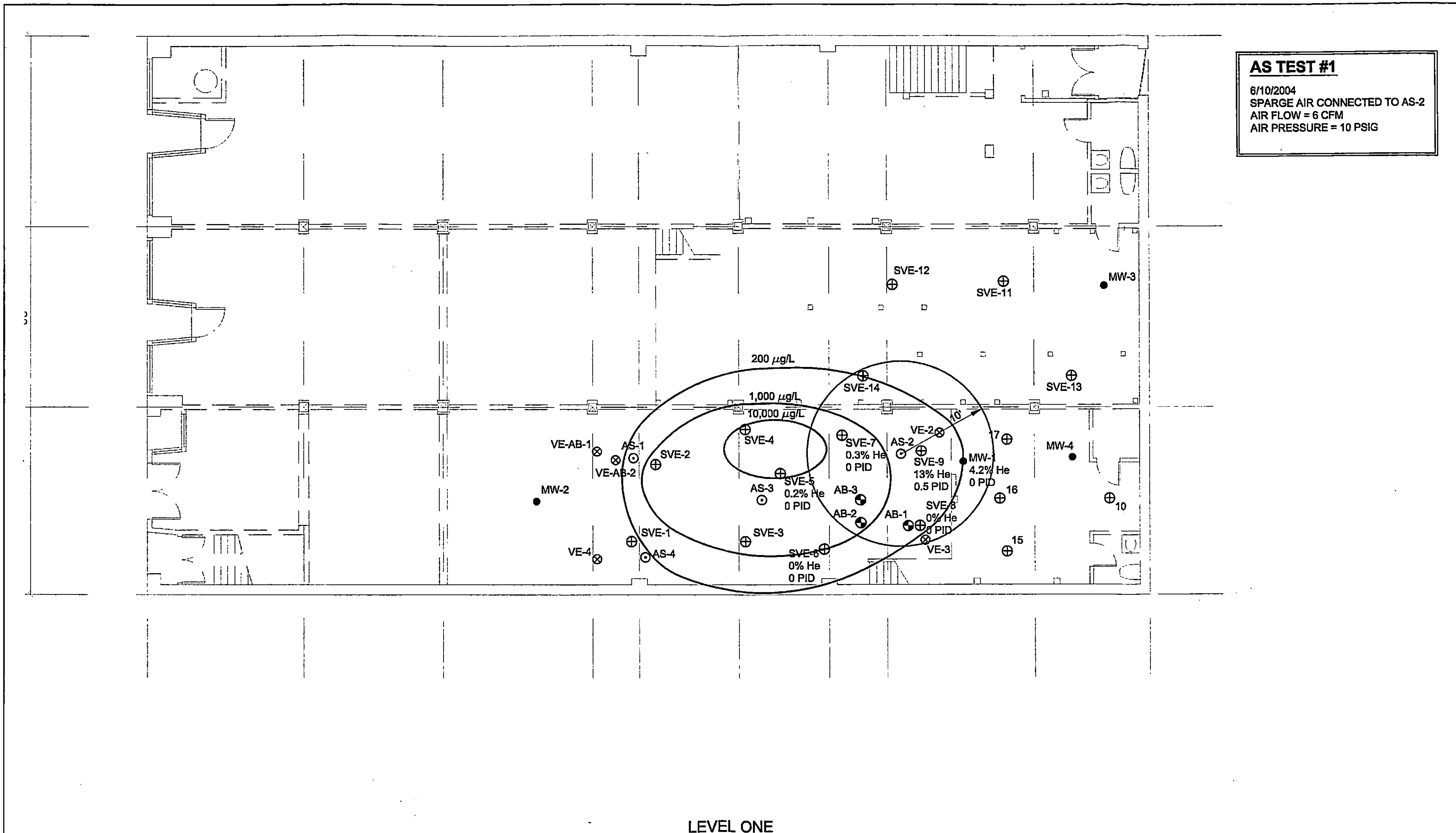
Date	Description of Activity	Significant Results
6/11/04	Collected groundwater VOC samples from surrounding wells one day after sparge test. Surrounding wells included SVE-1, SVE-2, SVE 5, SVE-8, and SVE-9.	Results of VOC testing confirmed no displacement of PCE plume by air sparging test on previous day
6/18/04	Collected groundwater VOC samples from surrounding wells 1 week after sparge test. Surrounding wells included SVE-1, SVE-2, SVE-5, SVE-8, and SVE-9.	Results of VOC testing confirmed no displacement of PCE plume by air sparging test on previous week.
9/30/04	Tested SVE-5 for vacuum influence. Air flow = 60 cfm.	Results in attached figure for VE Test #1 show radius of vacuum influence when connected to one well.
9/30/04	Tested SVE-5 and SVE-2 in series for vacuum influence. Air flow = 60 cfm.	Results in attached figure for VE Test #2 show radius of vacuum influence when connected to two wells.
9/30/04	Tested SVE-5, SVE-2, and VE-2 in series for vacuum influence. Air flow = 100 cfm.	Results in attached figure for VE Test #3 show radius of vacuum influence when connected to 3 wells. Vacuum influence covers the entire contaminated area.
9/30/04	Tested SVE-5, SVE-2, and VE-2 in series for vacuum influence, while at the same time air sparging at well AS-2.	Results in attached figure for VE Test # 4 show some decrease in vacuum pressure around sparge well as expected.

The pilot air sparging system consisted of an air compressor, flow meters, pressure gauges, piping, and the AS wells described above. Helium was used as a tracer in the air sparging tests. A helium detector and PID meter were used to monitor the effects of air sparging at adjacent wells. Results of the air sparging tests are displayed in Figure 5-2 and Figure 5-3 and described in Table 5-1. The test data indicate that each AS well will provide a radius of influence equal to approximately 10 feet or greater. Maximum operating pressure for air sparging wells will need to be approximately 10 psi and air flows will need to range between 1 and 6 cfm.

The pilot vapor extraction system consisted of a blower, condensate separator, activated carbon canister, flow meters, pressure gauges, vacuum gauges, piping, and VE and SVE wells described previously. Varying vacuums and flows were applied to different wells while monitoring vacuum influence in adjacent wells with a sensitive vacuum gauge. The presence of detectable vacuum in adjacent wells indicates zone of capture by the well or wells to which vacuum is applied. Separate tests were run for vacuum applied to a single well, two wells in series, three wells in series, and three wells in series while running the air sparging system. Results are displayed in Figures 5-4 through 5-7 and described in Table 5-1. Results of the pilot study indicate that a vacuum applied to 3 VE or SVE wells at a total combined flow of approximately 100 cfm will provide ample coverage of the entire site and beyond. This was observed to be the case with air sparging turned on. Results also showed that during continuous operation for two weeks, the VE system removed PCE from the subsurface at an average rate of 0.24 pounds per day. This was the case with air sparging turned off. Higher PCE removal rates would be expected to occur with air sparging turned on while running the vacuum extraction system.

Groundwater samples for analysis of PCE were collected before and after the air sparging pilot test. Baseline samples from surrounding wells were collected in March 2004. The same wells were sampled again in June, one day after the sparging tests. The same wells were sampled a third time, one week after the sparging tests. Because of the short duration of the pilot study, no significant removal of groundwater PCE was expected to occur. Rather, the purpose of testing groundwater concentrations before and after air sparging was to ensure that the hydraulic pressures exerted by the air would not cause displacement of the PCE plume. Test results displayed in Figure 5-7 indicate that air sparging did not result in displacement of the PCE plume. Concentrations of PCE in surrounding groundwater wells were essentially the same before and after the pilot study.

Groundwater levels were also tested before, during, and after the air sparging pilot study. The results showed that air sparging at high rates (5-6 cfm) caused groundwater in the immediate area to rise considerably. Lower air sparging rates of approximately 2 cfm resulted in less groundwater level movement (approximately 1-foot increase in nearby wells). Groundwater levels continued to equilibrate toward normal levels after several hours of air sparging. These effects on groundwater are expected. At modest air flow rates and pressure, groundwater level should increase initially in the immediate vicinity of the sparge point and return to normal levels after a few days of continuous sparging.



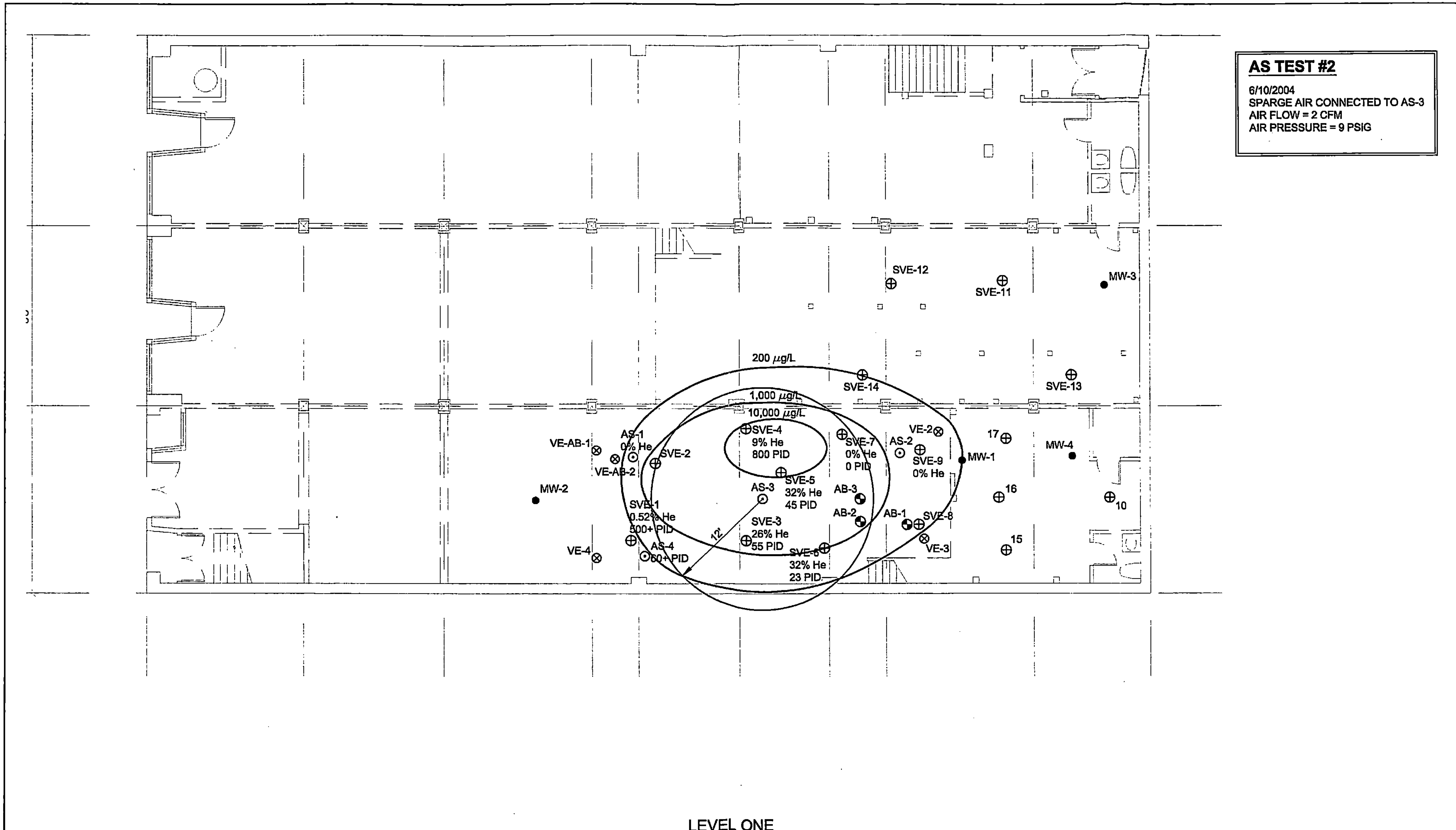
Parametrix DATE: 01/20/05 10:46am FILE: SU46930010311-F01

0 10
SCALE IN FEET

LEGEND:

- ● MONITORING WELLS
- SVE-4 ⊕ PRE-2004 SOIL VAPOR EXTRACTION WELL
- AS-1 ⊙ 2004 AIR SPARGING WELL
- VE-1 ⊗ 2004 SOIL VAPOR EXTRACTION WELL
- AB-1 2004 ABANDONED TEST BORING
- ⊙ AIR SPARGE POINT
- He = % HELIUM TRACER BY VOLUME
- PID = PPM ON PID METER
- AREA OF INFLUENCE (=MEASURABLE He)
- PCE BASELINE GROUNDWATER CONTAMINATION (µg/L) 3/15/04

Figure 5-1
Air Sparging Test #1



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- ● MONITORING WELLS
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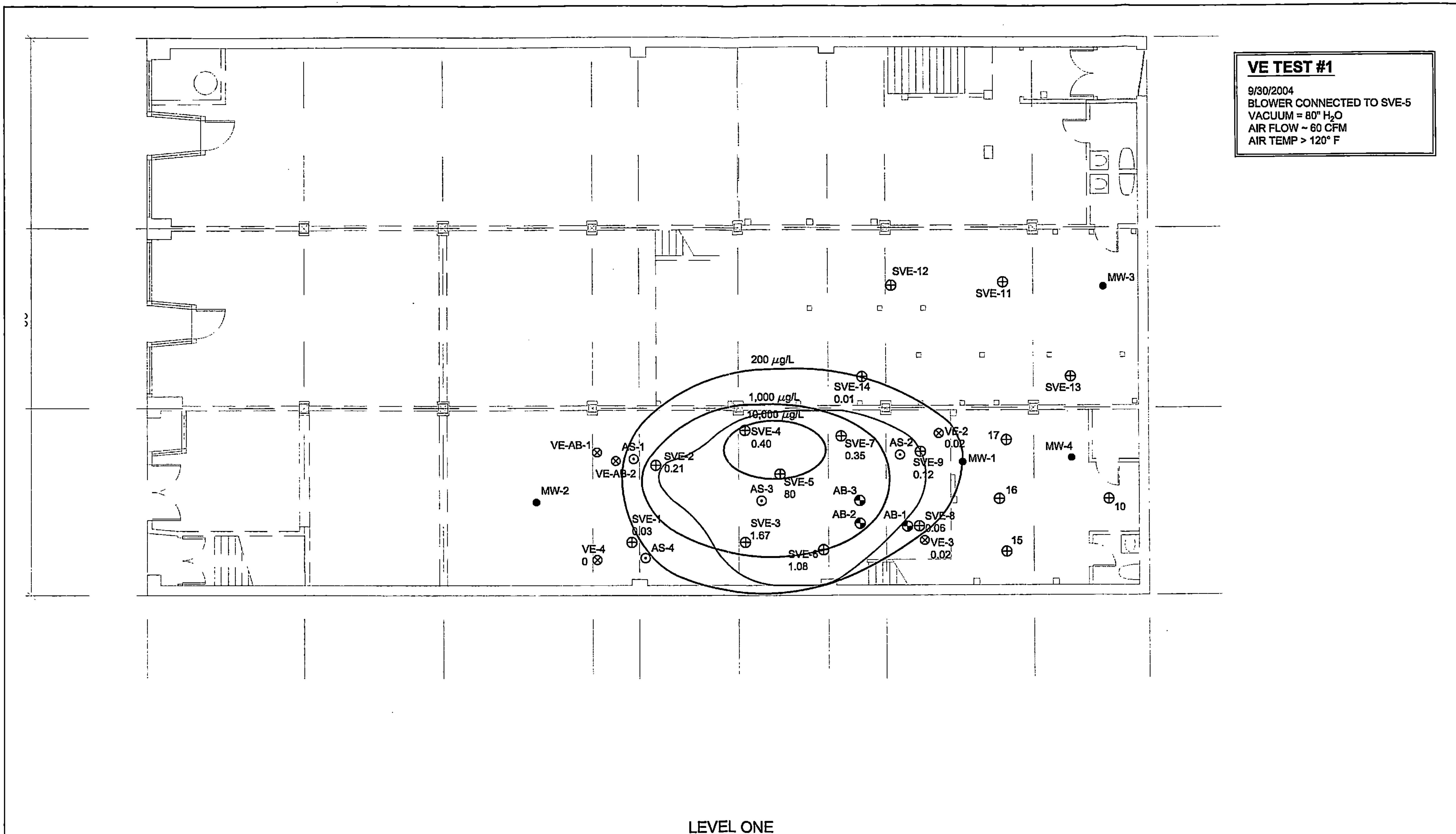
- AS-1 ⊙ 2004 AIR SPARGING WELL
- VE-1 ⊗ 2004 SOIL VAPOR EXTRACTION WELL
- AB-1 2004 ABANDONED TEST BORING
- ⊙ AIR SPARGE POINT
- He = % HELIUM TRACER BY VOLUME
- PID = PPM ON PID METER
- AREA OF INFLUENCE (=MEASURABLE He)
- PCE BASELINE GROUNDWATER CONTAMINATION (μg/L) 3/15/04

