Vapor Intrusion Mitigation System Installation and Long-Term Monitoring Work Plan

Prepared For:

Precision Engineering, Inc.
1231 S. Director Street
Seattle, Washington

October 2008

PIONEER
TECHNOLOGIES CORPORATION

MAUL FOSTER ALONGI
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October 16, 2008
Project No. 8006.08.04

Mark Adams
Washington Department of Environmental Quality
NW Regional Office
3190 160th Ave SE
Bellevue WA 98008-5452

Re: Final Pioneer Vapor Intrusion Mitigation System Installation and Long-Term Monitoring Work Plan for Precision Engineering Site, 1231 South Director Street, Seattle, Washington, VCP ID Number NW 1511.

Dear Mr. Adams:

On behalf of Precision Engineering, Maul Foster and Alongi, Inc., is submitting the Final Vapor Intrusion Mitigation System Installation and Long-Term Monitoring Work Plan completed by Pioneer Technologies Corporation. This letter responds to many of the comments you provided in your July 8, 2008, email, and summarizes agreements that you and I reached in our phone conversation on September 24, 2008.

Your July 8th comments indicated the need for three stack samples collected at various times following the installation of the VI Mitigation system. You asked that the samples be screened against MTCA Method B criteria for a residential setting. However, as we discussed, this approach would not take into consideration the point of exposure (i.e. the breathing zone). The alternative approach that we agreed to is that the EPA screen 3 model will be used to conservatively predict what the concentrations will be at the point of compliance in the nearby residences' breathing zone, based on the initial stack sample results. Pioneer has incorporated into the final work plan the collection of one stack sample after installation with use of the screen 3 modeling.

To address additional Ecology comments, the final work plan has been modified to include the following: 1) the indoor air confirmation sample will be collected during the heating season, 2) there will be routine documentation that the pressure differential is being maintained (as discussed, this information does not need to be submitted to Ecology, but should be available upon request), and 3) the exhaust stack will be at least 10 horizontal feet away from any adjacent air intake duct. Per your request, edits have also been made to Figure 1-2 to include data and the proposed sub-slab depressurization (SSD) system location on one figure.

Sincerely,

Maul Foster & Alongi, Inc.

Merideth Gibson, LG
Project Geologist

Attachments: Final Vapor Intrusion Mitigation System Installation and Long-Term Monitoring Work Plan completed by Pioneer Technologies Corporation

cc: Jim Okel, Precision Equipment, Inc.
Tom Newlon, Stoel Rives, LLP

VAPOR INTRUSION MITIGATION SYSTEM INSTALLATION AND LONG-TERM MONITORING WORK PLAN

Prepared for:

Precision Engineering, Inc.
1231 S. Director Street
Seattle, Washington

Prepared by:

PIONEER TECHNOLOGIES CORPORATION

ADVANCED RADON TECHNOLOGIES INC.

October 2008

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SECTION 1 – INTRODUCTION

The former Precision Engineering, Inc. (Precision) site at 1231 S. Director Street in Seattle, Washington entered the Washington State Department of Ecology (Ecology) Voluntary Cleanup Plan (VCP) in October 2005, after completing a preliminary soil and groundwater assessment in June 2005. The site's VCP identification number is NW 1511. Under the VCP, a remedial investigation (RI) and risk assessment (RA) were prepared by Maul Foster & Alongi, Incorporated (MFA) (MFA, 2006) to characterize chemical concentrations and assess potential risk associated with the contamination present at the site. Results of the RI and RA indicated that volatile organic chemicals (VOCs), specifically trichloroethylene and the associated breakdown products (dichlorothylene and vinyl chloride) were present in subsurface soil, groundwater, and soil gas. Indoor air sampling conducted in the Precision warehouse indicated that VOC concentrations were below levels of concern. However, the VOC concentrations measured in subsurface soil, groundwater, and soil gas exceeded risk-based screening concentrations derived to be protective of vapor intrusion (VI) into the building. Sampling results, the derivation of risk-based screening concentrations, and comparison of site concentrations to risk-based screening concentrations are documented in the *Remedial Investigation and Risk Assessment Report* (MFA, 2006).

1.1 Background

Background information on the location and history, geology, hydrogeology, and VOC concentrations present at the Precision site was obtained from the *Remedial Investigation and Risk Assessment Report* (MFA, 2006), and is presented below.

1.1.1 Site Location and History

The former Precision facility is located at 1231 S Director Street in Seattle, Washington. The approximately 3.5-acre site is in King County, Washington, section 32, township 24 north, range 4 east, Willamette Meridian. The site is approximately 1,800 feet (less than 0.5 mile) west of the Duwamish River. The area surrounding the site is characterized by mixed industrial and residential use. The site is zoned I (Industrial). A single 62,000-square-foot building is located at the site. The east side of the building was constructed in 1968, and the west part was added in 1979. The building is surrounded by an asphalt parking lot.

Precision operated continuously at the property between 1968 and 2005, ceasing operations on March 1, 2005. Precision specialized in the manufacture and repair of large hydraulic cylinders, large rolls used in the manufacture of paper and metal sheet products, and other equipment. Services included precision grinding and polishing, honing, hard-chrome plating, milling, welding, and a large number of flame- and arc-applied metal coatings. Much of Precision's work involved the use of chromic acid. Approximately 10,000 square feet of the west side of the building was leased to Baszile Metals Service, an aluminum distributorship, between approximately 1985 and 2003.

West of the former Precision property is a business that repairs and sells refrigerators. East of the former Precision property is towing and limousine service business. According to former Precision personnel, the property to the east was used as a paint shop in the 1970s, and before that it was a fiberglass-boat manufacturing operation.

1.1.2 Geology

The site is underlain by localized fill up to 10 feet thick (observed only in the eastern portion of the site); alluvium comprised of silt and sand (from the surface to a depth of approximately 20 feet, observed only on the eastern portion of the site); dense, gravelly, sandy silt glacial till (observed from surface to approximately 20 feet below ground surface (bgs) in the western part of the site and observed from 20 feet to 30 feet bgs in the eastern part of the site); and alluvium comprising sand and gravel (advanced outwash, observed from 30 feet bgs and below).

1.1.3 Hydrogeology

Two water-bearing zones (WBZs) are present beneath the site: (1) a confined alluvial WBZ beneath the eastern side of the site that flows easterly toward the Duwamish River (shallow WBZ), and (2) a confined sand and gravel WBZ beneath the low-permeability glacial till (deep WBZ, which is also referred to as the advanced outwash WBZ). East of the facility, the glacial till appears to hydraulically separate the two WBZs.

The first groundwater in the alluvium is encountered between 5 to 8 feet bgs. Saturated conditions are first encountered deeper in the till (between approximately 7 and 14 feet bgs). The depth to groundwater in wells installed in the shallow WBZ is between 3.49 and 6.39 feet bgs. The higher static groundwater elevations in the monitoring wells indicate confined conditions in the alluvium and the till. Estimated potentiometric contours show that the shallow WBZ generally flows from west to east or northeast.

1.1.4 Summary of Volatile Organic Chemical Concentrations in Soil, Groundwater, Sub-slab Vapors, and Indoor Air

Soil

Seven indicator hazardous substances (IHS) (i.e., hexavalent chromium (Cr^{+6}), trivalent chromium (Cr^{+3}), arsenic, lead, diesel range organics (DRO), oil range organics (ORO), and trichloroethylene (TCE)) were identified from the 64 soil samples collected "on-site." Comparison of the detected concentrations of these IHS to risk-based cleanup levels (CULs) indicated that four of the seven IHSs ($Cr^{+6,}$ arsenic, lead, and TCE) were present in concentrations that exceeded CULs (MFA, 2006). TCE was the only VOC detected in soil and the sampling results are presented in Table 1-1. Soil sampling locations are shown in Figure 1-1.