0 10
SCALE IN FEET

Figure 5-2
Air Sparging Test #2



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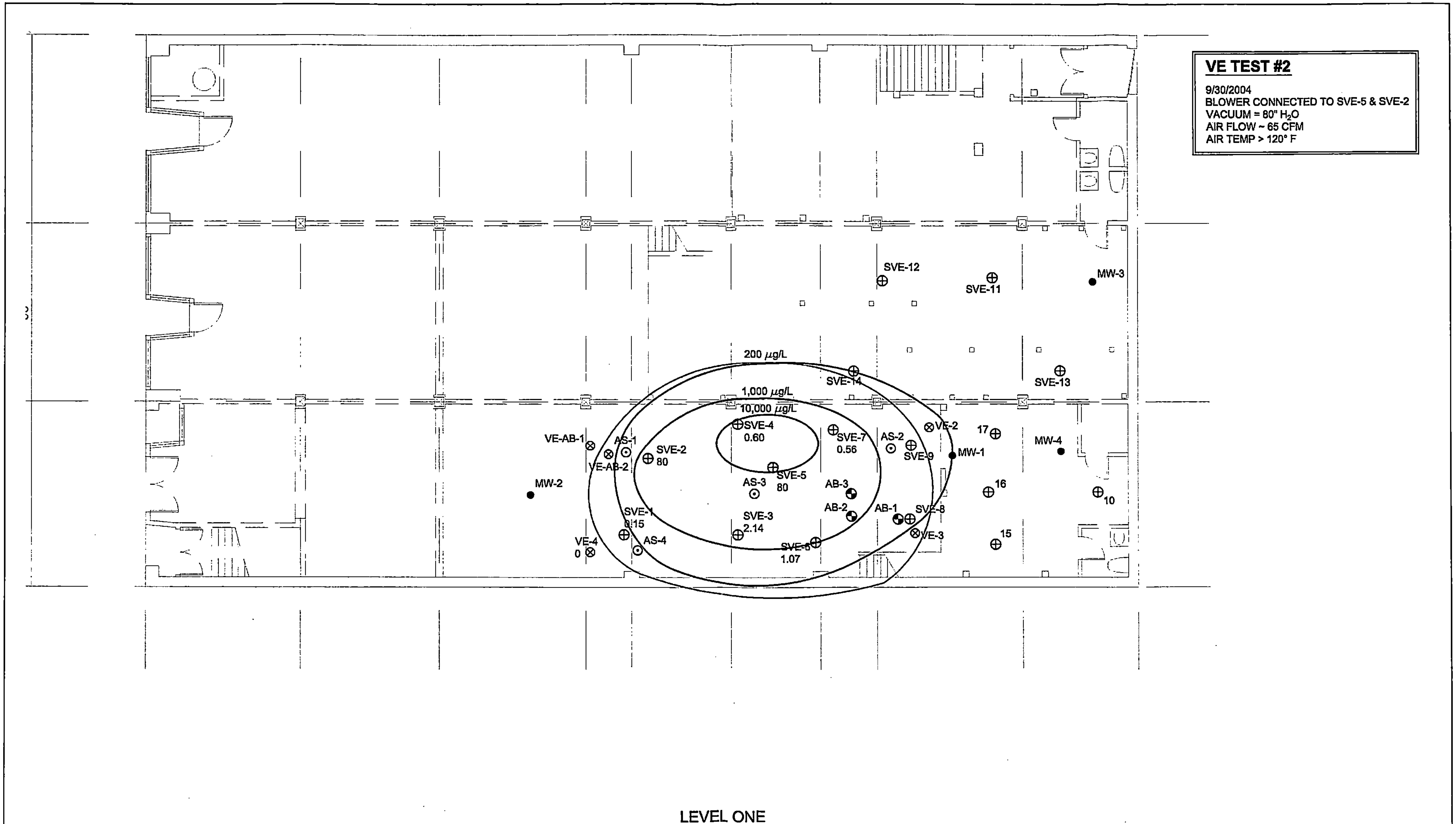
SCALE IN FEET

LEGEND:

- ● MONITORING WELLS
- SVE-4 ⊕ PRE-2004 SOIL VAPOR EXTRACTION WELL
- AS-1 ⊙ 2004 AIR SPARGING WELL
- VE-1 ⊗ 2004 SOIL VAPOR EXTRACTION WELL
- AB-1 2004 ABANDONED TEST BORING
- ⊕ BLOWER CONNECTION POINT
- 0.40 = INCHES H_2O VACUUM
- AREA OF INFLUENCE (=0.01" H20)
- PCE BASELINE GROUNDWATER CONTAMINATION (μg/L) 3/15/04

Figure 5-3
Vapor Extraction Test #1



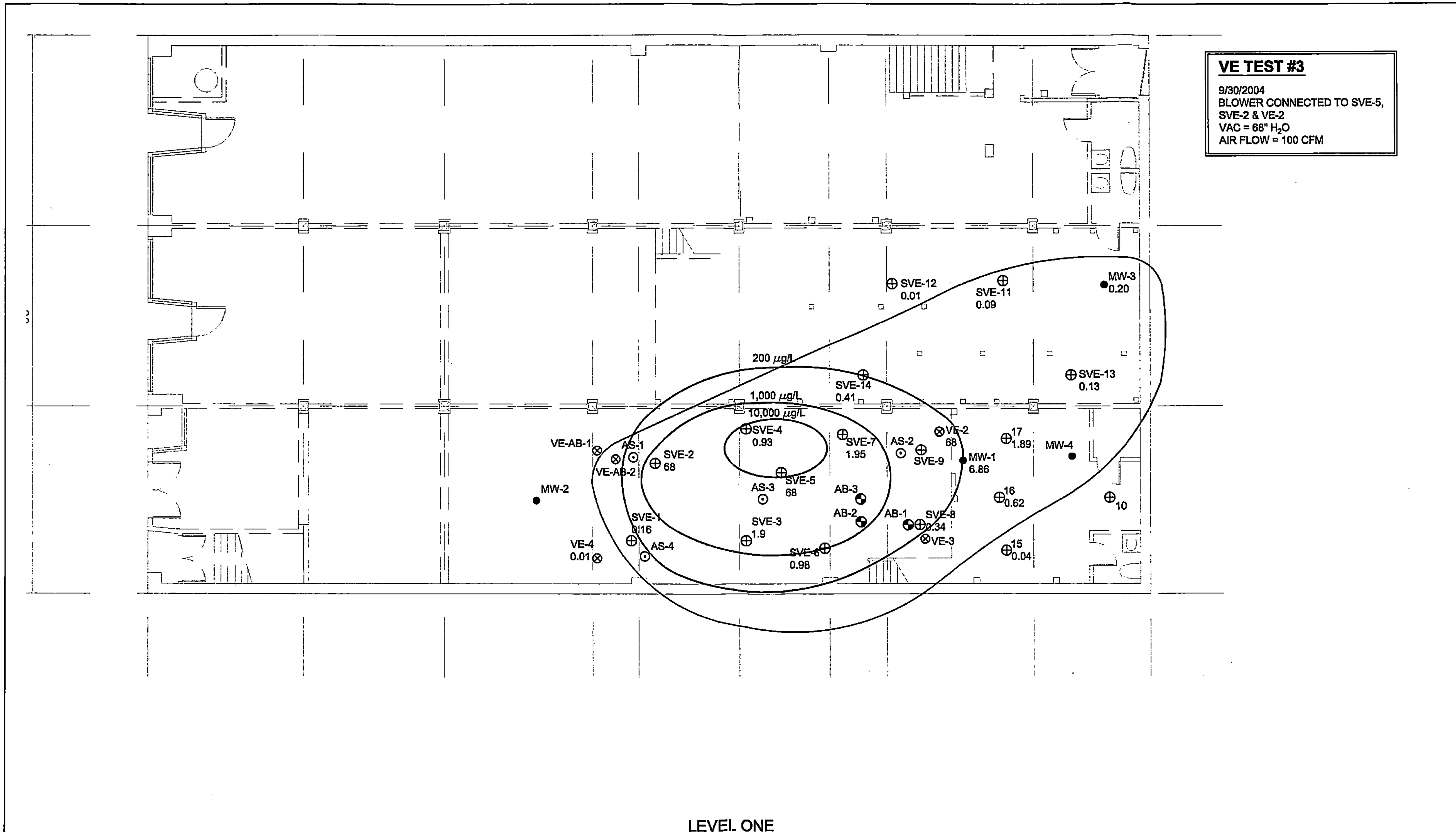
Parametrix DATE: 01/20/05 10:32am FILE: SU46930010311-F04

LEGEND:

- ● MONITORING WELLS
- SVE-4 ⊕ PRE-2004 SOIL VAPOR EXTRACTION WELL
- AS-1 ⊙ 2004 AIR SPARGING WELL
- VE-1 ⊗ 2004 SOIL VAPOR EXTRACTION WELL
- AB-1 2004 ABANDONED TEST BORING
- ⊕ BLOWER CONNECTION POINT
- 0.40 = INCHES H_2O VACUUM
- AREA OF INFLUENCE (=0.01" H20)
- PCE BASELINE GROUNDWATER CONTAMINATION (µg/L) 3/15/04

0 10
SCALE IN FEET

Figure 5-4
Vapor Extraction Test #2



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0 10
SCALE IN FEET

LEGEND:

- ● MONITORING WELLS
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- AS-1 ⊙ 2004 AIR SPARGING WELL
- VE-1 ⊗ 2004 SOIL VAPOR EXTRACTION WELL
- AB-1 ◕ 2004 ABANDONED TEST BORING
- ⊕ BLOWER CONNECTION POINT
- 0.40 = INCHES H_2O VACUUM
- AREA OF VACUUM INFLUENCE (=0.01" H20)
- PCE BASELINE GROUNDWATER CONTAMINATION (µg/L) 3/15/04

Figure 5-5
Vapor Extraction Test #3

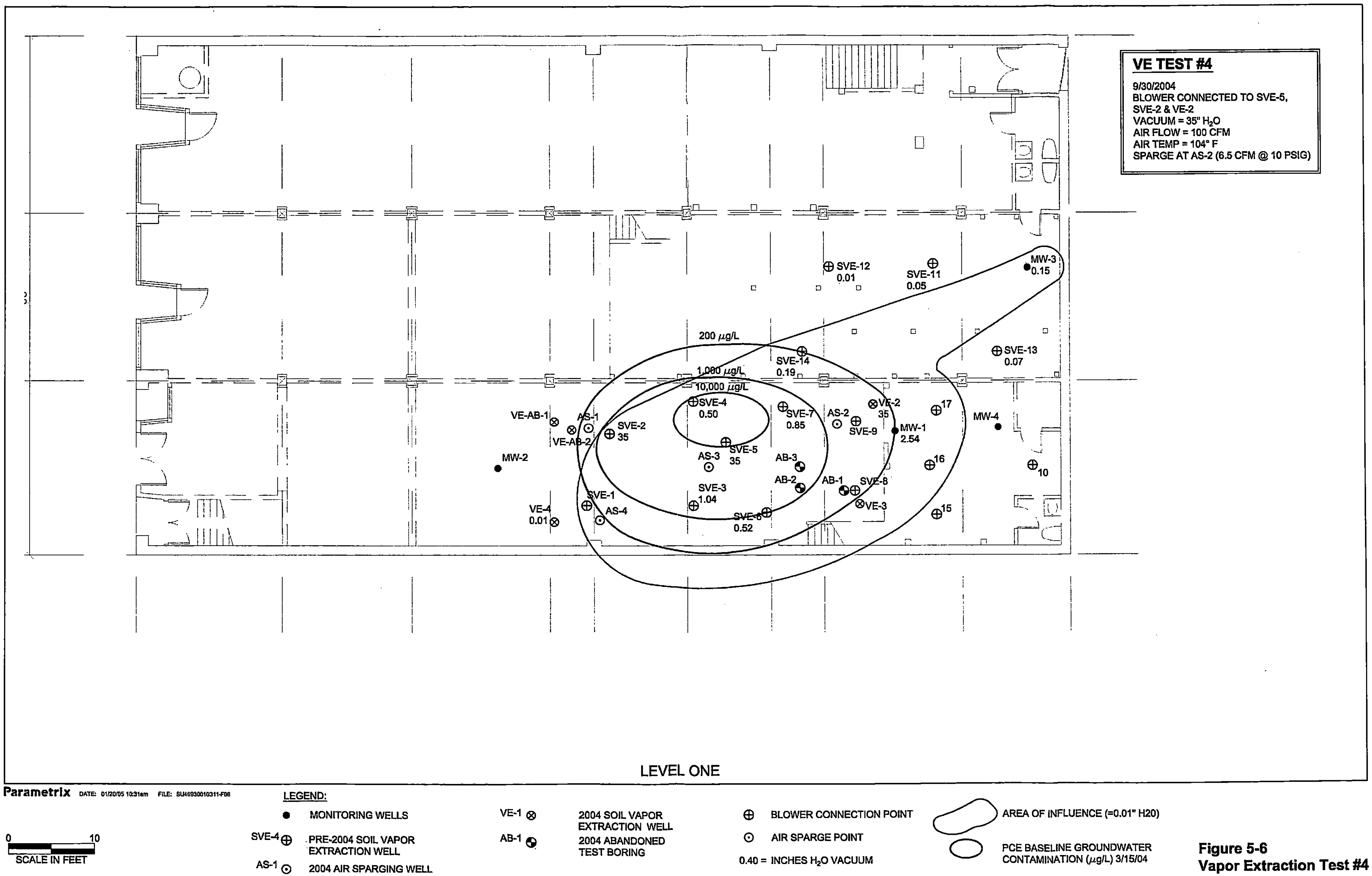


Figure 5-6
Vapor Extraction Test #4

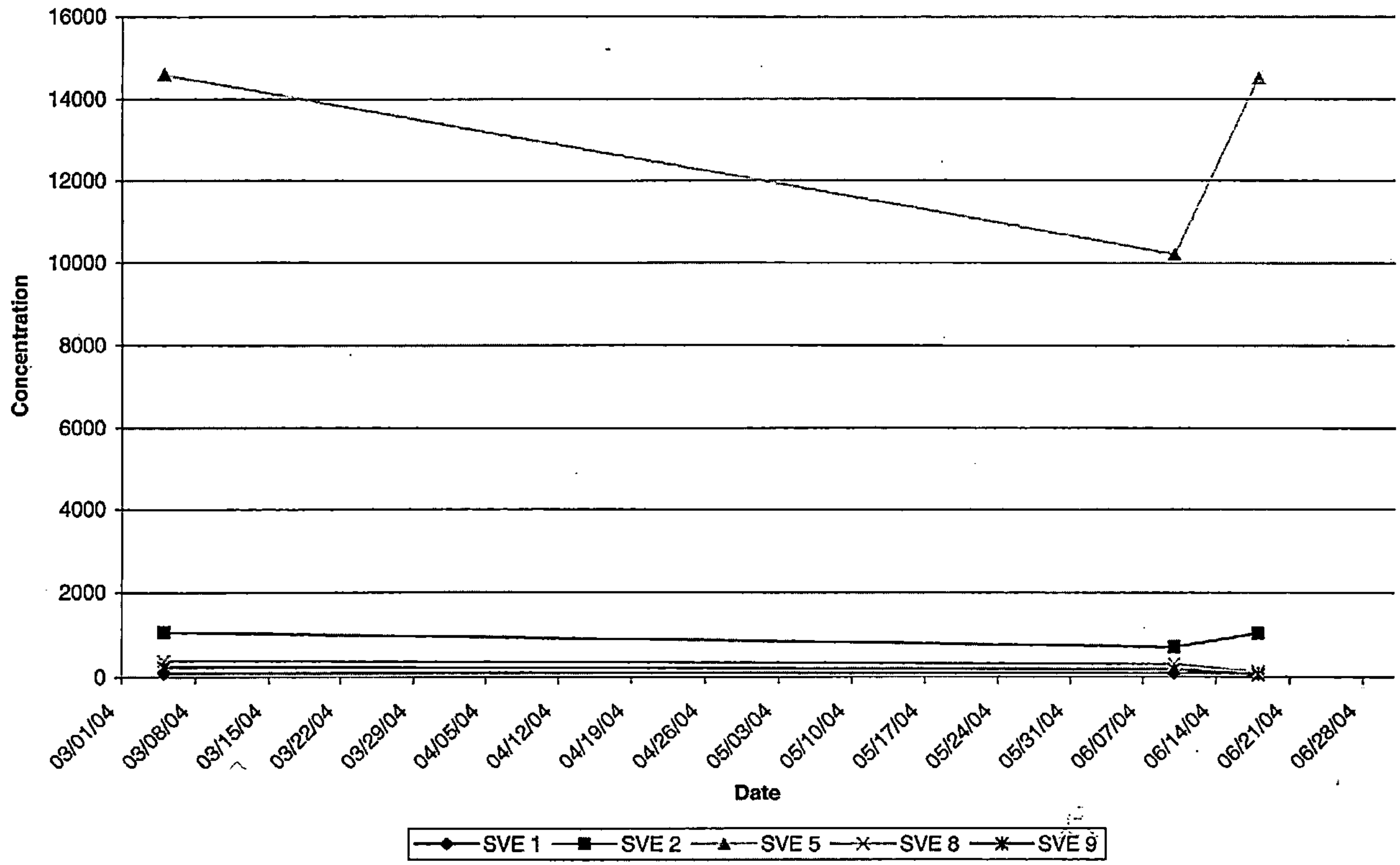


Figure 5-7. Groundwater PCE Concentrations Before and After Pilot Study

6. DESIGN CRITERIA AND PLANS AND SPECIFICATIONS

Design of the AS/VE system was based on previous experience designing similar systems and on site-specific results of the pilot study. This section provides design rationale and detailed plans and specifications for the remediation system. Separate sections are provided for air sparging, vertical vapor extraction wells, and horizontal vapor extraction wells.