Groundwater

Nine IHS (i.e., Cr^{+6}, Cr^{+3}, arsenic, copper, selenium, DRO, ORO, TCE, and vinyl chloride (VC)) were identified from the eight reconnaissance groundwater samples and two rounds of groundwater monitoring from monitoring wells MW1 through MW8. Comparison of the detected concentrations of these IHS to CULs indicated that five of the nine IHS (i.e., Cr^{+3}, $Cr^{+6,}$

arsenic, TCE and VC) were present in concentrations that exceeded CULs (MFA, 2006). TCE and VC are the only VOCs detected in groundwater and the sampling results are presented in Table 1-2. Groundwater sampling locations are shown in Figure 1-1.

Sub-Slab Vapor

Based on the exceedances of CULs in soil and groundwater, seven sub-slab vapor samples were collected to characterize the potential for VI into the warehouse. The sub-slab vapor sampling results indicated that only one IHS, TCE, was present at concentrations that exceeded CULs (MFA, 2006). Sampling results for TCE and VC are presented in Table 1-3 and the sampling locations are show in Figure 1-2.

Indoor Air

To identify potential VI, nine indoor air samples were collected from eight locations inside of the warehouse. In addition, one ambient air sample (IA7) was collected outside at an upwind location. The indoor air sampling results indicated that only one IHS, TCE, was detected in indoor air, and that all detected concentrations were below the CUL. TCE was also detected in ambient air at a concentration below the CUL. Sampling results for TCE are presented in Table 1-4 and the sampling locations are shown in Figure 1-2.

1.2 Work Plan Overview

Based on the results of risk-based screening for subsurface soil, groundwater, and soil gas, Precision decided to install a sub-slab depressurization (SSD) system (VI mitigation system) to ensure that VOC concentrations inside of the warehouse remain below levels of concern. The purpose of the SSD system is to depressurize the ground immediately below the building's slab which will be achieved by using an exhaust fan designed to generate sufficient suction to remove air from beneath the building and vent it to ambient air. This type of system has been designed for a wide variety of VOCs that migrate through soil via diffusion. This system will decrease the pressure below the building slab so that pressure inside the building is higher than the pressure beneath the slab, thus, the flow of gases in the building will be downward out of the building and into the sub-slab area.

The following sections of this work plan present the design criteria and steps for installing the SSD system, and the process for monitoring the effectiveness of the SSD system. Some of the information required for installation of the SSD system (e.g., the number and location of the sumps and the size of the fan) cannot be determined until additional diagnostic testing is performed at the Precision site. Therefore, this work plan will be supplemented by a Sub-Slab Depressurization System Installation "As-Built" Report that will be submitted after the SSD System has been installed. This report will contain site-specific SSD system drawings, the results of diagnostic testing, and the specifications of the fan used to achieve negative pressure per the design criteria presented in this work plan.

SECTION 2 – DESIGN CRITERIA AND INSTALLATION OF THE SUB-SLAB DEPRESSURIZATION SYSTEM

2.1 SSD System Design Criteria

The SSD system design will be consistent with the standards for installing radon mitigation systems presented in ASTM standard E2121-03, "Standard Practice of Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings" (ASTM, 2003) and the Environmental Protection Agency's Radon Mitigation Standards (EPA, 1994). Radon mitigation systems are the same type of system that is required for VOC vapor mitigation, and rely on creating negative pressure extension beneath the building slab. More detailed information regarding the installation of vapor mitigation measures can be found in the Environmental Protection Agency's (EPA's) Options for Developing and Evaluating Mitigation Strategies for Indoor Air Impacts at CERCLA Sites (EPA, 1993). Advanced Radon Technologies, Inc. (ART) will be responsible for the design and installation of the SSD system.

The design criteria for sub-slab negative pressure extension in the radon mitigation industry, where SSD systems are frequently used, is approximately -0.005" water column (wc) or 1 Pascal (Pa) of pressure differential.[1] When this negative pressure extension is reached, radon levels have been reduced below regulatory action levels. Based on extensive experience with radon and VOCs, -0.005" wc pressure differential should be sufficient to redirect the VOCs into the SSD system and away from the heated envelope of the warehouse. The specific type of fan needed to obtain the required depressurization will be determined at the time of installation, and will be based on diagnostic testing, as described below. Most likely a commercial fan will be required to provide the necessary negative pressure extension beneath the warehouse slab.

2.2 SSD System Installation

SSD system installation will be accomplished in four sequential steps, which are:

1. Diagnostic Testing
2. System Design
3. System Installation
4. Confirmation of System Effectiveness

The overall schedule for installation of the SSD system is presented in Table 2-1. The steps of SSD system installation are discussed below.

[1]The standard for pressure differential is based on the experience of those in the radon mitigation industry, and has been communicated through the VI industry through project experience and professional conferences.

2.2.1 Diagnostic Testing

Diagnostic testing is the first step of system installation, and will be conducted to determine the size of depressurization system (i.e., how many sumps and the type of fan) required to achieve the design criteria sub-slab pressure differential of – 0.005" wc.

The steps of diagnostic testing are the following:

1. All major floor cracks in the slab will be sealed with an applicable sealant (if a particular crack or gap is impeding the system from meeting its goals). Sealants will be chosen for use based on both the compatibility of the sealant with the surfaces to be sealed, and on the presence of VOCs in the sealant. Sealants to be used will not contain any of the VOCs associated with the soil or groundwater contamination (i.e., trichloroethylene and its degradation products cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, and vinyl chloride).

2. One 5" diameter suction hole will be drilled in the concrete slab with a diamond tip, non-impact core bore drill. Approximately 15 to 20 gallons of soil will be removed from beneath the concrete slab through this hole which typically results in good pressure field extension. The sump shape and size is based on compaction rates under the slab, porosity of the soil, and the negative pressure extension that is generated. The typical sump size is approximately 2 feet deep. The sumps will be located as close to the impacted sub-slab areas as possible. The excavated soil will be drummed for disposal by Precision.

3. A test fan will be placed over the 5" diameter hole. A diagram showing the equipment used for diagnostic testing is presented in Figure 2-1.

4. A minimum of four 1/2" holes will be drilled around the perimeter of the area being depressurized to serve as pressure test holes. The holes will be drilled to a depth equal to the suction hole described above. The pressure test holes will be installed so that the extent of the pressure differential can be established and measured. A cross-sectional view of a pressure test hole is presented in Figure 2-2. Until the diagnostic testing is performed, the radius of influence of the fan associated with one sump cannot be established.

5. Sub-slab pressure will be measured in each of the pressure test holes. The test fan will be started and then the static pressure and the air exhaust volume will be gradually increased until the test holes all read a minimum of -0.005" wc (using a DM1 Micro-Manometer by Infiltec). A diagram of the Micro-Manometer is shown in Figure 2-2.

If -0.005" wc is not achieved in each pressure test hole, Steps 2-5 will be repeated after altering the size and shape of the existing sump or by installing an additional sump(s). Additional sumps will be located at other locations until the desired negative pressure is achieved in each of the pressure test holes. If the desired negative pressure is not achieved after 4 sumps have been constructed, an alternate SSD system design will be discussed with Precision.

2.2.2 System Design

When diagnostic testing has been completed, the specific design (i.e., a description of where the sump(s) and pipe runs will be located, the type of fan to be used, and the location of the fan on the roof) will be discussed with Precision. Upon agreement with Precision on the SSD system design, ART will prepare design drawings and other necessary paperwork for submittal to the City of Seattle to obtain a Construction Permit for installation of the SSD system. It is anticipated that an electrical permit will also be required. The electrical contractor will apply for this permit from the City of Seattle Department of Design, Construction and Land Use (DCLU).