6.1 AIR SPARGING SYSTEM DESIGN

Based on results of the pilot study, the four air sparging wells, AS-1, AS-2, AS-3, and AS-4 (see Drawing C-1), will provide more than adequate spatial coverage of the contaminated groundwater plume. Each well is expected to provide a radius of influence equal to approximately 10 feet or greater. Operating pressures for air sparging wells will need to be 10 psi and air flows will need to range between 1 and 6 cubic feet per minute (cfm). Specifications for the air compressor and other equipment related to the AS system are shown in Table 6-1. Equipment cut sheets are included in Appendix B. It is anticipated that actual air flows will be maintained at low levels in each well (approximately 2 cfm) to limit the amount of pressure placed on the groundwater system and thus limit groundwater displacement by the sparging air. The AS system will be carefully monitored during start-up (i.e., monitoring of air pressure, air flow, and surrounding groundwater elevation) to determine the proper balance of air flows. In addition, the system design will provide the flexibility to control and measure air flow and pressure to each well.

Table 6-1. Air Sparging System Design Specifications

Item	Design Parameter	Specification
Compressor	Power, hp	2
	Motor voltage, V	115/230
	Motor phase	Single
	Motor frequency, Hz	60
	Air flow at 10 psig, cfm	20
	Max pressure, psig	20
AS Wells	Diameter, inches	2
	Well screen length, inches	12
	Material	Schedule 40 PVC
Wells Included		AS-1, AS-2, AS-3, AS-4
Compressed Air Line	Diameter, inches	1
	Material	Carbon steel/Schedule 80 CPVC

A design layout of the AS system is shown in Drawing C-1. A detail drawing for sparging wells (which have already been installed) is provided in Drawing C-2. A detail showing the air compressor and flow control manifold is provided in Drawing M1. As shown in Drawing C-2, each sparging well is screened near the bottom of the aquifer to promote dispersion and coverage of sparging air. Each well will be accessible for monitoring and maintenance by providing a flush-mount well casing and cap at the top of each well. As shown in Drawings C-2 and M2, the piping material for the manifold directly downstream of the blower will be 1-inch carbon steel and the underground piping leading to each AS well will be 1-inch CPVC. These piping materials have been carefully selected to handle the elevated air temperatures generated by the compressor. Maximum air temperatures in the flow control manifold may reach 250 degrees F and temperatures in the 1-inch underground lines could reach up to 200 degrees F. Due to natural heat dissipation, air temperatures in the air sparging wells are expected to be relatively low. The sizing of all lines in the air sparging system is larger than required to limit friction and pressure losses. Air pressure losses between the compressor and wells were calculated and determined to be negligible.

6.2 VERTICAL VAPOR EXTRACTION WELL SYSTEM DESIGN

Based on results of the pilot study, the design will utilize both new VE wells and existing SVE wells to remediate contaminated soils, as well as vapors that will be released to the subsurface by the air sparging system. Because the site consists of fine-grained, low-permeability soils, a design with low air flows and low vacuum applied over many wells is required (as opposed to a design using high vacuum with few wells). A low vacuum/low flow system will provide greater overall coverage of vacuum and reduce entrainment of fine soil particles into the VE system. Results of the pilot study indicate that a vacuum applied to 3 VE or SVE wells at a total combined flow of approximately 100 cfm will provide ample coverage of the entire site and beyond. This was observed to be the case during the pilot study with air sparging turned on. The same blower used in the pilot study will be used in the final design. This blower has vacuum and flow capacity beyond that which was shown to be suitable for complete coverage in the pilot study. Specifications for the blower and other equipment associated with the vertical VE system are shown in Table 6-2. Equipment cut sheets are included in Appendix B.

Table 6-2. Vertical Vapor Extraction Well System Design Specifications

Item	Design Parameter	Specification
Blower	Power, hp	3
	Motor voltage, V	208-230/460
	Motor phase	Three
	Motor frequency, Hz	50
	Air flow at 10-inch vac, cfm	150
	Max vacuum, inches H_2O	80
VE/SVE Wells	Diameter, inches	2
	Well screen length, feet	10-20
	Material	Schedule 40 PVC
Wells Included		VE-4, SVE-1, SVE-2, SVE-4, 5, 6, 7, 8, VE-2, VE-3
Activated Carbon	Drum size, gallons	55
	Carbon fill volume, feet^3	7
	Air flow, cfm	100
	Pressure, psig	15
	Weight, pounds	250
Liquid Condensate Separator	Volume, gallons	19

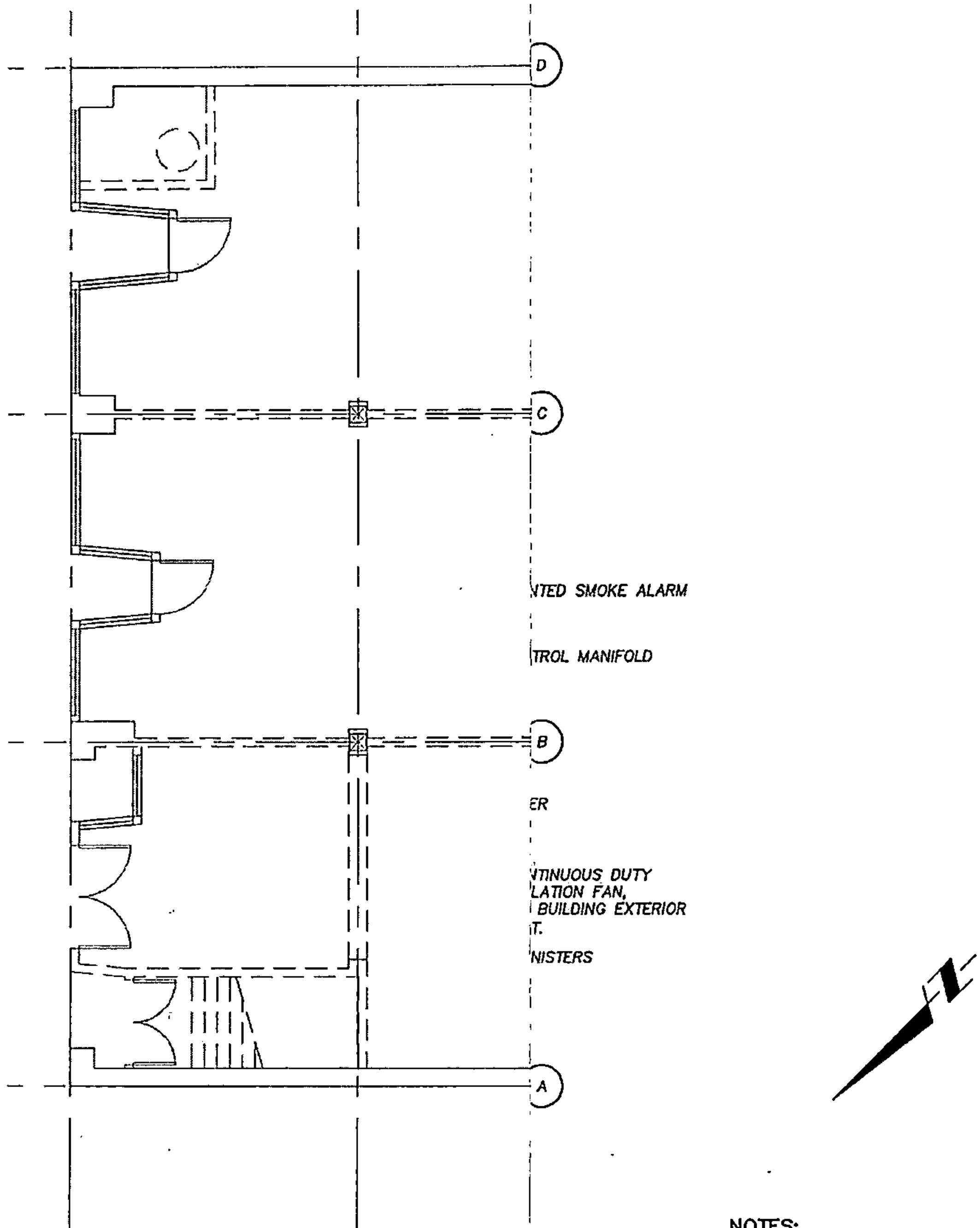
As shown in Drawing C1, the VE system design will include a total of nine vertical VE wells distributed across the site. Three rows containing three wells connected in series will form three independent lines running below the slab and to the Blower Room as shown in the figure. Wells shown in Drawing C1 that are not connected to the VE or AS system will be used for monitoring purposes. Monitoring may include groundwater samples, vacuum testing, or groundwater level measurement. A cross section showing a typical existing VE well is shown in Drawing C2. As shown in the drawing, each VE well is screened in the vadose zone above the groundwater table. Each VE (and SVE) well, will be accessible for monitoring and maintenance by providing a flush-mount well casing and cap at the top of the well.

Air flow from each of the three VE lines will enter a flow control manifold located inside the Blower Room as shown in Drawing M1. Flow meters and valves on the manifold will allow control of flow and vacuum to each line independently. Thus, the design is flexible to allow preferential application of vacuum to certain zones of the site or to apply vacuum evenly across all wells. The optimal application of vacuum will be established during start-up and initial monitoring of the system.

As shown in Drawing M1, air flows from the flow control manifold will enter a common condensate separator. Moisture or free liquid will be removed from the air stream prior to it entering the blower. Discharge air from the blower will be routed to a steel 55-gallon drum canister containing granular activated carbon. Clean air from the carbon unit will be routed to a vent line that exists through the roof of the building. As shown in Drawing M1, the design includes numerous pressure gauges, vacuum gauges, and sample points for complete monitoring of the system.

The Blower Room will meet building code requirements that are applicable to the rest of the building and will include sound insulation. Because PCE and TCE are non-combustible, the Blower Room will not require special fire protection measures, other than a smoke detector and alarm.

A | B | G | H



NOTES:

1. PROVIDE FLUSH–MOUNT WELL VAULTS ON ALL VE, AS, SVE, AND MW WELLS EXCEPT THOSE THAT ARE ABANDONED. SEE TYPICAL DETAIL ON DWG C2.
2. ABANDON WELL PER WAC 173–160–460, FILL THE PROBE OR WELL CASING FROM BOTTOM TO LAND SURFACE WITH DRY WESTERN SODIUM BENTONITE POWDER THAT IS FREE OF ORGANIC POLYMERS. THE BENTONITE SHALL BE INTRODUCED INTO THE CASING SUCH THAT VOIDS OR BRIDGES DO NOT OCCUR AND THE CASING IS COMPLETELY FILLED. ONCE FILLED, THE CASING MAY BE CUT AT ANY POINT FOR REMOVAL FROM THE EXCAVATION. THE WELL OR PROBE NUMBER, DATE, AND TIME OF DECOMMISSIONING SHALL BE RECORDED AND SUBMITTED TO THE ENGINEER.

LEGEND:

- MONITORING WELLS
- SVE–4 PRE–2004 SOIL VAPOR EXTRACTION WELL
- AS–1 2004 AIR SPARGING WELL
- VE–1 2004 SOIL VAPOR EXTRACTION WELL
- AB–1 2004 ABANDONED TEST BORING

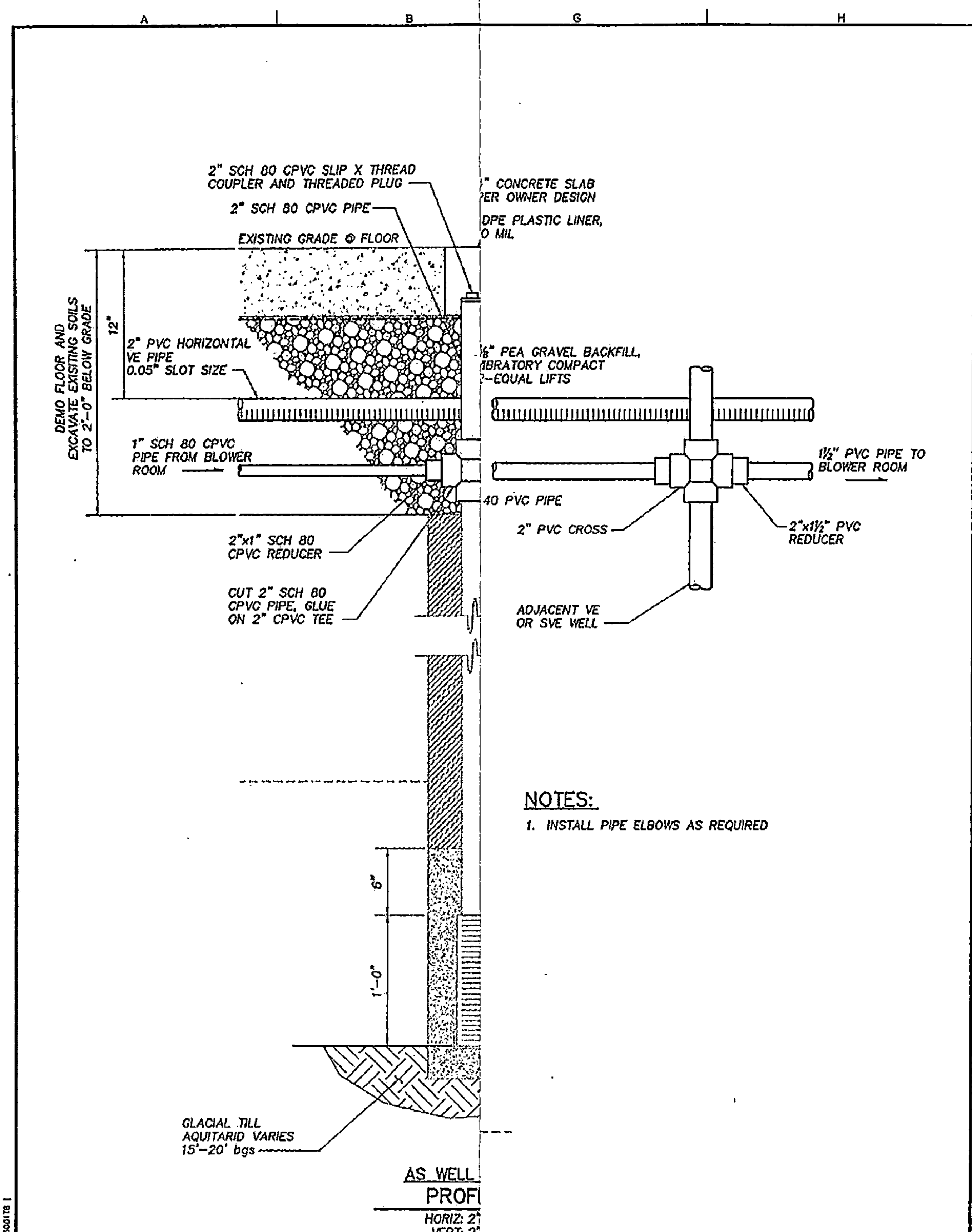
△	REVISIONS	DATE	BY	DESIGNED B. BALL
				DRAWN K. TAYLOR
				CADD CHECKED
				CHECKED
				APPROVED

AIR SPARGING SYSTEM PLAN

DRAWING NO. 1 OF 4

C1

DATE: 01/05/05 3:34pm IMAGES: XREFS: XS4693001TB



NOTES:

1. INSTALL PIPE ELBOWS AS REQUIRED

△	REVISIONS	DATE	BY	DESIGNED B. BALL	WELL HEAD CONNECTIONS	DRAWING NO. 2 OF 4
				DRAWN K. TAYLOR		C2
				CADD CHECKED		
				CHECKED		
				APPROVED		