Based on an initial site visit, ART identified a potential depressurization system design, which is presented in Figure 2-3. As identified in this figure, it is estimated that three-to-four sumps will be needed to provide adequate depressurization beneath the slab, and that it may be necessary to cut the concrete in places to install additional subsurface ventilation pipe due to the compacted, silty soil located beneath the slab. Achieving air movement through compacted, silty soil is more difficult due to its low permeability.

2.2.3 System Installation

When the approved Construction Permits are received from the City of Seattle, installation of the SSD system will begin. The steps of SSD system installation are the following:

1. Each of the 5" diameter suction holes and sump pits that were created for diagnostic testing will be utilized for the installation of the final SSD system.
2. A 4" diameter PVC coupling will be inserted in to the 5" diameter sump hole, and a 4" to 3" diameter reducer will be placed inside the coupling. A 3" diameter riser will then be connected to the reducer.
3. The individual 3" diameter vertical risers will be plumbed together on the roof. The plumbed risers will be connected to an exhaust fan. This fan will be part of the SSD system, and will not be part of the existing warehouse HVAC system.
4. The roof will be penetrated with a roof jack and sealed with asphalt-based roofing mastic and flashing after the pipe and fan are installed.
5. The fan will sit on the roof on a spring isolator to minimize vibration. The fan will exhaust vertically above the roof, with the exhaust point approximately 24 inches above and 10 horizontal feet away from any adjacent air intake ducts. A diagram of the proposed pipe and fan configuration on the roof is shown in Figure 2-4.
6. An electrical connection to the fan will be provided in accordance with the applicable Electric Codes.
7. All debris will be removed from the site, and all holes in floors, walls, and other construction materials will be appropriately patched or sealed.

Three and four inch diameter schedule 40 PVC pipe will be used to construct the SSD system. A cross-section view of a typical commercial SSD system is shown in Figure 2-5. The SSD system shown in this figure has two sumps to show how risers are typically joined together before they are attached to the fan.

In the event that installation of the system is interrupted for any reason, arrangements will be made with Precision and the building owner to leave the work area in the building in a protective condition, where any open holes or other potential hazards to building occupants are guarded.

Specific information on the design of the installed SSD system will be documented in a Sub-Slab Depressurization System Installation "As-Built" Report. Photographs of the installation will also be taken and included in this report. The outline for this report is presented in Appendix A.

2.2.4 Confirmation of System Effectiveness

The effectiveness of the SSD system will be confirmed via pressure differential readings and indoor air sampling.

Pressure Differential Measurements

Immediately following installation of the SSD system, pressure differential measurements will be collected to ensure that a negative pressure of at least -0.005" wc has been achieved across the extent of the impacted sub-slab area. Pressure differential measurements will be collected using the following procedure:

1. The fan will be turned off, and pressure differential measurements will be collected at the pressure test holes designated during diagnostic testing.
2. The fan will be turned back on and the system will be allowed to equilibrate for approximately 10 minutes. Then pressure differential measurements will be collected again in the test holes.
3. A negative pressure of at least -0.005" wc, measured at each of the pressure test holes after the fan has been turned on, indicates that the SSD system is achieving the design criteria.

This measurement will be conducted again approximately 4 weeks after installation of the SSD system.

Air Sampling

One round of post-installation air sampling will also be performed to verify system effectiveness. Air sampling will include collection of both an indoor air sample and an ambient air sample, collected upwind of the Precision warehouse. It should be noted that ambient air can contribute to indoor air VOC concentrations. Therefore, the ambient air sample VOC concentrations will be compared to VOC concentrations measured in indoor air to determine if ambient air may be impacting indoor air concentrations.

This sampling will be conducted approximately 4 weeks after installation of the SSD system, during the heating season. Sampling is proposed during the heating season because this is the time when vapor intrusion is expected to be of most concern due to the "stack effect" caused by heating the building. The VOCs sampled will be limited to those VOCs that have been detected in the subsurface (i.e., trichloroethylene, cis-1,2 dichloroethylene, trans-1,2 dichloroethylene, and vinyl chloride). The need for additional indoor air sampling will be based on the results of the initial round of sampling.

In urban areas, such as the Georgetown neighborhood where the Precision warehouse is located, ambient air concentrations are sometimes higher than health based cleanup standards and may be higher than the contribution of soil gas to indoor air. For this reason, VOC measurements will not be the sole measure of system performance, but will be used in conjunction with pressure differential measurements.

2.2.5 *Measurement of Stack Emissions*

Stack emission sampling will be conducted approximately four weeks following installation to verify that MTCA Method B and Method C air standards are not being exceeded. For this evaluation, measured stack concentrations will be incorporated into EPA's Screen 3 Model (http://www.epa.gov/scram001/dispersion_screening.htm) to estimate exposure point (i.e., breathing zone) concentrations of trichloroethylene, cis-1,2 dichloroethylene, trans-1,2 dichloroethylene, and vinyl chloride at multiple distances from the Precision facility. These modeled concentrations will be compared to MTCA Method B and Method C risk-based screening concentrations for air. The need for additional stack sampling will be based on the results of initial sampling.

SECTION 3 – LONG-TERM MONITORING OF THE SSD SYSTEM

The continued effectiveness of the SSD system will be evaluated via a long-term monitoring plan, consisting of annual inspections, fan performance monitoring, and pressure differential readings. Each component of this plan is discussed below, and a summary of the plan is presented in Table 3-1.

3.1 Annual Inspections

The SSD system will be inspected annually, which will consist of a visual inspection of the system, including performance of fan maintenance as recommended by the manufacturer, and measurement of the sub-slab pressure differential. The building tenant will also be questioned regarding any concerns with the installed system. The inspection checklist that will be completed during the annual inspection is included in Appendix B.

3.1.1 Fan Performance Readings

To enable continuous monitoring of the fan function, a U-Tube Manometer will be installed into the side of one of the PVC risers at a location easily accessible to building occupants. In general, if the fluid level in each side of the "U" tube is at different levels, it indicates that there is a pressure differential between the air in the pipe and the air inside the building. This indicates that the fan is creating negative pressure by pulling air from beneath the building and, therefore, the SSD system is working as designed.

The building owner and Precision will be advised on the location and how to read the U-Tube Manometer at the time of final system installation. The fluid level reading that indicates proper system function will be specified on a sticker located next to the manometer. A drawing of the U-Tube Manometer, including reading instructions, is presented in Figure 2-6. Should the manometer indicate that the SSD system is not functioning as designed, the building occupant will have a phone number for contacting a person capable of evaluating and repairing the SSD system. The maintenance requirements for the system will be documented in the As-Built SSD System Installation Report. Precision will be responsible for the maintenance of the installed system.

3.1.2 Annual Pressure Differential Measurements

Annual pressure differential measurements will be collected during the annual inspection of the SSD system to ensure that the SSD system is continuing to achieve the design criteria of at least -0.005" wc in each test hole located within the extent of the impacted sub-slab area.

Section 4 – References

American Society for Testing and Materials, International (ASTM). 2003. ASTM E-2121-03. Standard Practice of Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings. February 10.

United States Environmental Protection Agency (EPA). 1993. Options for Developing and Evaluating Mitigation Strategies for Indoor Air Impacts at CERCLA Sites. EPA/451/R-93/012.

EPA (United States Environmental Protection Agency). 1994. Radon Mitigation Standards. EPA 402-R-93-078. October, 1993, Revised April, 1994.