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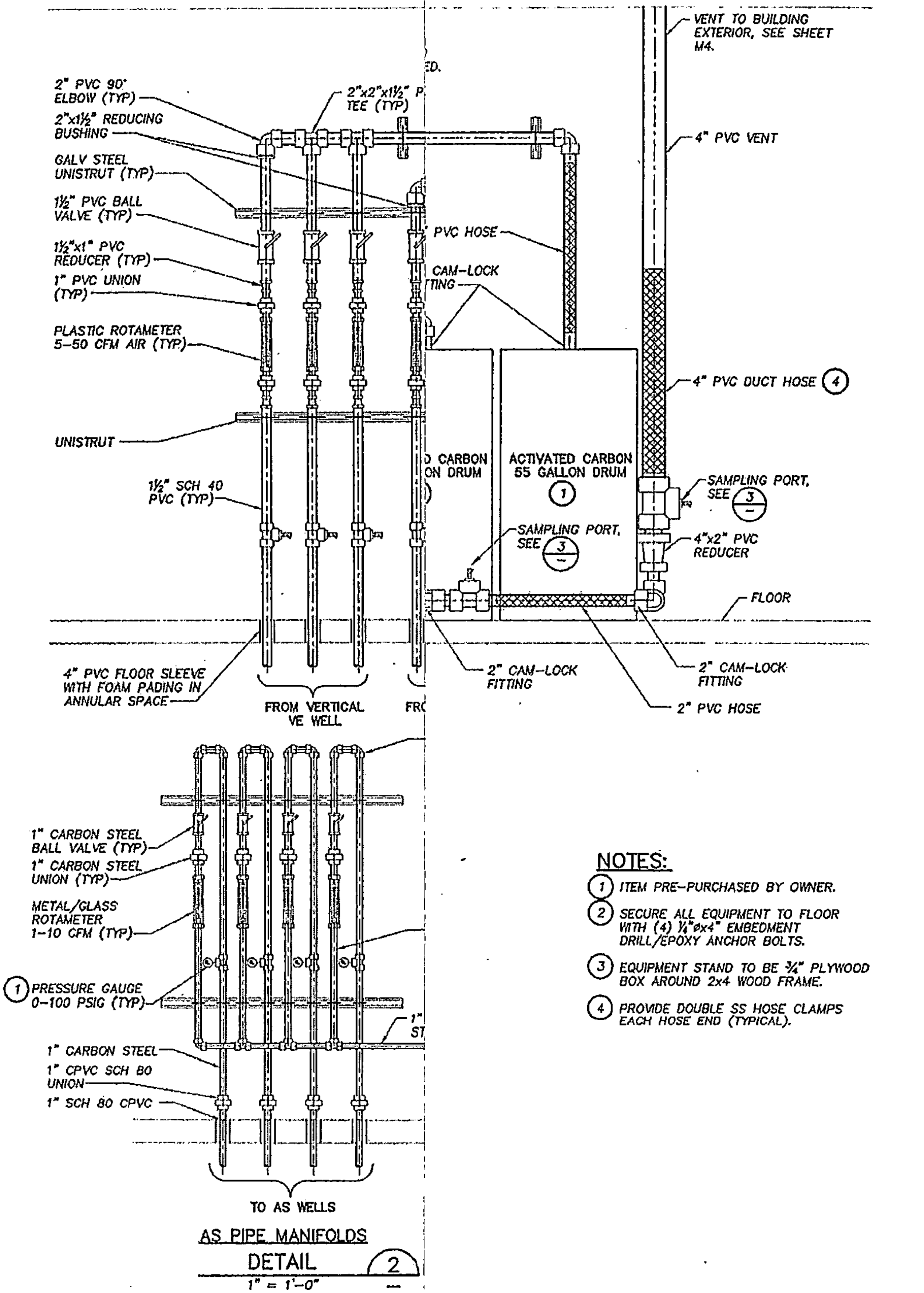


AS PIPE MANIFOLDS

DETAIL 2

1" = 1'-0"

NOTES:

1. ITEM PRE-PURCHASED BY OWNER.
2. SECURE ALL EQUIPMENT TO FLOOR WITH (4) ¼"øx4" EMBEDMENT DRILL/EPOXY ANCHOR BOLTS.
3. EQUIPMENT STAND TO BE ¾" PLYWOOD BOX AROUND 2x4 WOOD FRAME.
4. PROVIDE DOUBLE SS HOSE CLAMPS EACH HOSE END (TYPICAL).

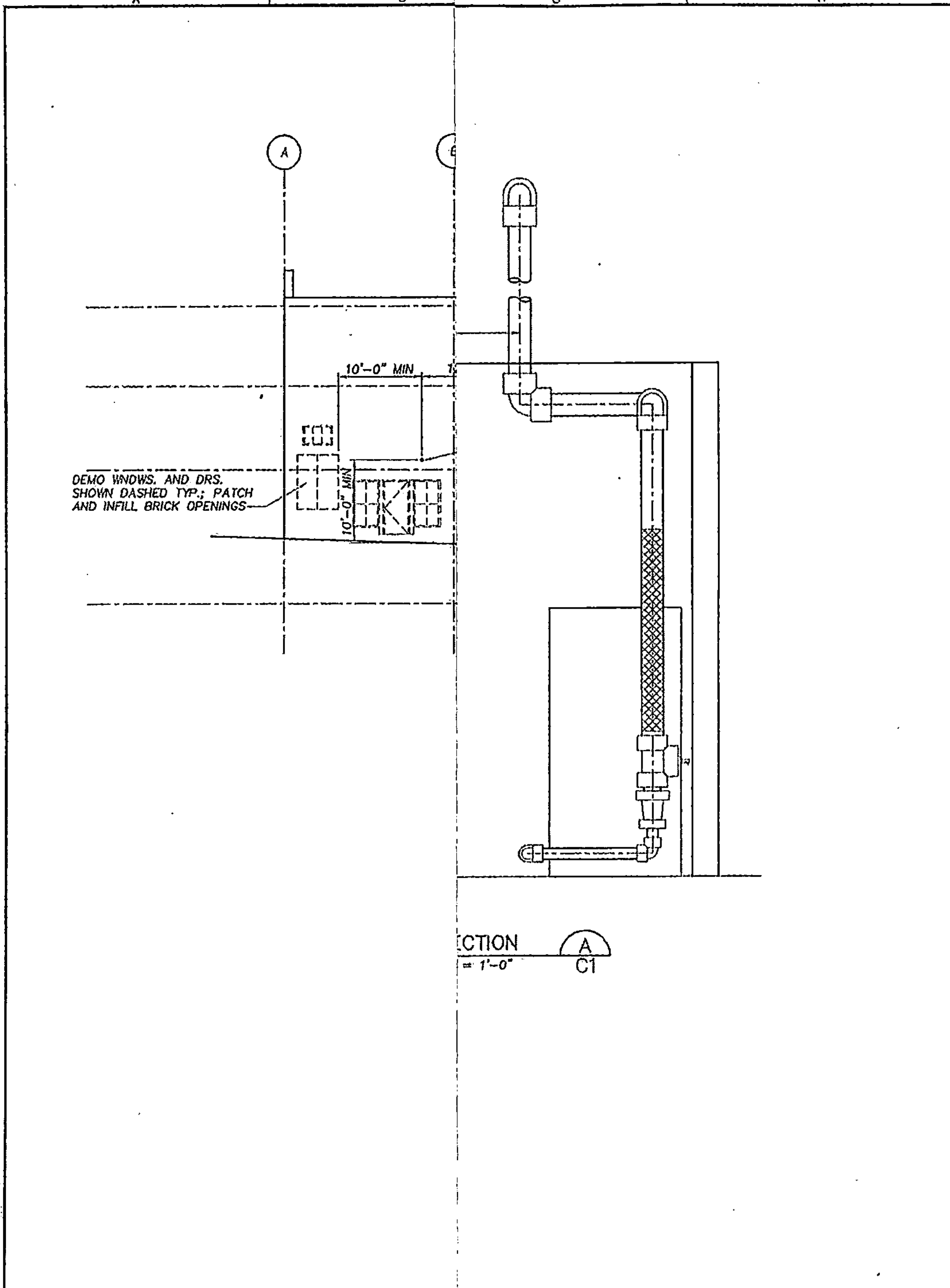
△	REVISIONS	DATE	BY	
				DESIGNED B. BALL
				DRAWN J. TORR
				CADD CHECKED
				CHECKED
				APPROVED

MECHANICAL DETAILS

DRAWING NO. 3 OF 4

M1

DATE: 01/11/05 12:42pm IMAGES: 1954_001 | XREF'S: X5463200118 |



REVISIONS	DATE	BY	
			DESIGNED B. BALL
			DRAWN J. TORR
			CADD CHECKED
			CHECKED
			APPROVED

MECHANICAL DETAILS

DRAWING NO.
4 OF 4

M2

6.3 HORIZONTAL VAPOR EXTRACTION WELL SYSTEM DESIGN

Horizontal vapor extraction wells will be installed immediately below the floor slab as an added safety precaution to prevent vapors from entering the occupied building area. As shown in Drawing C1, three rows of horizontal wells will be installed and will be routed to the Blower Room through independent lines. As shown in Drawing C2, the horizontal wells will be constructed of 2-inch slotted PVC pipe. The pipe will be buried in gravel backfill. Approximately 2 feet of existing soils will be removed to make room for the piping and gravel backfill. A polyethylene vapor barrier and final concrete floor slab will be placed over the gravel backfill.

Air flow from each of the three horizontal lines will enter a flow control manifold located inside the Blower Room as shown in Drawing M1. Flowmeters and valves on the manifold will allow control of flow and vacuum to each line independently. Thus, the design is flexible to allow preferential application of vacuum to certain zones beneath the floor slab or to apply vacuum evenly across the entire area. The optimal application of vacuum will be established during start-up and initial monitoring of the system.

As shown in Drawing M1, air flows from the flow control manifold will enter a common condensate separator. Moisture or free liquid will be removed from the air stream prior to it entering the blower. Discharge air from the blower will be routed to a steel 55-gallon drum canister containing granular activated carbon. Clean air from the carbon unit will be routed to a vent line that exists through the roof of the building. As shown in Figure M1, the design includes numerous pressure gauges, vacuum gauges, and sample points for complete monitoring of the system. The horizontal VE well system is designed conservatively to provide complete capture and containment of vapors beneath the floor slab. Detailed specifications are shown in Table 6-3. Equipment cut sheets are included in Appendix B.

Table 6-3. Horizontal Vapor Extraction Well System Design Specifications

Item	Design Parameter	Specification
Blower	Power, hp	3
	Motor voltage, V	208-230/460
	Motor phase	Three
	Motor frequency, Hz	50
	Air flow at 10-inch vac, cfm	150
	Max vacuum, inches H_20	80
Horizontal Wells	Diameter, inches	2
	Screen slot, inches	0.005
	Material	Schedule 40 PVC
Activated Carbon	Drum size, gallon	55
	Carbon fill volume, $feet^3$	7
	Air flow, cfm	100
	Pressure, psig	15
	Weight, pounds	250
Liquid Condensate Separator	Volume, gallon	19

7. DESIGN FEATURES TO CONTAIN VAPORS AND WASTES

The design includes horizontal VE pipes immediately below the floor slab (in addition to vertical soil vapor extraction wells) to remove vapors from underlying soils and vapors produced by the air sparging system. The vertical VE wells, alone, are expected to provide ample removal of vapors. The horizontal wells are added as an additional safety factor to prevent vapors from entering the occupied space above. Also, a polyethylene vapor barrier is included immediately beneath the slab (see Drawing C-2) as another additional barrier to contain vapors.

The horizontal wells are designed to serve as a passive ventilation system beneath the floor slab. Following active remediation, the blowers can be removed and the horizontal system can be vented passively to the atmosphere, thus providing long-term assurance that the vapors will not enter the occupied building space.

The only wastes generated by the system will be a small amount of liquid condensate that accumulates in the separator drums and depleted gas-phase activated carbon. Based on pilot testing results, the amount of liquid condensate generated in the separators is expected to be very minor. No condensate was observed in separators during pilot testing, which involved a 2-week period of continuous operation. The liquid levels in the condensate separators will be checked routinely in accordance with the schedule specified in the system O&M Plan. Condensate will be drained from the separators into 5-gallon buckets. The condensate waste will be tested and sent to a permitted facility for disposal. A level sensor is included in the separator drum to automatically turn off the blower and signal an alarm if the separator should become full of liquid.

Emissions entering and leaving the activated carbon canisters will be tested routinely in accordance with the schedule specified in the system O&M Plan. Sample ports for air samples (e.g., Drager tube or PID) are included on the inlet and outlet sides of the activated carbon canisters. Initially, samples will be collected frequently to establish carbon capacity and to establish a schedule for carbon change out. Any volatiles or PCE/TCE detected in the carbon canister outlet will indicate the need to promptly change out the canisters. Data from initial sampling will also be used to calculate and estimate the replacement frequency for activated carbon. Canisters containing depleted carbon will be removed from the Blower Room and replaced with canisters containing fresh carbon. The design includes quick-disconnect fittings on activated carbon canisters to facilitate removal and replacement of canisters. Depleted carbon will be tested and sent to a permitted facility for disposal or regeneration.

8. IDENTIFICATION OF CONSTRUCTION AND OPERATING PERMITS

Because of the low emissions that will be exhausted from the remediation system, it is expected that no formal air quality permit will be required for the construction. As per the exemption in Puget Sound Clean Air Agency (PSCAA) Regulation I (c) (94), levels of vinyl chloride and perchloroethylene are expected to be below threshold limits. As required by PSCAA, the system operator will develop and maintain documentation (including mass emission calculations) to show the system will maintain emissions below the threshold limits. Results of the pilot study show that air emissions of PCE following treatment through the activated carbon canisters are below detectable limits and are well below PSCAA regulatory limits.

It is likely that construction permits will be required by the King County Department of Public Development (DPD). The remediation construction contractor (Clearcreek) will apply for permits from DPD. It is anticipated that permits will be required for electrical, plumbing, and mechanical portions of the system.

9. GENERAL DESCRIPTION OF CONSTRUCTION TESTING

A design engineer (Engineer) from Parametrix will conduct routine inspections during construction of the remediation system to ensure the system is constructed in accordance with the design plans and specifications. Inspection reports will be prepared to document construction activities and any changes or modifications agreed to by the Engineer and Contractor. As-built drawings will be completed for the final system. The Engineer will inspect all pipe joints to ensure the joints are cemented and sealed properly prior to backfill. The Engineer will also inspect all equipment to ensure conformance with the specifications.

Upon completion of the installation, including electrical connection to all mechanical equipment, the Engineer will start the blowers and compressor to ensure proper operation. The Engineer will inspect all above-grade piping and fittings for any air leaks. The Engineer will route flows through the flow control manifolds to confirm that required flows, pressures, and vacuums are attainable with the system.

Further start-up testing to observe the performance of the system and to establish optimal air flow and vacuum to different zones of the site will be described in the O&M Plan.

10. OPERATION AND MAINTENANCE PLAN

An O&M Plan for the remediation system will be developed following initial start-up. The O&M Plan will be submitted as an addendum to this report.

11. DESIGN, CONSTRUCTION, AND START-UP AND OPERATION SCHEDULE

The design of the system is completed and included with this Engineering Report. Construction to remove the upper 2 feet of soils and to install subsurface piping is underway. It is anticipated that construction of the remedial system will be completed by the end of January 2005. Start-up and testing will begin immediately following approval from Ecology. It is estimated that the remediation system will remain in operation for at least 1 year. Performance monitoring will be conducted routinely to gauge the progress of cleanup.

APPENDIX A

Pilot Study Work Plan

Appendix A – Pilot Study Work Plan

Prepared for

1925 Third LLC
300 East Pine Street
Seattle, WA 98122

Prepared by

Parametrix
1231 Fryar Avenue
Sumner, WA 98390-1516
253-863-5128
www.parametrix.com

CITATION

Parametrix. 2005.

Appendix A – Pilot Study Work Plan. Sumner, WA.

TABLE OF CONTENTS

LIST OF TABLES

KEY TERMS

AS	air sparging
OD	outside diameter
psi	pounds per square inch
scfm	standard cubic feet per minute
VE	vapor extraction

1. INTRODUCTION

This work plan provides testing procedures for the pilot-scale study of soil vapor extraction (VE) and groundwater air sparging (AS) to be conducted at a former dry cleaning site at 1925 3rd Avenue, Seattle, Washington.

2. OBJECTIVES

The pilot study has the following specific objectives:

- Determine radius of influence of AS wells and required separation distance between wells.
- Verify pressure and flow requirements for sparging air.
- Determine horizontal and vertical influence of soil vacuum.
- Verify vacuum and flow requirements for SVE system.

3. TESTING APPROACH AND SYSTEM COMPONENTS

3.1 AIR SPARGING TESTS

The test approach for air sparging involves injecting pressurized air into groundwater through wells screened at the bottom of the groundwater table and measuring influence parameters at nearby wells. The data to be collected include air pressure, air flow, groundwater depth, helium tracer, PID, dissolved oxygen, and PCE and TCE concentrations in groundwater (before and after air sparging). All air sparging Wells AS-1 through AS-4 will be tested for pressure and air flow to verify each well is functioning properly. Wells AS-1 and AS-2 will be tested for area of sparging influence.

The basic equipment used for testing will include air compressor, flow meters, pressure gauges, and piping. A full list of testing and monitoring equipment is shown in Table 1 (page 2).

3.2 SOIL VAPOR EXTRACTION TEST

The test approach for vapor extraction involves pulling a vacuum on selected VE and SVE wells with a blower and measuring influence at nearby wells. The data to be collected include vacuum pressure at neighboring wells, air flow, and blower vacuum, air temperature, pressure drop across carbon canister.

The basic equipment used for the testing will include blower, condensate separator, activated carbon canister (for treatment of off gas), and piping and fittings. A full list of testing and monitoring equipment is shown in Table 1 (page 2).

Table 1. Equipment and Materials for Pilot Study

	Item	Quantity	Units
EQUIPMENT	Well packers to separate GW screen interval from Vados zone screen interval	3	ea
	Pressure relief valve for blower, AG258, 1-1/2-inch MPT	2	ea
	Pressure gauge, 0–160 inches H20, 1/4-inch MPT, AE133	1	ea
	Vacuum gauge, 0–160 inches H20, 1/4-inch MPT, AE134	3	ea
	Roto meter for compressor, 0–10 cfm	1	ea
	Roto meter for blower, 0–200 cfm	1	ea
	Equipment and supplies for groundwater sampling		
	Geopump		
	Hydrolab		
	150 feet poly tubing		
	10 feet silicon tubing		
	Bottles from ARI		
	Tubing for existing wells		
	Nitrile gloves		
	Water level tape		
PARTS/ HARDWARE	2-inch Schedule 40 PVC pipe		
	PVC glue and primer		
	2-inch elbows, inside thread to socket		
	Miscellaneous tees, elbows		
	Reducer from 2 inches to 1/4 inch to receive pressure gauges and sampling ports		
	Caps for all existing VES wells		
	Fittings to plug in helium		
	Pressure gauges 0–30 psig	2	ea
	Duck tape		
	Teflon tape		
	Fans	2	ea
	Electrical part	1	ea
	1-inch plug for knock out drum	1	ea
METERS	Tape to measure water levels	1	ea
	pH meter	hydrolab	
	DO meter with long cable	1	ea
	Helium detector, Marks Products Model 1820A	1	ea
	PID meter to measure HVOCs	1	ea
	Drager Pump	1	ea
	Drager tubes for PCE	30	ea
RENTAL EQUIPMENT	Helium bottles, technical grade, with regulator and flow meter	2	ea
	Air compressor, 8 cfm, with pressure gauge, regulator, and air/oil filter	1	ea
	Small vacuum pump for sampling helium tracer	1	ea

4. TEST PROCEDURES

4.1 AIR SPARGING TESTS

1. Background Check: Uncap the sparge and the monitoring wells. Measure DTW, background helium, pH, ORP, DO, and vacuum.
2. Sample for Select Constituents: Collect groundwater samples from Wells SVE-1, SVE-2, SVE-5, SVE-8, and SVE-9 for laboratory analysis for HVOCs by EPA Method 8260B. The HVOC data will serve as a baseline.
3. Install Equipment: Use pipe to connect the oilless air compressor (capable of 6 standard cubic feet per minute [scfm] at 20 pounds per square inch [psi]) to the AS manifold and to the well. The manifold will consist of an air regulator, air/oil filter, flow indicator (rotameter), gate valve, helium tracer injection port, and pressure gauges.
4. Helium Tracer Equipment: Connect a cylinder of technical grade helium to the air injection line just downstream of the compressor using a two-stage pressure regulator, calibrated flow meter, needle type valve, and 1/4-inch outside diameter (OD) polyethylene tubing.
5. Control and Monitor Air Injection: Begin the AS test by slowly applying air pressure to AS-1. Manually record the injection pressure and air flow. Continue opening the gate valve until the flow reaches approximately 6 scfm. Continue to measure and record corresponding injection pressure and flow. Do not exceed 20 psi. Repeat for Wells AS-2 through AS-4.
6. Monitor Influence: Monitor the initial influence of the sparge test by listening for bubbling sounds in nearby wells.
7. Additional Monitoring: Perform influence monitoring by measuring DTW and visual bubbling at monitoring wells that are within a 20-foot radius of the sparge well.
8. Helium Tracer Test: After the pressure response has stabilized, a helium tracer test will be performed by injecting helium into the injection air stream at an approximate flow rate of 5 percent of the air injection flow rate. Using a portable helium detector (Marks Products, Model 1820A or equivalent) the concentration of helium (within 0.2 percent) in adjacent monitoring wells will be measured in the field. These measurements will be made by connecting a small vacuum pump to each wellhead, purging the well casing with approximately three well volumes of air, and recording the concentration of helium. Monitoring wells located closest to the sparge test will be analyzed first working in a circular pattern around the close wells and moving outward as helium is detected. The injection concentration of helium will be measured by sampling the injection air at the sparge wellhead using the helium detector.
9. PID Readings: Use the PID to measure the level of HVOCs in the air stream that is collected for the helium tracer.
10. Test Duration: Continue monitoring helium for approximately 2 hours.
11. End of Test: At the conclusion of the test, turn off the compressor and measure groundwater elevation.
12. Collect Final Groundwater Samples: One day following the test, collect final groundwater samples from the monitoring wells for laboratory analysis for HVOCs by EPA Method 8260B as in Step 2. Repeat 1 week following air sparging.

4.2 VACUUM EXTRACTION TESTS

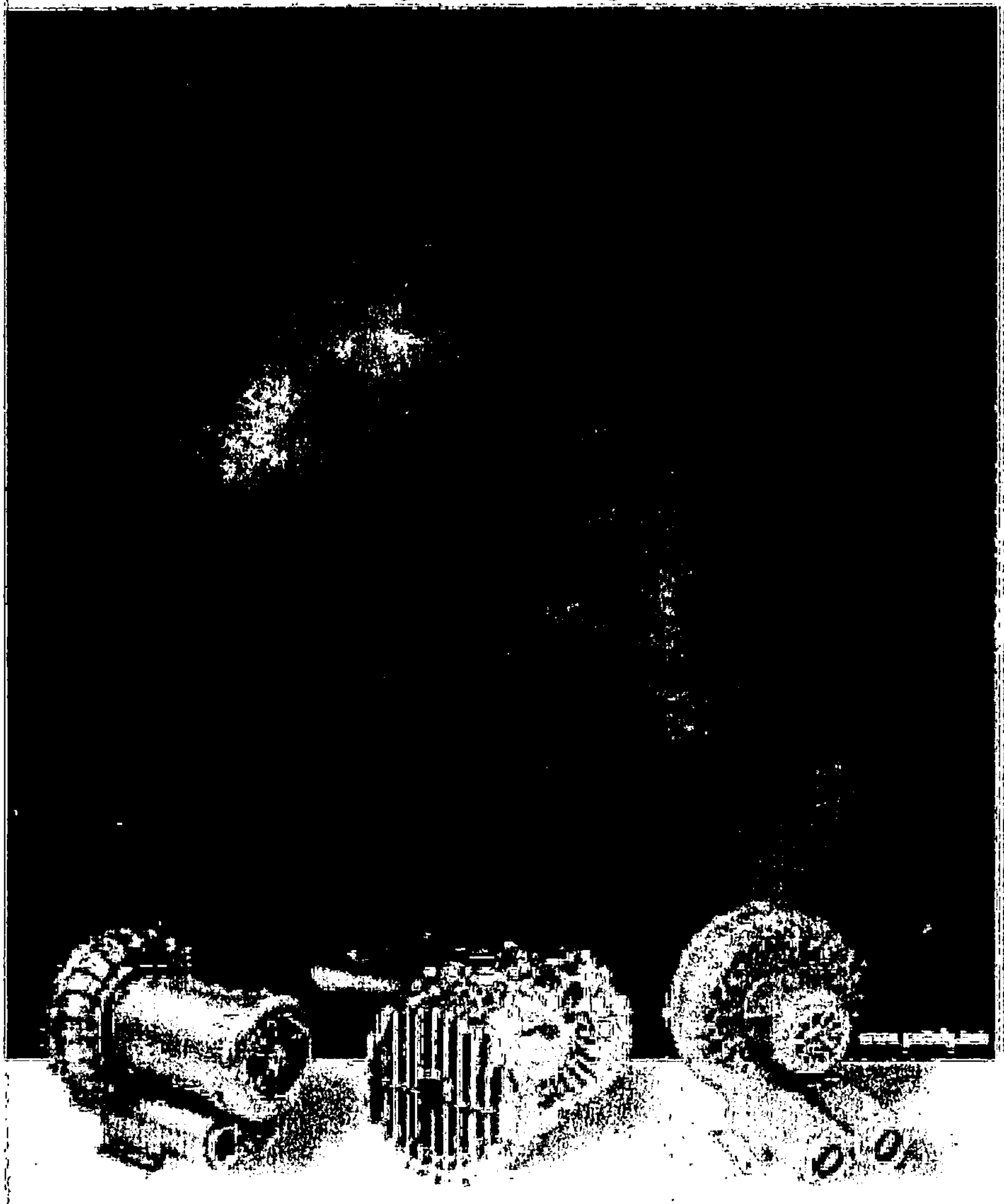
1. Background Check: Uncap the vacuum extraction and monitoring wells and measure background vacuum. If background vacuum levels are not zero, subtract background vacuum from all test readings accordingly.
2. Connect blower piping to the well(s) to be tested. Connect blower outlet to the air flow meter and activated carbon canister. Connect vacuum relief valve to upstream side of blower.
3. Turn blower on and adjust vacuum to be equal to or less than 80 inches H20 by turning the screw on the pressure relieve valve. A vacuum of 80 inches H20 is the maximum the blower can tolerate.
4. Connect a sensitive vacuum gauge (.01 inch H20) to a rubber stopper of the same inside diameter of the monitoring wells.
5. Take vacuum readings in a radius around the vacuum well and continue moving outward until no vacuum is detected.
6. Collect vacuum measurements from neighboring wells every 1/2 hour until readings stabilize.
7. Measure air temperature at outlet of blower.

APPENDIX B

Equipment Cut Sheets

GAST

Regenair® Regenerative Blowers



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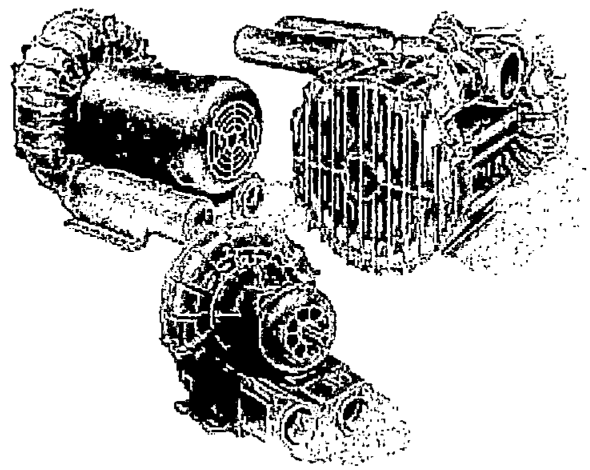


Regenerative Blowers

The Gast full line of Regenair® Regenerative Blowers for high volume vacuum or compressed air applications offers both motor-mounted and separate drive models. Air flow capabilities range from 27 to 1350 cfm (46 to 2294 m^3/h), vacuum capabilities up to 183 in. H_2O (13.5 in. Hg/456 mbar), and pressure capabilities up to 284 in.H_2O (10.25 psig/707 mbar). TEFC electric motors are UL and CSA certified on several models and come in single and three-phase, dual frequency, and multi-voltage versions for worldwide applications; 12 volt DC is available on the smallest model. Horsepowers range from 1/8 to 30 HP (0,09 to 22,4 kW).

The explosion-proof motors series, designed primarily for soil vapor extraction operations, have air flow capacities up to 425 cfm (722 m^3/h), with vacuum levels to 110 in. H_2O (8.1 in. Hg/274 mbar) and pressure capabilities up to 100 in. H_2O (3.6 psig/249 m/bar). Motors range from 1/3 to10 HP (0,25 to 7,5 kW). A complete line of recommended accessories for all blower series is also available.

- Complete line of blowers satisfies all single and three-phase motor requirements
- Low noise operation
- Continuous, non-pulsating, oil-free air flow
- Low maintenance
- Fan cooling dissipates heat around the bearings to help prolong bearing life
- Performance modifications and/or special requirements can be accommodated

The Regenerative Principle

In a regenerative blower, the compression space consists of a hollow, circular ring between the tips of the impeller blades and the walls of the housing. In operation, the rotating impeller draws in air from the inlet port into the compression space and moves it radially outward to the curved housing by centrifugal force.

The action is called "regenerative" because a certain amount of air slips past each impeller blade during rotation and returns to the base of a succeeding blade for reacceleration.

Because of this dynamic principle, regenerative blowers can generate pressure and vacuum performance comparable to many multi-stage or positive displacement blowers.

Regenair® Blower Features and Benefits

Standard Motor Mounted Models

- Rugged construction of cast aluminum or cast iron, depending on model size
- UL and CSA approved motors; TEFC on single-ended models, OPEN on dual-ended models
- Permanently sealed ball bearings incorporate new polyurea grease that extends bearing life and offers superior resistance to washout, rust and corrosion
- Integrated mufflers on single-ended models minimize operating noise

Explosion-Proof Motor Series

- UL and CSA approved explosion-proof multi-voltage motors with thermal protection
- Double sealed ball bearings with a B10 life exceeding 30,000 hours of continuous operation at the maximum rated continuous blower load
- Sealed air streams; leak tested to less than 5 cc/min

Separate Drive Series

- Drive pulley size can be changed to lower speeds and adjust performance
- Built-in acoustical muffling reduces operation noise
- Precision balanced impellers provide low vibration operation

Gast Manufacturing Inc., A Unit of IDEX Corporation, Benton Harbor, MI USA • ph 269-926-6171 • fx 616-925-8288 • www.gastmfg.com

Blower System Design Tips

In order to utilize your regenerative blower most efficiently, proper system design is essential. The most important thing to recognize is that by utilizing large diameter plumbing, friction losses in plumbing can be greatly reduced. Here are some guidelines to use when setting up your blower system:

1. The plumbing should at least be the same size as the blower port or ideally one size larger (example - blower has ports that are 1-1/2" NPT, plumbing should be 2" NPT). The plumbing should remain this size until it has reached the location of the work area.
2. Plumbing for Separate Drive Blowers operating above 3500 RPM should be at least one pipe size larger than the blower ports.
3. Elbows create additional friction which causes pressure loss and back pressure. Plumbing at least one pipe size larger than the blower pipe ports minimizes the friction loss they create.
4. The pressure/vacuum relief valve should be installed in a "T" which is at least one pipe size larger than that of the exhaust of the blower. To properly protect a large horsepower blower, set the relief value to limit the blowers duty to 5 in. H_2O below its continuous duty rating.
5. Operating the blowers at high altitude decreases their maximum pressure or vacuum duty rating. If this is a consideration, review the information on Fan Laws in the Application Engineering section of this catalog.
6. The exhaust air temperature of the blowers increases with increasing duty. At duties over 70 in. H_2O it is too hot for most plastic pipe. Metal pipe must be considered. To prevent danger of burns, access to these pipes should be limited, guarded or marked "Danger Hot."

Performance Data

The performance data shown in this catalog was determined under the following conditions:

- Line voltage @ 60 Hz. 230V or 460V for three-phase units. 115V or 230V for single-phase units.
- Line voltage @ 50Hz. 220V for three-phase or single-phase units.
- Units in a temperature stable condition.
- Delivery measurements made with output port throttled.
- Suction measurements made with input port throttled.
- Test Conditions: Inlet air density at 0.075 lbs. per cu.ft. [20°C (68°F), 29.92 in. Hg (14.7 PSIA)].
- Normal performance variations on the resistance curve within ± 10% of supplied data can be expected.

Pictorial and dimensional data is subject to change without notice.

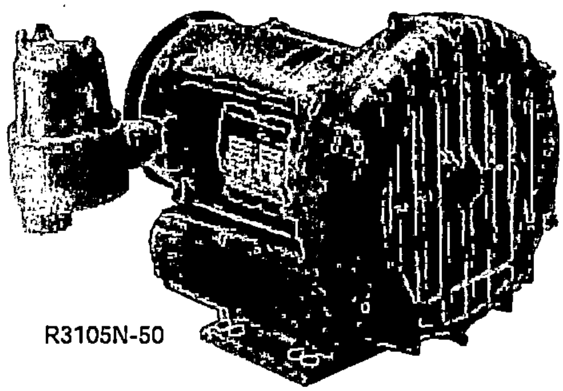
The information presented in this catalog is based on technical data and test results of nominal units. It is believed to be accurate and is offered as an aid in the selection of Gast products. It is the user's responsibility to determine suitability of the product for intended use and the user assumes all risk and liability whatsoever in connection therewith.

Gast can also provide CE compliant blowers with BSP threads, as well as customized blowers for specific applications. Consult a Gast Representative/Distributor for more information.

Environmental and application conditions may affect advertised life.