Maul, Foster & Alongi, Inc. (MFA). 2006. Remedial Investigation and Risk Assessment Report. Former Precision Engineering, Inc. Site, 1231 S. Director Street. August 28, 2006.

TABLES

Table 1-1
Risk-Based Screening of Volatile Organic Compound IHSs in Soil (µg/kg)
Precision Engineering, Inc. Seattle, Washington

Location	Sample ID	Sample Date	Depth (ft. bgs)	Trichloroethene	Vinyl Chloride
MTCA Method A CULs for Unrestricted Land Use				30	NA
MTCA Method B CULs for Ingestion only				2,500	667
MTCA Method C CULs for Ingestion Only				330,000	88,000
CUL for Industrial Workers - Direct Contact				6,780	NA
CUL for Vapor Intrusion				41.5	NA
On-Site Geoprobe Sampling					
GP1	GP1-S-1.5	6/7/2005	1.5	0.839 U	0.839 U
	GP1-S-6.0	6/7/2005	6	1.12 U	1.12 U
	GP1-S-10.0	6/9/2005	10	7.65 U	7.65 U
GP2	GP2-S-1.0	6/7/2005	1	0.96 U	0.96 U
	GP2-S-10.0	6/9/2005	10	8.81 U	8.81 U
GP3	GP3-S-2.0	6/9/2005	2	15.9 U	15.9 U
	GP3-S-6.0	6/9/2005	6	8.96 U	8.96 U
	GP3-S-14	6/9/2005	14	7.71 U	7.71 U
GP4	GP4-S-1.5	6/16/2005	1.5	10.3 U	10.3 U
GP5	GP5-S-1.5	6/16/2005	1.5	7.12 U	7.12 U
	GP5-S-8.0	6/16/2005	8	7.03 U	7.03 U
	GP5-S-14.0	6/16/2005	14	8.1 U	8.1 U
GP6	GP6-S-1.0	6/16/2005	1	40.5	8.5 U
	GP6-S-14.5	6/16/2005	14.5	**1,160**	8.28 U
GP7	GP7-S-2.0	6/16/2005	2 8	7.81 U	7.81 U
	GP7-S-8.0	6/16/2005	8	8.84 U	8.84 U
GP8	GP8-S-1.5	6/16/2005	1.5	9.86 U	9.86 U
GP9	GP9-S-2.0	6/17/2005	2	7.42 U	7.42 U
GP10	GP10-S-1.5	6/17/2005	1.5	11.2 U	11.2 U
	GP10-S-13.5	6/17/2005	13.5	7.96 U	7.96 U
GP11	GP11-S-2.0	6/17/2005	2	**87.2**	8.37 U
	GP11-S-6.5	6/17/2005	6.5	**281**	8.61 U
GP12	GP12-S-3.0	12/13/2005	3	2.39 U	2.39 U
	GP12-S-5.0	12/13/2005	5	2.27 U	2.27 U
GP13	GP13-S-1.0	12/14/2005	1	9.89 U	9.89 U
	GP13-S-6.0	12/14/2005	6	2.89 U	2.89 U
GP14	GP14-S-3.0	12/13/2005	3	4.49	2.44 U
	GP14-S-6.0	12/13/2005	6	2.62 U	2.62 U
GP15	GP15-S-3.0	12/13/2005	3	2.72 U	2.72 U
	GP15-S-6.0	12/13/2005	6	10.5 U	10.5 U
GP16	GP16-S-1.0	12/13/2005	1	3.63	1.85 U
	GP16-S-5.0	12/13/2005	5	2.12 U	2.12 U
GP17	GP17-S-1.0	12/13/2005	1	2.09 U	2.09 U
	GP17-S-6.0	12/13/2005	6	2.27 U	2.27 U
GP18	GP18-S-1.0	12/13/2005	1	3.43	2.36 U
GP19	GP19-S-1.0	12/13/2005	1	2.67 U	2.67 U
	GP19-S-1.0-Dup	12/13/2005	1	2.40 U	2.40 U
	GP19-S-7.0	12/13/2005	7	2.72 U	2.72 U

Table 1-1
Risk-Based Screening of Volatile Organic Compound IHSs in Soil (µg/kg)
Precision Engineering, Inc. Seattle, Washington

Location	Sample ID	Sample Date	Depth (ft. bgs)	Trichloroethene	Vinyl Chloride
GP20	GP20-S-1.0	12/14/2005	1	2.62 U	2.62 U
	GP20-S-6.0	12/14/2005	6	4.52 U	4.52 U
GP21	GP21-S-1.0	12/14/2005	1	2.18 U	2.18 U
	GP21-S-6.5	12/14/2005	6.5	2.79 U	2.79 U
GP22	GP22-S-1.0	12/13/2005	1	2.26 U	2.26 U
	GP22-S-10.0	12/13/2005	10	1.89 U	1.89 U
GP23	GP23-S-7.0	12/14/2005	7	1.80 U	1.80 U
	GP23-S-10.5	12/14/2005	10.5	2.27 U	2.27 U
GP24	GP24-S-3.0	12/14/2005	3	2.58 U	2.58 U
	GP24-S-3.0-Dup	12/14/2005	3	2.50 U	2.50 U
	GP24-S-6.5	12/14/2005	6.5	2.83 U	2.83 U
GP25	GP25-S-1.0	12/12/2005	1	2.13 U	2.13 U
	GP25-S-7.0	12/12/2005	7	2.47 U	2.47 U
GP26	GP26-S-1.0	12/12/2005	1	2.01 U	2.01 U
	GP26-S-9.5	12/12/2005	9.5	2.65 U	2.65 U
GP27	GP27-S-1.0	12/12/2005	1	2.19 U	2.19 U
	GP27-S-13.0	12/12/2005	13	2.05 U	2.05 U
GP28	GP28-S-1.0	12/12/2005	1	1.87 U	1.87 U
	GP28-S-7.0	12/12/2005	7	2.17 U	2.17 U
GP29	GP29-S-1.0	12/12/2005	1	2.47 U	2.47 U
	GP29-S-6.0	12/12/2005	6	2.43 U	2.43 U
GP30	GP30-S-1.0	12/12/2005	1	2.39 U	2.39 U
	GP30-S-6.0	12/12/2005	6	3.32 U	3.32 U
GP31	GP31-S-1.0	12/12/2005	1	2.02 U	2.02 U
	GP31-S-6.0	12/12/2005	6	3.41 U	3.41 U
GP32	GP32-S-1.0	12/14/2005	1	2.37 U	2.37 U

Notes:
Source: This table was obtained from the Draft Remedial Investigation and Risk Assessment Report (MFA, 2006).
Bolded results exceed one or more of the cleanup levels.
CUL = Cleanup Level
ft. bgs = Feet Below Ground Surface
IHS = Indicator Hazardous Substance
MTCA = Washington State Model Toxics Control Act
U = Analyte was not detected.