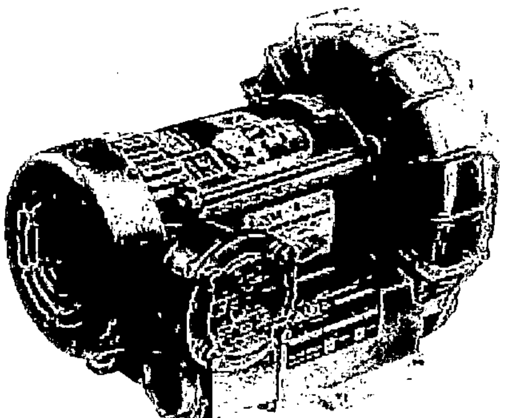
Warning:
Models Without Explosion-Proof Motors Should Not Pump Combustible Gases or Be Used In Combustible Ambients

R3-R7 Series - Explosion Proof Motors



R3105N-50

MODELS	Maximum Pressure ("H_2O) 60 Hz	Maximum Pressure ("H_2O) 50 Hz	Maximum Vacuum ("H_2O) 60 Hz	Maximum Vacuum ("H_2O) 50 Hz	Maximum Air Flow (CFM) 60 Hz	Maximum Air Flow (CFM) 50 Hz
R3105N-50	43	31	40	28	53	44
R4110N-50 R4310P-50	51	38	48	35	92	74
R4P115N-50	65	45	60	40	133	112
R5125Q-50 R5325R-50	55 65	- 50	60 65	- 47	160 160	- 133
R6130Q-50	60	75	70	65	215	180
R6340R-50	100	75	80	65	215	180
R6P155Q-50 R6P355R-50	95 100	80 80	85 85	65 65	280 280	235 232
R7100R-50	100	90	110	85	425	350



R4 - R7 Series

PRODUCT FEATURES

- Rugged design, maintenance free
- Quiet operation within OSHA standards
- Blowers and motors rated for continuous duty
- UL and CSA approved multi-voltage motors, incorporating approved thermal protection
- Motors classified as Explosion Proof Division 1 and 2 for Group D explosive atmospheres
- Motors carry full rated load at temperatures below Class B motor insulation limits
- Class F motor insulation used in motors larger than 1 HP
- Motors conform to NEMA frame sizes; motor enclosures conform to IP54 (suitable for outdoor use)
- Pilot duty thermal overload protection is standard on all 1 HP and larger motors
- Double sealed motor ball bearings with a B10 life exceeding 30,000 hours of continuous operation at the maximum rated continuous blower load
- Sealed air streams
- Aluminum impeller, housing and cover; viton shaft seal.
- Pressurized and leak-tested to less than 5cc/minute

Recommended Accessories	R3 Series	R4 Series	R4P Series	R5 Series	R6 Series	R6P Series	R7 Series
Pressure Gauge	AJ496	AJ496	AE133	AE133	AE133	AE133	AE133
Vacuum Gauge	AJ497	AJ497	AE134	AE134	AE134	AE134	AE134
Pressure Filter	AJ126C	AJ126D	AJ126D	AJ126D	AJ126F	AJ126F	AJ126G
Vacuum Filter (Inline)	AJ151C	AJ151D	AJ151D	AJ151E	AJ151G	AJ151G	AJ151H

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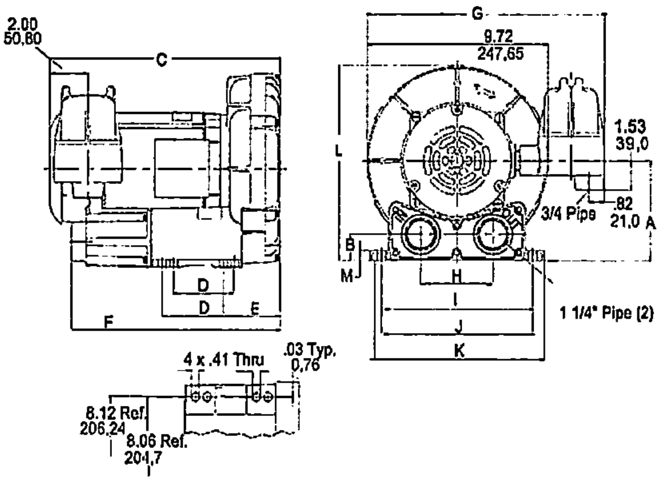
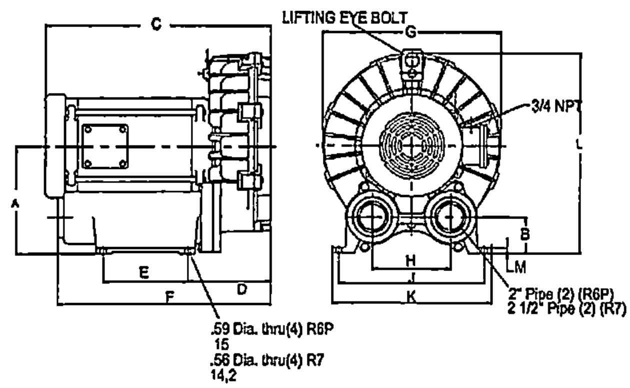
Product Dimensions (in. mm)

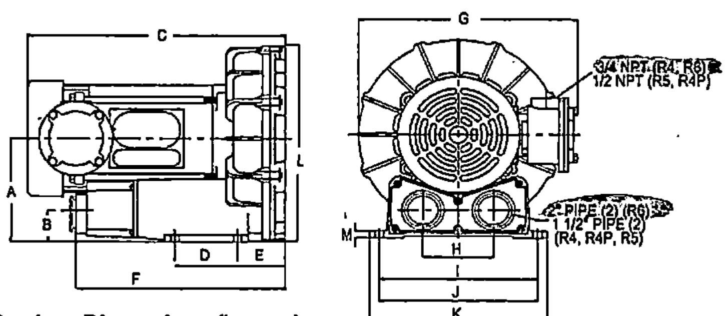
Model R3



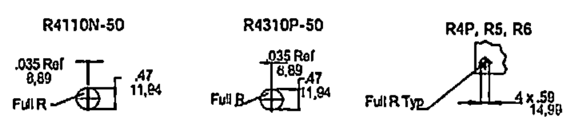
Models R6P, R7



Models R4, R4P, R5, R6



Mounting Hole Detail



Product Dimensions (in. mm)

Model	A	B	C	D	E	F	G	H	I	J	K	L	M
R3105N-50	5.21	1.37	12.3	3.25	3.06	11.06	12.75	3.88	8.06	8.12	9.38	10.15	.53
	132	35	312	83	78	281	324	99	205	206	238	258	13
R4110N-50	6.18	1.68	15.34	3.75	2.85	12.44	12.34	3.96	8.86	8.93	10.00	11.80	.44
	157	43	390	95	72	316	313	101	225	227	254	300	11
R4310P-50	6.18	1.68	14.09	3.75	2.84	12.44	12.34	3.96	8.86	8.93	10.00	11.80	.44
	157	43	358	95	74	316	313	101	225	227	254	300	11
R4P115N-50	6.98	1.84	17.41	4.50	3.25	13.93	13.75	4.75	10.25	10.31	11.75	13.61	.60
	177	47	442	114	83	354	349	121	260	262	298	346	15
R5125Q-50	7.02	1.82	17.59	4.50	3.55	14.22	13.72	4.75	10.25	10.31	11.75	13.80	.59
	178	46	447	114	90	361	348	121	260	262	298	351	15
R5325R-50	7.02	1.82	16.75	4.50	3.55	14.22	13.56	4.75	10.25	10.31	11.75	13.80	.59
	178	46	1425	114	90	361	344	121	260	262	298	351	15
R6130Q-50	7.75	1.94	18.97	5.50	3.85	16.02	15.17	4.92	11.38	11.42	12.96	15.34	.52
	197	49	482	140	98	407	385	125	289	290	329	390	13
R6340R-50	7.75	1.94	18.82	5.50	3.85	15.89	15.17	4.92	11.38	11.42	12.96	15.34	.52
	197	49	478	140	98	404	385	125	298	290	329	390	13
R6P155Q-50	9.77	3.15	22.81	5.12	5.51	16.85	16.75	5.00	-	11.42	12.80	18.14	.50
	248	80	579	130	140	428	425	127	-	290	325	461	13
R6P355R-50	9.77	3.15	19.92	5.12	5.51	16.85	16.75	5.00	-	11.42	12.80	18.14	.50
	248	80	506	130	140	428	425	127	-	290	325	461	13
R7100R-50	10.79	3.64	22.77	8.36	8.50	21.50	18.00	7.90	-	14.76	16.14	20.03	.56
	274	92	578	212	216	546	457	201	-	375	410	509	14

Notice: Specifications subject to change without notice.

Product Specifications

MODEL NUMBER		R3105N-50	R4110N-50	R4310P-50	R4P115N-50
Motor Enclosure		XPFC	XPFC	XPFC	XPFC
HP/kW	60 Hz	.50/0,37	1.0/0,75	1.0/0,75	1.5/1,1
	50 Hz	.33/0,25	.60/0,45	.60/0,45	1.0/0,75
Voltage	60 Hz	115/208-230-1	115/208-230-1	208-230/460-3	115/208-230-1
	50 Hz	110/220-240-1	110/220-240-1	220/380-3	110/220-240-1
Amps	60 Hz	5.2/2.9-2.6	11.4/6.2-5.6	3.4-3.3/1.6	20.3/11.2-10.6
	50 Hz	4.8/2.4-2.2	9.2/5.2-4.6	3.2/1.6	15.2/7.6-8
Starting Amps	60 Hz	12.5 @ 230V	36.5 @ 230V	19.7 @ 230V	60.6 @ 230V
	50 Hz	13 @ 220V	40.6 @ 240V	23.3 @ 220V	Consult Factory
Insulation Class		B	B	B	F
Recommended NEMA Starter Size		00/00	0/00	0/0	1/0
Net Weight (lbs/kg)		52/24	60/28	58/27	79/36

MODEL NUMBER		R5125Q-50	R5325R-50	R6130Q-50	R6340R-50
Motor Enclosure		XPFC	XPFC	XPFC	XPFC
HP/kW	60 Hz	2.0/1,5	2.0/1,5	3.0/2,2	4.0/3,0
	50 Hz	-	1.5/1,1	2.5/1,9	3.0/2,2
Voltage	60 Hz	115/230-1	208-230/460-3	230-1	208-230/460-3
	50 Hz	-	190-220/380-415-3	220-240-1	190-220/380-415-3
Amps	60 Hz	25/12.5	6.6-6.1/3.05	16.3	13-12/6
	50 Hz	-	5.0-4.4/2.5-2.6	14.7-13.5	14.4-13.4/7.2-6.8
Starting Amps	60 Hz	78 @ 230V	48 @ 230V	64 @ 230V	125 @ 230V
	50 Hz	-	Consult Factory	Consult Factory	Consult Factory
Insulation Class		F	F	F	F
Recommended NEMA Starter Size		1/0	0/0	1	1/0
Net Weight (lbs/kg)		77/35	75/34	129/59	112/51

MODEL NUMBER		R6P155Q-50	R6P355R-50	R7100R-50
Motor Enclosure		XPFC	XPFC	XPFC
HP/kW	60 Hz	5.5/4,1	6.0/4,5	10/7,5
	50 Hz	4.0/3,0	4.5/3,4	8.0/6,0
Voltage	60 Hz	230-1	208-230/460-3	208-230/460-3
	50 Hz	220-240-1	190-220/380-415-3	190-220/380-415-3
Amps	60 Hz	29.9	20-18/9	26.5-24/12
	50 Hz	20.8-19.1	14.9-11/7.45-5.8	23.2-21.0/11.6-10.9
Starting Amps	60 Hz	198.4 @ 230V	59 @ 460V	105 @ 460V
	50 Hz	189 @ 240V	Consult Factory	Consult Factory
Insulation Class		F	F	F
Recommended NEMA Starter Size		0/2	1/0	2/1
Net Weight (lbs/kg)		243/110	233/105	297/134

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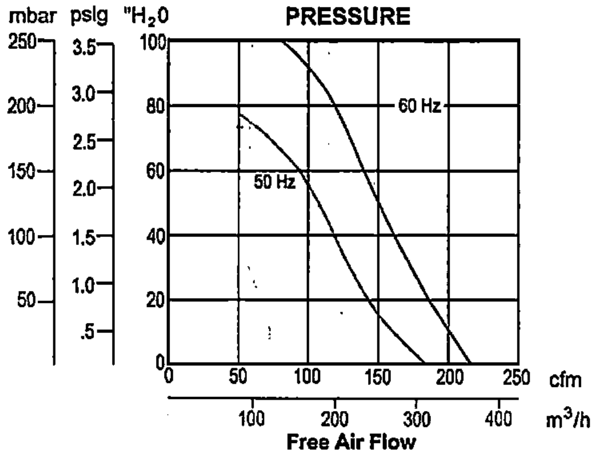
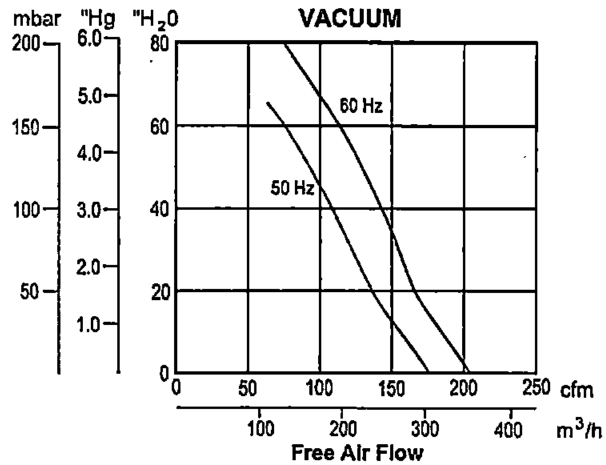
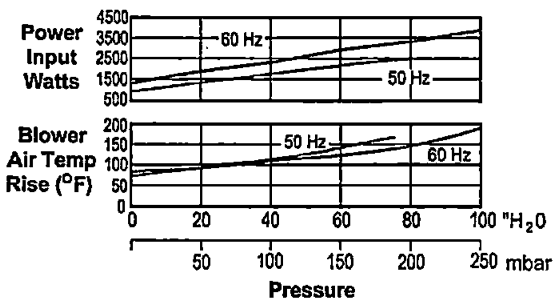
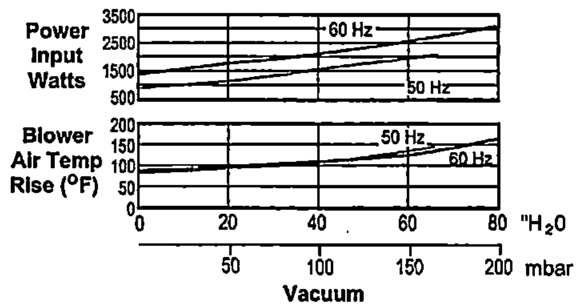
R6340R-50

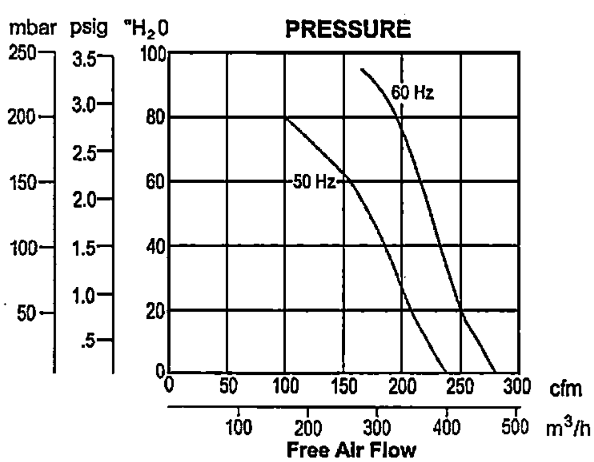


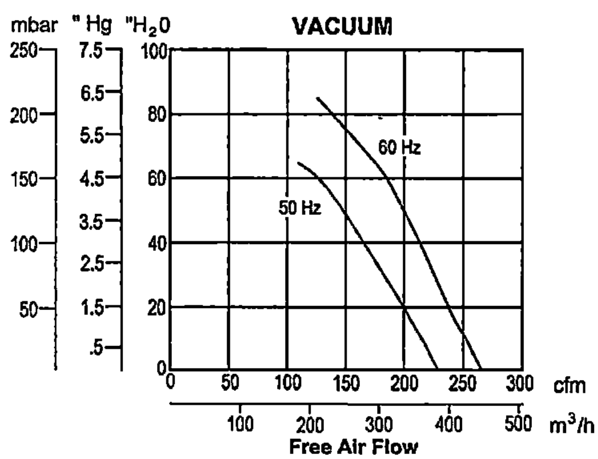


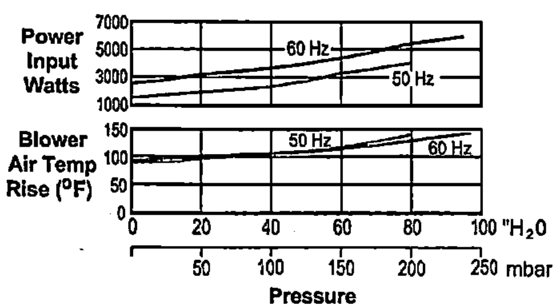


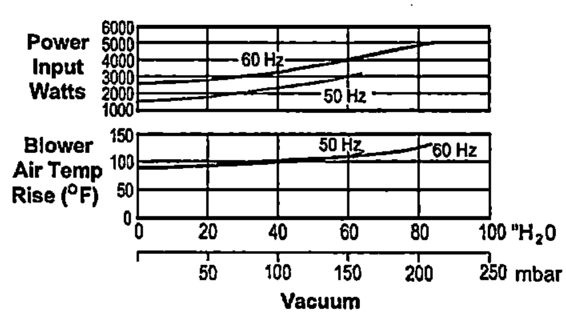


R6P155Q-50









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Q. What happens to the noise when I locate two blowers close together?

A. If the blowers are of the same design they produce sound frequencies that are close together. These may cause a "beating" change in volume of the blower noise. This is because the units are not synchronized. If two small blowers are needed this change in volume can be reduced by moving tham further apart. With larger blowers a dual blower with two blowers on one motor will solve this problem.

Q. What causes the noise relief valves make?

A. Air rush through the valve.

Q. How do I control relief valve or bleed off valve noise?

A. Attach AJ121 series silencer on the port of the relief valve that is open to atmosphere.

Contact Gast at 616-926-6171 or www.gastmfg.com with any further questions you may have on reducing blower noise in your application.

Noise Reduction and Absorption Coefficients for Common and Specialty Noise Reduction Materials

	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	NRC
Brick, unglazed	.03	.03	.03	.04	.05	.07	.04
Carpet 1/4 in pile height	.05	.10	.15	.30	.50	.55	.26
Fabric Heavy Velour 18 oz per sq. yd draped to 1/2 area	.14	.35	.55	.72	.70	.65	.62
Hardwood Plywood Paneling 1/4 in thick wood frame	.58	.22	.07	.04	.03	.07	.09
Tecnifoam* TFP4 Pyramind shape	.39	.60	1.21	1.14	1.16	1.13	1.05
Tecnifoam* TFW4000 Anaechoic Wedge shape	.64	1.10	1.34	1.23	1.24	1.21	1.25

Source: Mechancial Engineering Reference Manual

*TFP4 and TFW4000 are products of Tecnifoam, Inc., 7145 Boone Avenue North, Minneapolis, MN., 55428

Blower Sound Levels of Gast Blowers

Data is highest sound level out of 4 places around the blower at 1 meter.

Data represents average of several units run at nominal voltage.

Lowest to highest maximum dba level throughout performance range is shown.

Readings at other than the maximum around the blower at 1 meter may be from 2 to 10 dba less than data shown.

Readings taken in a laboratory sound room that does not reflect much noise.

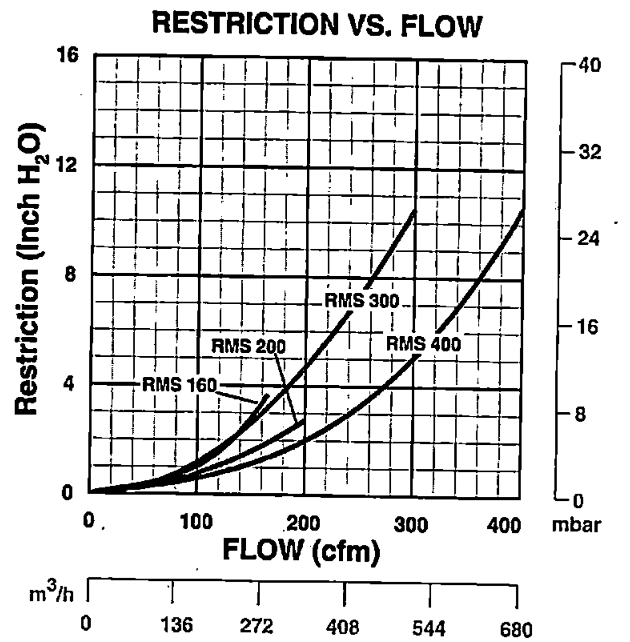
Note: For comparison purposes, some blower manufacturers show sound data from 1–1/2 meters instead of from 1 meter; also, some blower manufacturers show an "average" sound level across performance instead of the full range between minimum and maximum sound levels; either of these methods will provide different and usually lower sound levels compared to Gast's sound level method.

60Hz	dBa at Pressure	50Hz	dBa at Pressure
R1	59-67	R1	59-64
R2	66	R2	61-63
R3	67-70	R3	63-68
R4	69-73	R4	64-69
R4P	69-75	R4P	64-71
R5	73-77	R5	71-77
R6	73-79	R6	70-79
R6P	82-83	R6P	77-80
R6PP	77-79	R6PP	73-76
R6PS	76-77	R6PS	72-75
R7	82-84	R7	77-79
R7P	77-80	R7P	74-79
R7S	75-77	R7S	72-76
R9	82-85	R9	78-85
R9P	81-88	R9P	79-86
R9S	79-81	R9S	77-81
R4H	80-82	R4H	75-81
R4M	82-83	R4M	78-79
R7H	83	R7H	79-81

60Hz	dBa at Vacuum	50Hz	dBa at Vacuum
R1	58-63	R1	54-60
R2	67	R2	63-64
R3	67-71	R3	64-69
R4	70-72	R4	66-70
R4P	73-74	R4P	68-71
R5	75-76	R5	71-73
R6	78-80	R6	74-77
R6P	81-85	R6P	79-81
R6PP	81-83	R6PP	78-79
R6PS	79-81	R6PS	76-77
R7	85-87	R7	79-84
R7P	84-86	R7P	80-83
R7S	82-83	R7S	78-80
R9	85-90	R9	83-84
R9P	88-90	R9P	84-87
R9S	87-88	R9S	83-86
R4H	82-89	R4H	79-88
R4M	85-89	R4M	80-85
R7H	82-91	R7H	80-90

The separator removes liquids from the gas stream in a soil vapor extraction process, to help protect both blower and vapor treatment system from corrosion and mineral deposit buildup. The separator is located between the extraction wells and the blower. An in-line filter is installed between separator and blower.

Cut away to show ball float. Above model shows optional explosion proof float switch

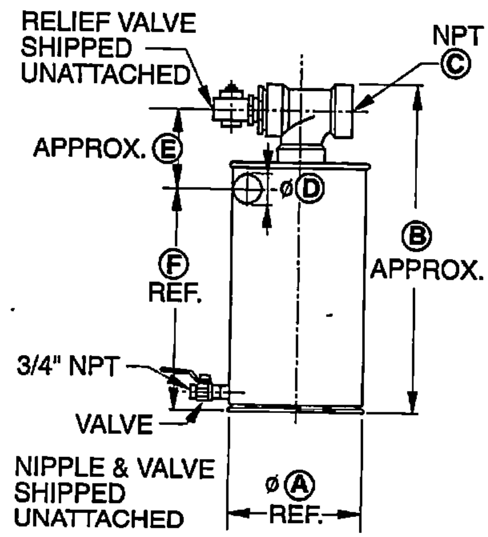


Regenair® Liquid Separator Specifications

Practical Design Engineered to remove and contain moisture ranging from a fine mist to slugs of water from blower inlet air streams, Gast separators incorporate a cyclonic action which results in a very high degree of efficiency.
A floating ball valve which closes when the liquid level becomes too high prevents collected liquid from overflowing back into the air stream. When the float valve closes an integral vacuum relief valve opens, admitting air to cool the blower and prevent overheating.

Rugged Construction Gast separator drums are made from ribbed heavy gauge cold-rolled steel, with heavy steel inlet, drain and float switch ports welded to the drum wall. Drum interiors are epoxy coated to resist abrasion, corrosion and chemicals, while the drum exterior is coated with durable urethane. For ease of connection, the outlet port is female pipe threaded. The heavy-duty 304 stainless steel ball float resists chemicals.

Included is a pilot operated precision relief valve capable of functioning over a wide duty range. This vacuum relief valve is designed and built to proven reliability and durability standards. Moving parts are nickelplated for corrosion resistance and smooth operation.

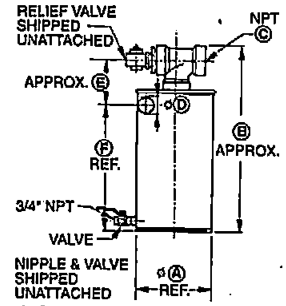


Part No.	Liq. Cap. (gal.)	A(dia.)	Dim. B	C(NPT)	D(dia.)	Dim. E	Dim. F
RMS160	10	14.8"	37.5"	2"	2"	7.5"	26.6"
RMS200	19	19.7"	35"	2"	2"	7.5"	26.6"
RMS300	19	19.7"	35"	2.5"	2.5"	7.5"	26.6"
RMS400	40	24"	44"	3"	3"	9.7"	29"

ACCESSORIES

Liquid Separators

Separators remove liquids from the gas stream in a vacuum process, helping protect the blower from corrosion and a buildup of mineral deposits.



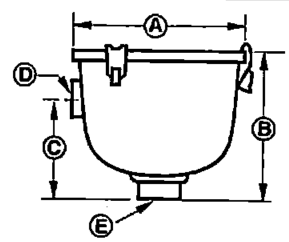
Part No.	Liq. Cap. (gal.)	A(dia.)	Dim. B	C(NPT)	D(dia.)	Dim. E	Dim. F
RMS160	10	14.8"	37.5"	2"	2"	7.5"	26.6"
RMS200	19	19.7"	35"	2"	2"	7.5"	26.6"
RMS300	19	19.7"	35"	2.5"	2.5"	7.5"	26.6"
RMS400	40	24"	44"	3"	3"	9.7"	29"

Part No.	Product Type	Description	Used On
RMS160	Liquid separator	10 gallon liquid carrying capacity	R3, R4, R4P, R5 Blowers
RMS200	Liquid separator	19 gallon liquid carrying capacity	R4, R4P, R5, R6 Blowers
RMS300	Liquid separator	19 gallon liquid carrying capacity	R5, R6, R6P Blowers
RMS400	Liquid separator	40 gallon liquid carrying capacity	R6P, R7 Blowers
AJ213	Float switch	SPDT switch, 5 amp 125/250 VAC, 1" NPT mounting	RMS Series-Separators

Filters

Since the blower impeller passes very close to the housing, it is always wise to have an in-line or inlet filter to ensure trouble free life.

In-line (for vacuum)



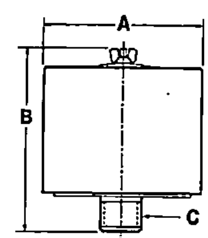
Part No.	Dim. A	Dim. B	Dim. C	Dim. D	Dim. E
AJ151C	7.38"	6.81"	4.62"	1-1/4" FPT	1-1/4" FPT
AJ151D	7.38"	6.81"	4.62"	1-1/2" FPT	1-1/2" FPT
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
AJ151G	8.00"	10.25"	5.50"	2-1/2" FPT	2-1/2" FPT
AJ151H	14.00"	26.50"	18.13"	3" MPT	3" MPT
AJ151L	14.00"	27.13"	18.50"	4" MPT	4" MPT

MPT = Male Pipe Thread FPT = Female Pipe Thread All are heavy-duty for high amounts of particulates.
Inlet filters for REGENAIR® blowers are drip-proof when mounted as shown.

For Vacuum Service

AJ151C	In-line filter	10 micron filter (replacement element AJ135E)	R3 Blower
AJ151D	In-line filter	10 micron filter (replacement element AJ135E)	R4, R4P
AJ151E	In-line filter	10 micron filter (replacement element AJ135F)	R5, R4H Blowers
AJ151G	In-line filter	10 micron filter (replacement element AJ135G)	R6, R6P, R4M Blowers
AJ151H	In-line filter	10 micron filter (replacement element AJ135C)	R7 Blower

Inlet (for pressure units only)



Part No.	Dim. A	Dim. B	Dim. C
AJ126C	6.00"	7.12"	1-1/4" MPT
AJ126D	7.70"	7.25"	1-1/2" MPT
AJ126F	10.63"	4.81"	2" FPT
AJ126G	10.00"	13.12"	2-1/2" MPT
AJ126L	10.00"	14.62"	4" MPT

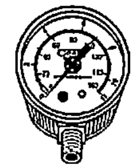
MPT = Male Pipe Thread FPT = Female Pipe Thread All are heavy-duty for high amounts of particulates.
Inlet filters for REGENAIR® blowers are drip-proof when mounted as shown.

For Compressor–Inlet

AJ126C	Inlet filter	10 micron filter (replacement element AJ134C)	R3 Blower, 2067, 2567
AJ126D	Inlet filter	10 micron filter (replacement element AJ134E)	80 Series, 6066, 1290, R4, R4H R4P, R5 Blowers
AJ126F	Inlet filter	25 micron filter (replacement element AG340)	R6, R6P, R4M Blowers
AJ126G	Inlet filter	10 micron filter (replacement element AJ135A)	R7 Blower
AL355	Inlet filter	10 micron filter	0823

Pressure-Vacuum Gauge

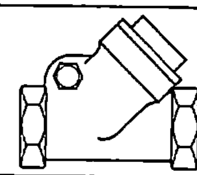
To monitor the system performance so maximum duties are not exceeded. Using two gauges (one on each side of the filter) is a great way to know when the filter needs servicing.



AJ497	Vacuum gauge	0-60" H_2O, 1/4" NPT connection	Blowers
~~AE134~~	~~Vacuum gauge~~	~~0-160" H_2O, 1/4" NPT connection~~	~~Blowers~~
AE134F	Vacuum gauge	0-15" HG, 1/4" NPT connection	R4H Blower
AA644B	Pressure gauge	0-30 psi, 1/4" NPT	80 Series, 2567, 2067, 6066, 0823
~~AE133~~	~~Pressure gauge~~	~~0-160" H_2O, 1/4" NPT connection~~	~~Blowers~~
AE133A	Pressure gauge	0-200" H_2O, 1/4" NPT connection	Blowers
AE133F	Pressure gauge	0-15 psi, 1/4" NPT connection	R4H Blower
AJ496	Pressure gauge	0-60" H_2O, 1/4" NPT connection	SVE Blowers

Check Valve

Designed to prevent back-wash of fluids that would enter the blower. Also prevents air back-streaming if needed. Can be mounted with discharge either vertical or horizontal. Valve will open with 3" of water pressure.



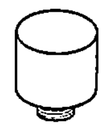
AH326D	Check valve	1-1/2" NPT (3" H_2O cracking pressure)	Blowers
AH326F	Check valve	2" NPT (3" H_2O cracking pressure)	Blowers
AH326G	Check valve	2-1/2" NPT (3" H_2O cracking pressure)	R7 Blower

Relief Valve

By setting a relief valve at a given pressure/vacuum you can ensure excessive duties will not harm the blower or products in your application.

AG258

AN225

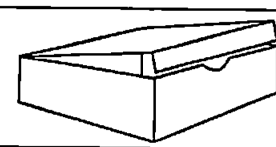


PV Series

AA307	Relief valve	For pressure, 3/4" NPT, adjustable 2-25 psi	6066, 2567 Series
AA600	Relief valve	For pressure, 3/8" NPT, adjustable 2-30 psi	0823
AG258	Relief valve	1-1/2" NPT adjustable 30-170" H_2O, vac. or press., 200 CFM max.	Blowers
AG258F	Relief valve	2-1/2" NPT adjustable for higher flows, vacuum or pressure	Blowers
PV065	Relief valve	For pressure, pre-set for 6.5 psi, 1-1/4" NPT connection (60Hz)	R3H Blower
PV072	Relief valve	For pressure, pre-set for 7.2 psi, 1-1/4" NPT connection (60Hz)	R3H Blower
PV098	Relief valve	For pressure, pre-set for 9.8 psi, 1-1/4" NPT connection (50Hz)	R4H Blower
PV102	Relief valve	For pressure, pre-set for 10.2 psi, 1-1/4" NPT connection (60Hz)	R4H Blower
AN225	Relief valve	15-45 cfm, 3/4" NPT connection, adjustable 0-20 psi	2080, 3080, 4080 Series

Service Kit

If pump performance on rotary vane models diminishes, installation of the Service Kit replacement parts will have it performing like new again.



K479A	Service Kit	Includes items for unit repair	0823 Model
K504	Service Kit	Includes items for unit repair	6066, 1290 (uses 2)
K583	Service Kit	Includes items for unit repair	2567 Models
K584	Service Kit	Includes items for unit repair	2080, 3080, 4080 Models
K585	Service Kit	Filter/Muffler Kit only	2080, 3080, 4080 Models

U.S. FILTER
WESTATES

VENT-SCRUB™
VSC-200P
Installation and Start-Up Instructions

IMPORTANT: Read all instructions prior to start-up

The Westates VENT-SCRUB™ has been designed for easy and rapid installation. Final installation requires the connection of the VENT-SCRUB™ to the process outlet through the use of pipes, ducts, or flexible hoses. The following instructions must be followed prior to system start-up:

1. Place the **VENT-SCRUB™** in an area close to the contaminated air source and accessible to maintenance personnel. The **VENT-SCRUB™** is self supporting and therefore requires no special stand or support pad. The area chosen for locating the **VENT-SCRUB™** should be level, flat and capable of supporting its weight.

2. Remove the **VENT-SCRUB™** protective shipping plugs from inlet and outlet and save for future storage and shipping.

3. Connect the **VENT-SCRUB™** to a pipe, duct or flexible hose to the inlet of the vessel. The **VENT-SCRUB™** is designed to operate under positive pressure. Please refer other applications to Westates.

4. For outdoor applications, the **VENT-SCRUB™** discharge should be equipped with a "U"-tube or rain hat to prevent water from entering the unit. **If flammable vapors are being adsorbed, a flame arrester should be installed at the inlet of the VENT-SCRUB™.** Consult your Westates sales representative for product selection.

5. All adsorption processes are exothermic in nature (liberate heat) and care must be exercised to ensure that excess heat does not build up in the **VENT-SCRUB™** during start-up and operation. In applications where low air flow and high concentrations of volatile organics are being treated, care must be taken to prevent overheating. If this type of application is anticipated or if the outlet air temperature from a **VENT-SCRUB™** should ever exceed 140°F, a Westates representative should be contacted for recommended precautions.

6. When using Westates' UOCH-KP or UOCH-KG, please refer to the "Use of UOCH-KP/UOCH-KG Activated Carbon" start-up instruction sheets.

7. Once operational, the **VENT-SCRUB™** will continue to remove contaminants with little or no maintenance, until the carbon is spent. Contact Westates for information on removal and reactivation of spent carbon.

NOTE: Studies conducted have shown that low oxygen content exists in adsorbers containing wet carbon. Laboratory experiments conducted since that time also have revealed that commercial activated carbons in a wet or moist condition will lower the oxygen content of an isolated space.