Table 1-2
Risk-Based Screening of Volatile Organic Compound IHSs in Groundwater (µg/L)
Precision Engineering, Inc. Seattle, Washington

Location	Sample ID	Sample Date	Trichloroethene	Vinyl chloride
MTCA Method A Groundwater CULs			5	0.2
MTCA Method B Groundwater CULs			0.109	0.0292
MTCA Method C Groundwater CULs			1.1	0.29
MTCA Method C Surface Water CULs			37	92
AWQC - Human Health			2.5	0.025
Surface Water ARAR - Aquatic Life - Acute			NR	NR
AWQC - Aquatic Life - Chronic			NR	NR
CUL for Vapor Intrusion			10.8	71.5
Site-Specific Groundwater CUL for the Protection of Surface Water			600	4
Excavation Worker Direct Contact Groundwater CUL			130	1,100
Monitoring Well Groundwater Data				
MW1	MW1-W-35.0 MW1-122705 MW1-041806	6/16/2005 12/27/2005 04/18/2006	1 U 0.200 U 0.055 U	1 U 0.200 U 0.14 U
MW2	MW2-W-0605 MW2-122805 MW2-041906	6/17/2005 12/28/2005 04/19/2006	1 U 0.200 U 0.055 U	1 U 0.200 U 0.14 U
MW3	MW3-0605 MW3-122905 MW3-041706	6/7/2005 12/29/2005 04/17/2006	1 U 0.200 U 0.055 U	1 U 0.200 U 0.14 U
MW4	MW4-0605 MW4-0605-Dup MW4-122705 MW4-041806	6/9/2005 6/9/2005 12/27/2005 04/18/2006	1 U 1 U 0.200 U 0.055 U	1 U 1 U 0.200 U 0.14 U
MW5	MW5-122805 MW5-041906	12/28/2005 04/19/2006	**22.1** 7.9	0.200 U 0.14 U
MW6	MW6-122905 MW6-041906	12/29/2005 04/19/2006	1.00 U 0.055 U	1.00 U 0.14 U
MW7	MW7-122805 MW7-041806 MW7-041806-Dup	12/28/2005 04/18/2006 04/18/2006	0.200 U 0.055 U 0.055 U	0.200 U 0.14 U 0.14 U
MW8	MW8-122805 MWDUP-122805 MW8-041806	12/28/2005 12/28/2005 04/18/2006	0.200 U 0.200 U 0.055 U	0.560 0.400 0.80 J
Reconnaissance Groundwater Data				
GP2	GP2-W-17-RECON	6/9/2005	5 U	5 U
GP4	GP4-W-8.0	6/16/2005	1 U	1 U
GP5	GP5-W-18.0	6/16/2005	1 U	1 U
GP6	GP6-W-18.0	6/16/2005	**1,130**	20 U
GP7	GP7-W-14.0	6/16/2005	1 U	1 U
GP8	GP8-W-10.0	6/16/2005	**16.8**	1 U
GP-13	GP13-W-8.0	12/14/2005	0.220	**16.5**
GP-15	GP15-W-8.0	12/14/2005	0.2 U	0.2 U

Notes:

Source: This table was obtained from the Draft Remedial Investigation and Risk Assessment Report (MFA, 2006).
AWQC = Ambient Water Quality Criteria
ARAR = Applicable or Relevant and Appropriate Requirement
Bolded results exceed one or more of the cleanup levels.
CUL = Cleanup Level
ft. bgs = Feet Below Ground Surface
IHS = Indicator Hazardous Substance
J = The analyte was detected but the concentration is an estimate.
MTCA = Washington State Model Toxics Control Act
NR = No value reported for this analyte.
U = Analyte was not detected.

Table 1-3
Risk-Based Screening of Volatile Organic Compounds in Sub-Slab Vapor (µg/m³)
Precision Engineering, Inc. Seattle, Washington

Location	Sample ID	Sample Date	Trichloroethene	Vinyl chloride
CUL for Vapor Intrusion to Indoor Air			8,150	103,000
A1	A1-042806	04/18/2006	4.0 U	1.9 U
A2	A2-042806	04/18/2006	4.9 U	2.3 U
A3	A3-042806	04/18/2006	6,100	8.4 U
A4	A4-042806	04/18/2006	NA	NA
A5	A5-042806	04/18/2006	**37,000**	420
A6	A6-042806	04/18/2006	3.5 U	1.7 U
A7	A7-042806	04/18/2006	3.5 U	1.7 U

Notes:
Source: *This table was obtained from the Draft Remedial Investigation and Risk Assessment Report (MFA, 2006).*
Bolded results exceed the cleanup level.
CUL = Cleanup Level
NA = Not analyzed
U = Analyte was not detected

Table 1-4
Risk-Based Screening of Volatile Organic Compounds in Air (µg/m³)
Precision Engineering, Inc. Seattle, Washington

Location	Sample ID	Sample Date	Trichloroethene
CUL for Air			0.22
IA1	IA1	06/13/2006	0.2
IA2	IA2	06/13/2006	0.083
IA3	IA3	06/13/2006	0.11
IA4	IA4	06/13/2006	0.14
IA5	IA5	06/13/2006	0.16
IA6	IA6	06/13/2006	0.15
IA6	IA6 Duplicate	06/13/2006	0.15
IA7	IA7	06/13/2006	0.046
IA8	IA8	06/13/2006	0.15

Notes:
Source: *This table was obtained from the Draft Remedial Investigation and Risk Assessment Report (MFA, 2006).*
CUL = Cleanup Level

Table 2-1
Schedule for Installation, Approval, and Documentation of the SSD System at the Precision Engineering Site

Task	Schedule
Initial Planning	
Initial Building Walk-Through	Completed in summer of 2007
Preparation of Work Plan for Depressurization System	Will be completed in December, 2007. Upon approval from Precision and Ecology, system installation will be scheduled.
SSD System Installation	
Diagnostic Testing	Will occur when Precision and building owner agree on a convenient time. Diagnostic testing is estimated to take 1-2 days. Based on the results of diagnostic testing, ART will prepare system design drawings for submittal to the City of Seattle.
SSD System Design	ART will apply to the City of Seattle for the required Construction Permit(s). Permitting time is estimated to be 2 – 3 months.
SSD System Installation	Upon receipt of the approved Construction Permit(s), ART will complete the system installation, estimated to take 2-3 days. Once the fan has been positioned the electrician will wire the system, which typically takes less than 4 hours.
Approval and Documentation of Completed SSD System Installation	
Obtain Approval of the Electrical Wiring and SSD System Construction from the City of Seattle	The electrician will schedule a wiring inspection, and following approval of the wiring, ART will request an inspection from the City of Seattle to obtain approval for the entire system installation. Both the electrician and ART will forecast their completion dates and request inspections ahead of completion to help expedite final approval.
Post-Installation Pressure Differential Readings	Will be collected immediately after the SSD system has been installed, and again approximately 4 weeks after installation.
One-Time Post-Installation Confirmation Air Sampling	Will be collected approximately 4 weeks after the SSD system has been installed.
Submit the Sub-Slab Depressurization System Installation "As-Built" Report to Ecology	Will be completed and submitted to Ecology within 3 months after the SSD system has been installed.