(CONTINUED)

CONNECTION SIZES

	SIZES	LOCATION
Inlet Outlet	2" FNPT 2" NPT	Top Lower Side

OPERATING CONDITIONS

	OPTIMUM	MAXIMUM
Vapor Flow Rate	0-100 cfm	100 cfm
Vapor Temperature	77°F	140°F
System Pressure	-	15 psig
Vacuum	6 in. Hg	18 in. Hg
Carbon Fill Volume	-	7.0 cu. ft.
Shipping weight (approximate)	-	250 lbs.

FOR ADDITIONAL INFORMATION PLEASE CONTACT
ONE FOR THE FOLLOWING OFFICES:

Los Angeles, CA
(800) 659-1771

Oakland, CA
(800) 659-1718

Baytown, TX
(800) 659-1723

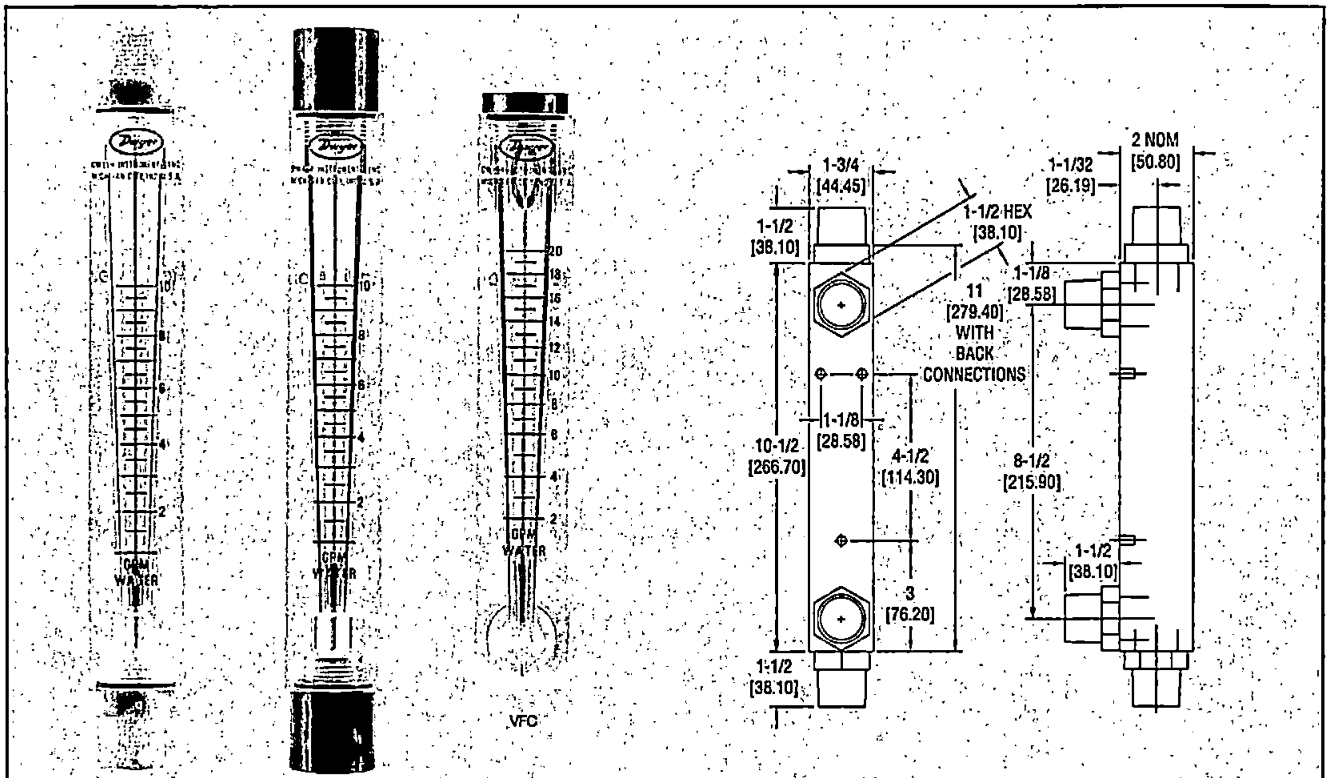
Warren, NJ
(800) 631-0878

Vacuum Blowers

Series VFC & VFCII

Visi-Float® Flowmeters

Used to Indicate Air or Water Flow



VFCII with End Connections — VFC with End Connections — VFC

The accurate and durable VFC Visi-Float® flowmeter contains a stainless steel guide rod and large diameter float for excellent stability and visibility in high flow rates. The large 5" scale provides a +/-2% full scale accuracy for precision measurement required in medical or laboratory applications. The VFC models have PVC 1" female NPT connections. VFC II units are equipped with acetal thermoplastic 1" male NPT fittings. VFC II fittings also include hex wrench flats to prevent stripped threads. All models have metal mounting inserts on the back for panel mounting. Units may also be supported directly by system piping.

How To Order
Series—Range No.—Option
Example: VFC-123-EC
Series VFC with 10-100 SCFH Air Range and 1" ~~female NPT~~ End Connections

POPULAR RANGES

Model VFC — 5" Scale			
Range No.	Range SCFM Air	Range No.	Range GPM Water
121	2.5-25	141	.5-5
122	5-50	142	1-10
123	10-100	143	2-20
	LPM Air		LPM Water
131	60-700	151	2-20
132	200-1400	152	4-40
133	300-2800	153	10-75

SPECIFICATIONS

Service: Compatible gases & liquids.
Wetted Materials:
Body: Acrylic plastic.
O-Ring: Buna-N (Viton® available).
Metal Parts: Stainless steel.
Float: Stainless steel.
Temperature & Pressure Limits: 100 psig (6.9 bar) @ 120°F (48°C).
Accuracy: 2% of full scale.
Process Connection: VFC: 1" female NPT back connections. End connections optional. VFCII: 1" male NPT back connections. End Connections optional.
Scale Length: 5" typical length.
Mounting Orientation: Mount in vertical position.
Weight: 24-25 oz (.68-.71 kg).

Series VFC & VFCII Models..........

Options
-EC, End Connections..........
-VIT, Viton® O-Rings..........
-FDA, 316 SS Float & Guide Rod (only available on VFCII with Viton® O-Rings)..........

Dwyer Instruments, Inc./P.O. Box 373/Michigan City, IN 46361/Phone 219 879-8000/Fax 219 872-9057 • U.K. Phone 44 1 494-461707 • Australia Phone 61 2 4272-2055

For Air Compressor

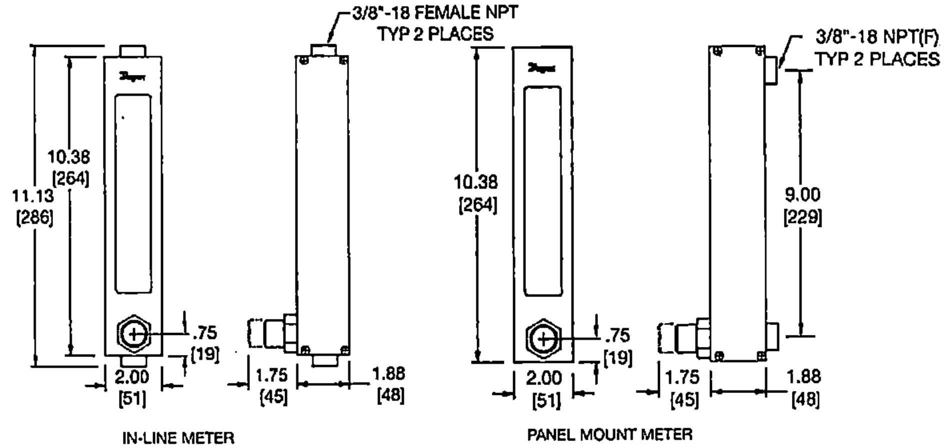
Series RSF

Rotatable Scale Flowmeters

CE

Dual, Rotatable Direct Reading Scales for Air and Water, ±7% Accuracy

NEW Teflon® Models



Series RSF Flowmeters are designed with unique rotatable scales of dual, air-water direct reading graduations. Flow rate is indicated in SCFM and SLPM for air and GPM and LPM for water. Graduations are marked on a rotating, polycarbonate tubeshield which also serves to protect the borosilicate glass flowtube. Flowmeters include a reflective plastic background and 1.5 X magnification lens to reduce eye fatigue and allow for more accurate readings. A blow-out back panel provides additional protection in the event of breakage. Series RSF Flowmeters are available in vertical in-line mounting or panel mounting. Units are shipped completely assembled and include standard mounting hardware for quick installation.

POPULAR MODELS

Brass & SS Vertical In-Line Meters					
Without Valve		With Valve		Max. Flow Rate	
Brass	SS	Brass	SS	Air scfm (SLPM)	Water GPM (LPM)
RSF011	RSF111	RSF011V	RSF111V	5(140)	1.2(4)
RSF012	RSF112	RSF012V	RSF112V	10(280)	2(8)
RSF013	RSF113	RSF013V	RSF113V	15(425)	3(11.5)
RSF014	RSF114	RSF014V	RSF114V	20(575)	4(15)
RSF015	RSF115	RSF015V	RSF115V	30(900)	5(20)

Brass & SS Panel Mount Meters					
Without Valve		With Valve		Max. Flow Rate	
Brass	SS	Brass	SS	Air scfm (SLPM)	Water GPM (LPM)
RSF021	RSF121	RSF021V	RSF121V	5(140)	1.2(4)
RSF022	RSF122	RSF022V	RSF122V	10(280)	2(8)
RSF023	RSF123	RSF023V	RSF123V	15(425)	3(11.5)
RSF024	RSF124	RSF024V	RSF124V	20(575)	4(15)
RSF025	RSF125	RSF025V	RSF125V	30(900)	5(20)

Teflon® Vertical In-Line Meters			
Without Valve	With Valve	Max. Flow Rate	
		Air scfm (SLPM)	Water GPM (LPM)
RSF211	RSF211V	3.5(100)	0.8(3)
RSF212	RSF212V	7(200)	1.5(5.75)
RSF213	RSF213V	10.5(300)	2.2(8.25)
RSF214	RSF214V	14(400)	2.9(11)
RSF215	RSF215V	17.5(500)	3.5(13.25)

Teflon® Panel Mount Meters			
Without Valve	With Valve	Max. Flow Rate	
		Air scfm (SLPM)	Water GPM (LPM)
RSF221	RSF221V	3.5(100)	0.8(3)
RSF222	RSF222V	7(200)	1.5(5.75)
RSF223	RSF223V	10.5(300)	2.2(8.25)
RSF224	RSF224V	14(400)	2.9(11)
RSF225	RSF225V	17.5(500)	3.5(13.25)

SPECIFICATIONS

Service: Compatible gases or liquids.

Wetted Materials:

Flowtube: Borosilicate glass.

Float: 316 stainless steel.

Tube Shield: Polycarbonate.

Float Stops: 316 stainless steel.

End Fittings: Brass or 316 stainless steel.

O-rings: Viton®.

Temperature Limit: 250°F (121°C).

Pressure Limit: 150 psig (10.34 bar) @ 200°F (93°C).

Accuracy: ±7% FS.

Repeatability: ±0.25% FS.

Scale: Direct Reading 127 mm scales for air and water.

Turn-Down Ratio: 10:1.

Connections: Two 3/8" female NPT.

Mounting: Vertical or panel mount.

Panel Cutout: Drill two 7/8" diameter holes 9.0" (229 mm) apart (for panel mount meters only).

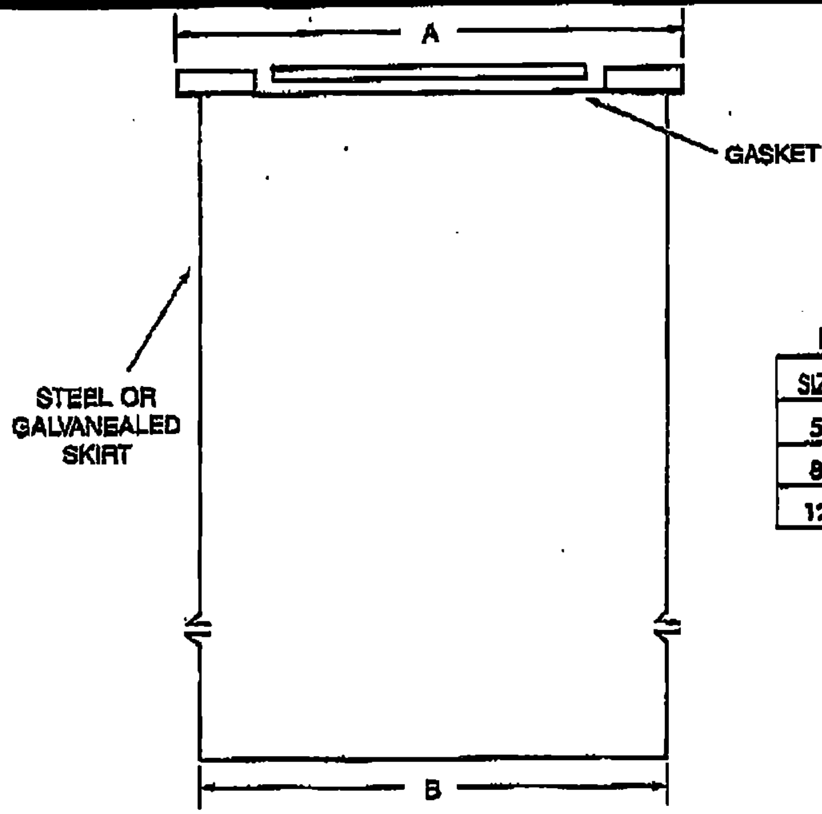
Valve: 6-turn needle (standard on models indicating "with valve").

Agency Approvals: CE.

APPLICATIONS

Flowmeters are suitable for metering air or water for film processing, paper manufacturing, chemical processing, semiconductor industry, water and air pollution analysis equipment, metals processing, industrial fuel and energy conservation, air metering, and general laboratory and industrial applications.

Dwyer Instruments, Inc./P.O. Box 373/Michigan City, IN 46361/Phone 219 879-8000/Fax 219 872-9057 • U.K. Phone (+44) (0)1494-461707 • Australia Phone 61 2 4272-2055



DIMENSIONS

SIZE	A	B
5"	6"	5 1/8"
8"	9 3/4"	8 5/8"
12"	13 1/8"	12 1/2"

BEARING STRENGTH TEST RESULTS

6" Diameter Monitor Well Covers
(Morris 5") Monitor Well Assembly

TEST PERFORMED: The submitted sample was tested for its ability to withstand a proof load in accordance with the procedures outlined in AASHTO M306-89. The test date was January 19, 1996.

RESULTS: The submitted sample is considered to meet the requirements of AASHTO M306-89 for proof load testing.

Procedure: On 8" diameter monitor well cover assembly a compressive load was applied with 6¼" diameter head centered on cover surface.

On 12" diameter monitor well cover assembly a compressive load was applied with 9⅝" diameter head centered on cover surface.

Lab. #	Diameter of Cover	Outer Diameter of the Assembly	Break Load
92-M117	8.5"	9.81"	65,000 lbs.
93-M046	12.0"	13.25"	59,000 lbs.

FULL COPIES OF TEST RESULTS ARE AVAILABLE UPON REQUEST.

SPARGING – COMPRESSORS – ROTARY VANE

·oduct Specifications ·del Number	Phase	Motor Specifications Hz	Voltage	HP	Max. Pressure @ 60Hz psig	1 bar	Max. Flow @ 60Hz cfm	m³h	Net Wt. lbs	kg
··23-P155-G608X*	Single	50	100-110/220-240	0.75	10 (15 inter)	0,7 (1,0)	8	14	50	23
		60	100-115/208-230							
·0-P124-T337	Three	60	230/460	2.0	15	1,0	25	42	135	61
2080-P124-T906X	Single	60	115/230	3.0	15	1,0	25	42	135	61
··0-P124-T338	Three	60	208-230/460	3.0	15	1,0	35	59	160	72
·0-P124-T907X	Single	60	208-230	5.0	15	1,0	35	59	160	72
··7-P118-G470X†	Single	60	115/230	1.5	20	1,4	17	29	84	38
2067-P118-G471*†	Three	50	220/380-415	1.0	20	1,4	17	29	84	38
		60	208-230/460	1.5						
·7-P132-G475†	Three	60	230/460	2.0	20	1,4	21	36	85	38
··7-P132-T908X†	Single	60	115/230	2.0	20	1,4	21	36	85	38
6066-P122-T339***†	Three	60	208-230/460	5.0	15	1,0	55	93	205	92
·6-P122A-T905**†	Three	60	208-230/460	5.0	20	1,4	37	63	205	92
·6-P122A-T909†	Three	60	208-230/460	7.5	20	1,4	55	93	205	92
1290-P110-T904***†	Three	60	208-230/460	10	15	1,0	112	190	430	194
·90-P110A-T910†	Three	60	208-230/460	15	20	1,4	112	190	440	198

·50Hz performance reduce air flow on grid by approximately 17%
··ole motor; 1140 RPM
***These models are capable of 15 psi max. performance, reference performance grid below
†Also available as separate drive, less the motor. To order as a separate drive version, specify the first two sets of digits only of this model number. Consult factory or distributor for the correct ·a frame size motor to use. Customer supplied motor must have minimum service factor of 1.15.