Table 3-1
Long-Term Monitoring Plan for the Precision SSD System

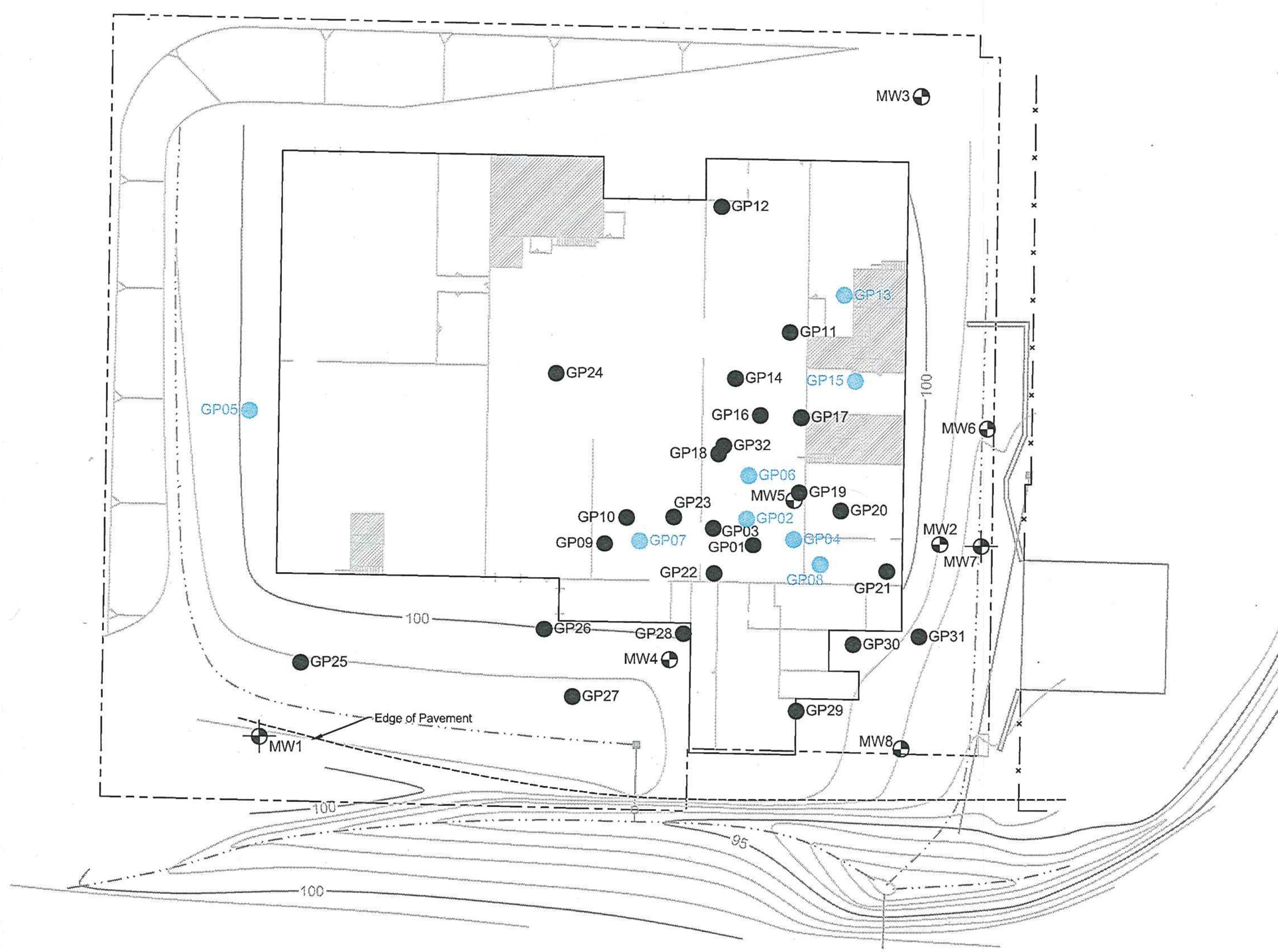
Schedule	Task Description
Weekly Inspection	
Manometer Inspection	The building tenant will inspect the manometer to verify that the fan is running, and report any concerns regarding the system.
Annual Inspection	
Completion of Inspection Checklist	The Inspection Checklist (see Appendix B) will be completed to document that the components of the SSD system are in good condition. Any concerns with the SSD system or operation will be documented on this form.
Fan Inspection and Maintenance	The fan will be inspected and routine maintenance (e.g., lubrication) will be performed.
Manometer Inspection	The manometer reading will be recorded and compared to the reading measured at the time of installation to ensure that readings are similar.
Pressure Differential Readings	Pressure differential readings will be collected in each of the test holes to ensure that the system is continuing to achieve the design criteria of -0.005" wc.

FIGURES

G:\8006.08 Stoel Rives-Precision Equipment\04_VI Mitigation Work Plan\Fig1-1_Sample Locations.dwg, 10/6/2008 1:35:24 PM, PDF-11x17 L.pc3

Figure 1-1
Soil and Groundwater Sample Locations

Precision Engineering, Inc.
Seattle, Washington



Legend:
- Property Boundary
- Fence
- Drainage Ditch
- Topographic Contour Interval
- 2-inch Asphalt Curbing
- Shallow Monitoring Well
- Deep Monitoring Well
- Geoprobe Boring
- Reconnaissance Groundwater Sample
- Building Second Floor Present

Notes:
1) Topography is based on an assumed vertical datum. Topography, storm sewer lines, fence line, and edge of pavement created from a 1989 survey by John R. Ewing and Associates.
2) Locations of property boundary, building corners, monitoring wells, and geoprobe borings based on 2006 survey by Duncanson Company, Inc. All other locations are approximate.

0 50 100
Feet

N

MAUL FOSTER ALONGI

Layout: 1 Project: 8006.08.04 Drawn By: A. Young Approved By: A. Hughes

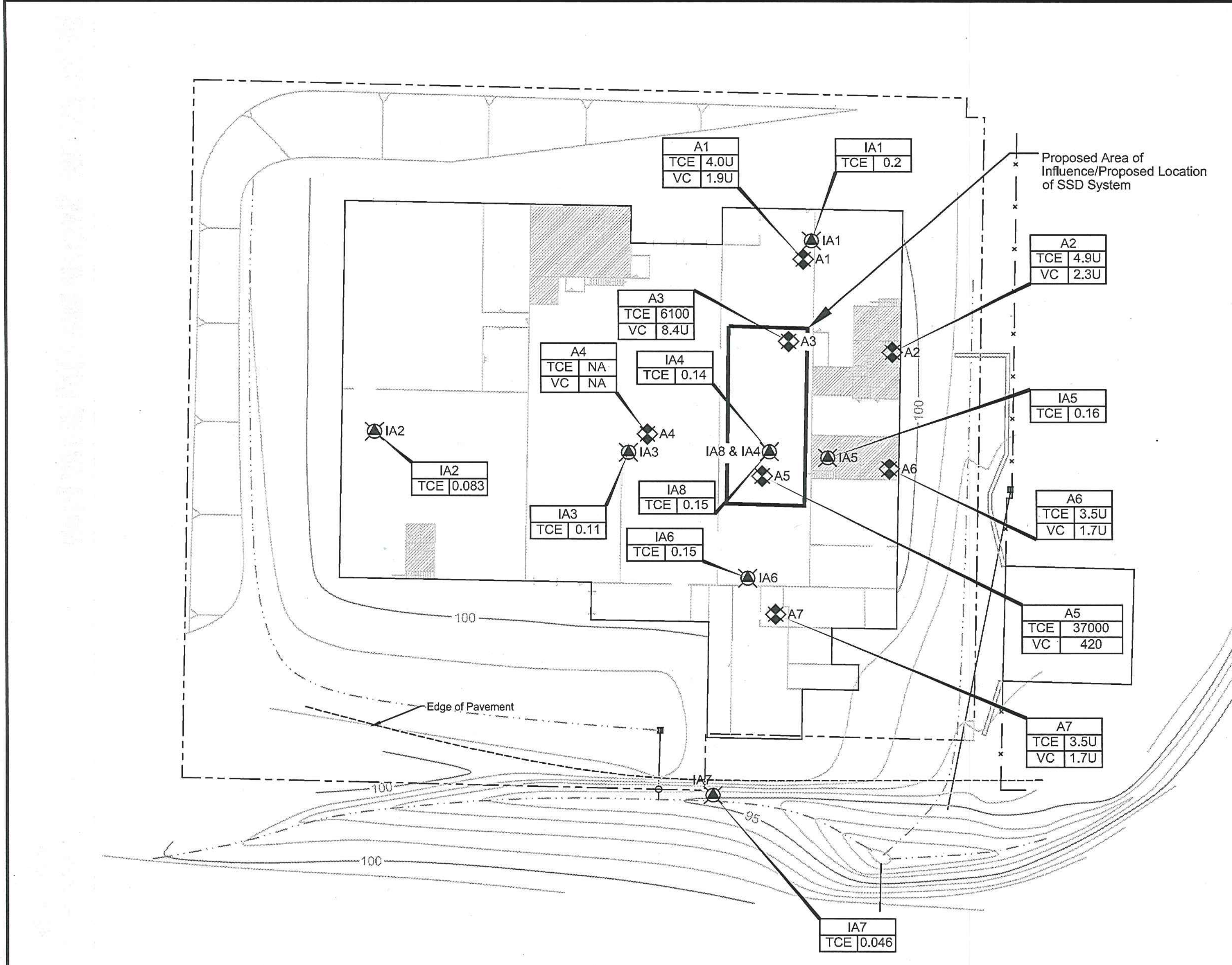


Figure 1-2
Sub-slab Vapor and Indoor Air Samples

Precision Engineering, Inc.
Seattle, Washington

Legend:

- Property Boundary
- Fence
- Drainage Ditch
- Topographic Contour Interval
- 2-Inch Asphalt Curbing
- Subsurface Vapor Monitoring Point
- Air Sample Point
- Building Second Floor Present

TCE	Trichloroethene
VC	Vinyl Chloride
U	Not Detected at or Above Method Reporting Limit
NA	Not Applicable

Notes:
1) Topography is based on an assumed vertical datum. Topography, storm sewer lines, fence line, and edge of pavement created from a 1989 survey by John R. Ewing and Associates.

2) Locations of property boundary, building corners and monitoring wells based on 2006 survey by Duncanson Company, Inc. All other locations are approximate.

3) Chemical compound detections reported in ug/m³.

0 50 100
Feet

N

MAUL FOSTER ALONGI

Layout: 1 Project: 8006.08.04 Drawn By: J. Fisher Approved By: M. Gibson

Figure 2-1
Diagnostic Testing Equipment

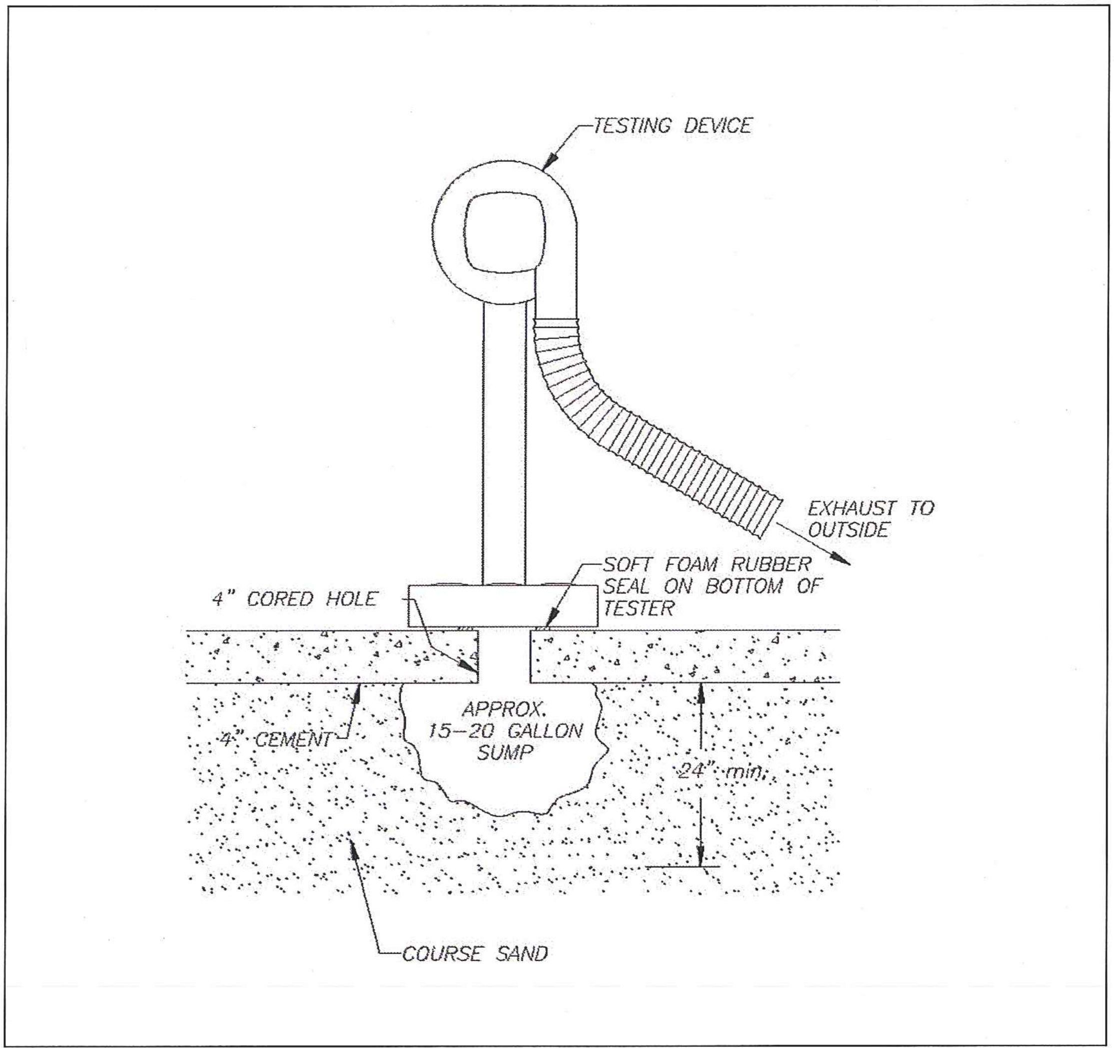


Figure 2-2
Example Cross-Sectional Diagram of Pressure Test Hole

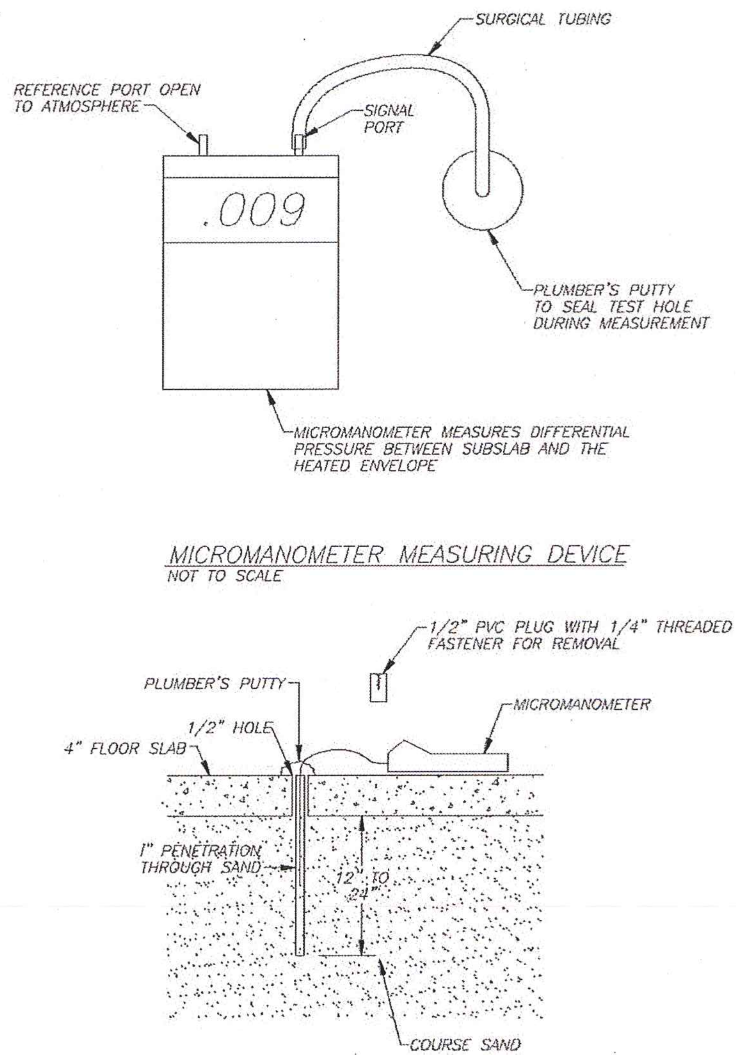


Figure 2-3
Plan View of Proposed SSD System

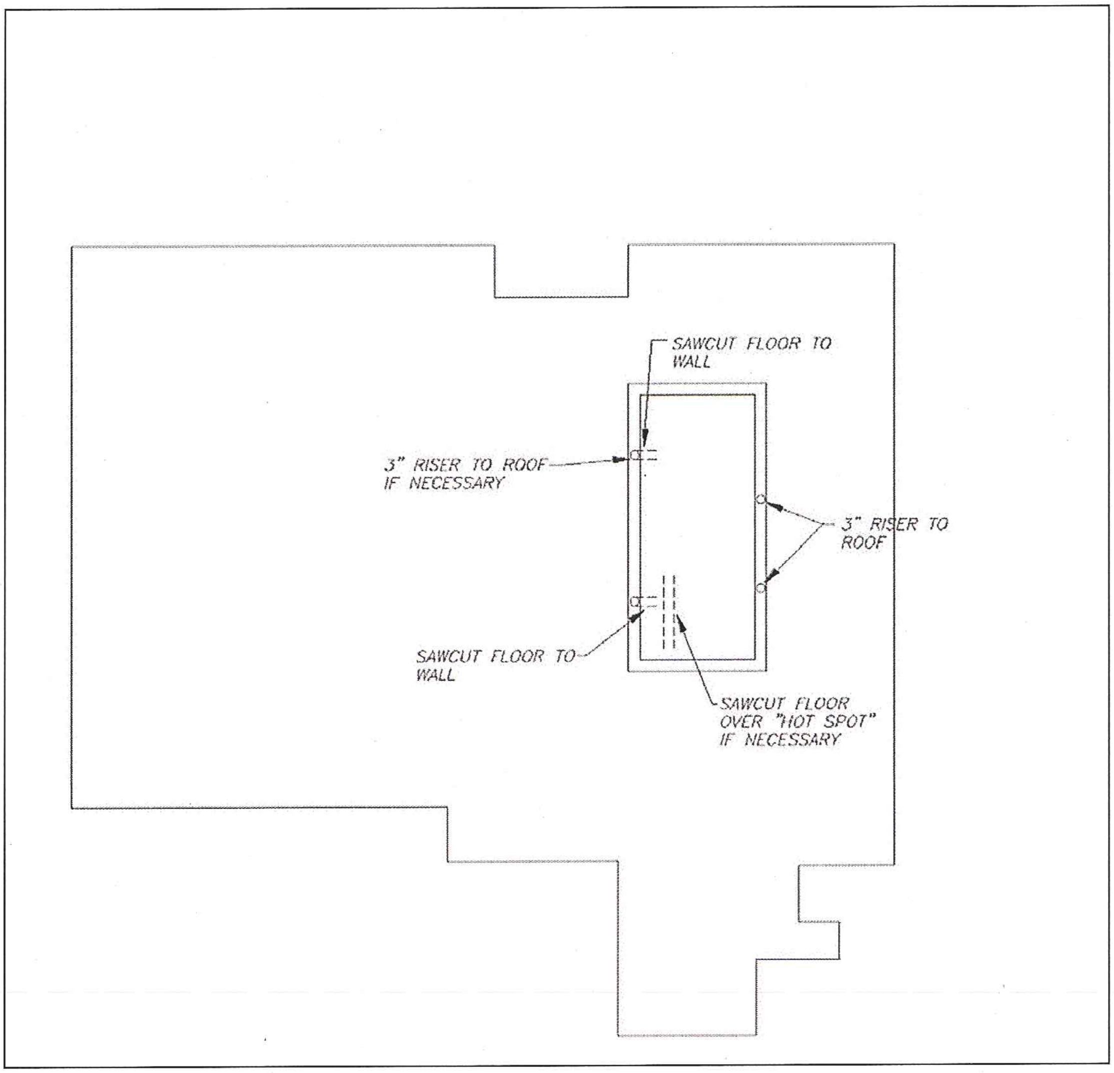


Figure 2-4
Proposed Fan and Pipe Configuration on Roof

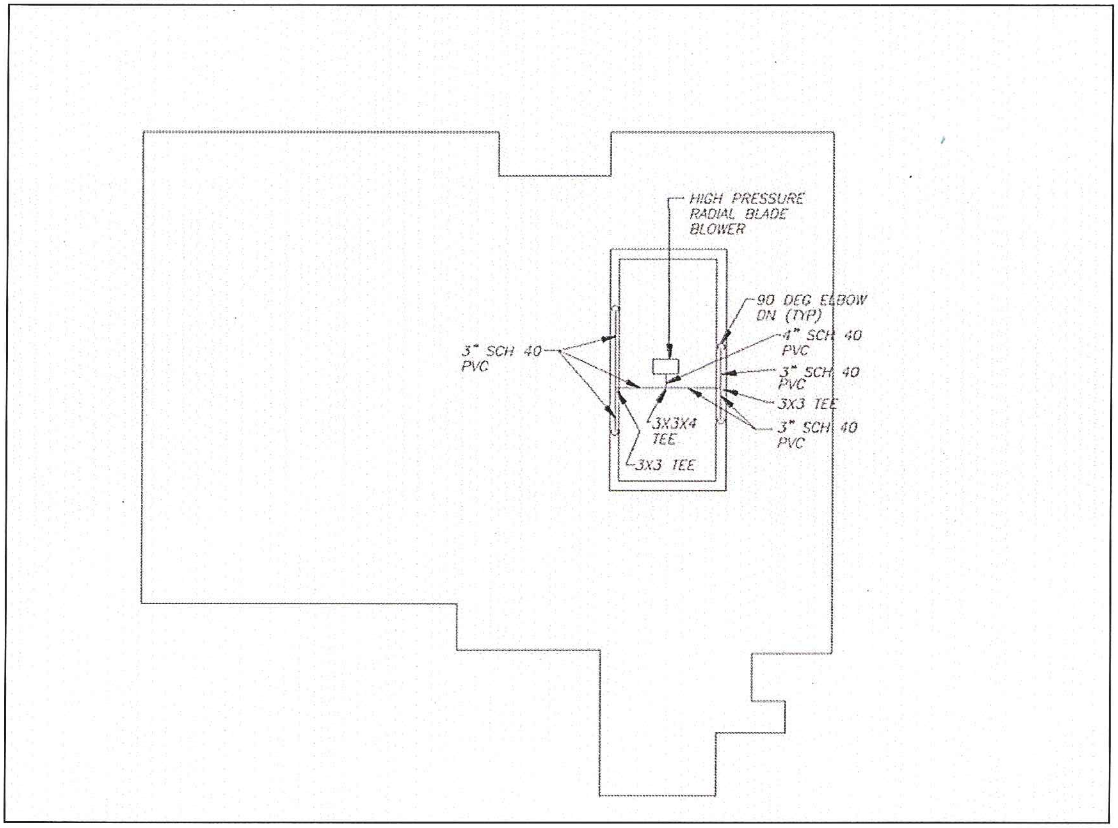
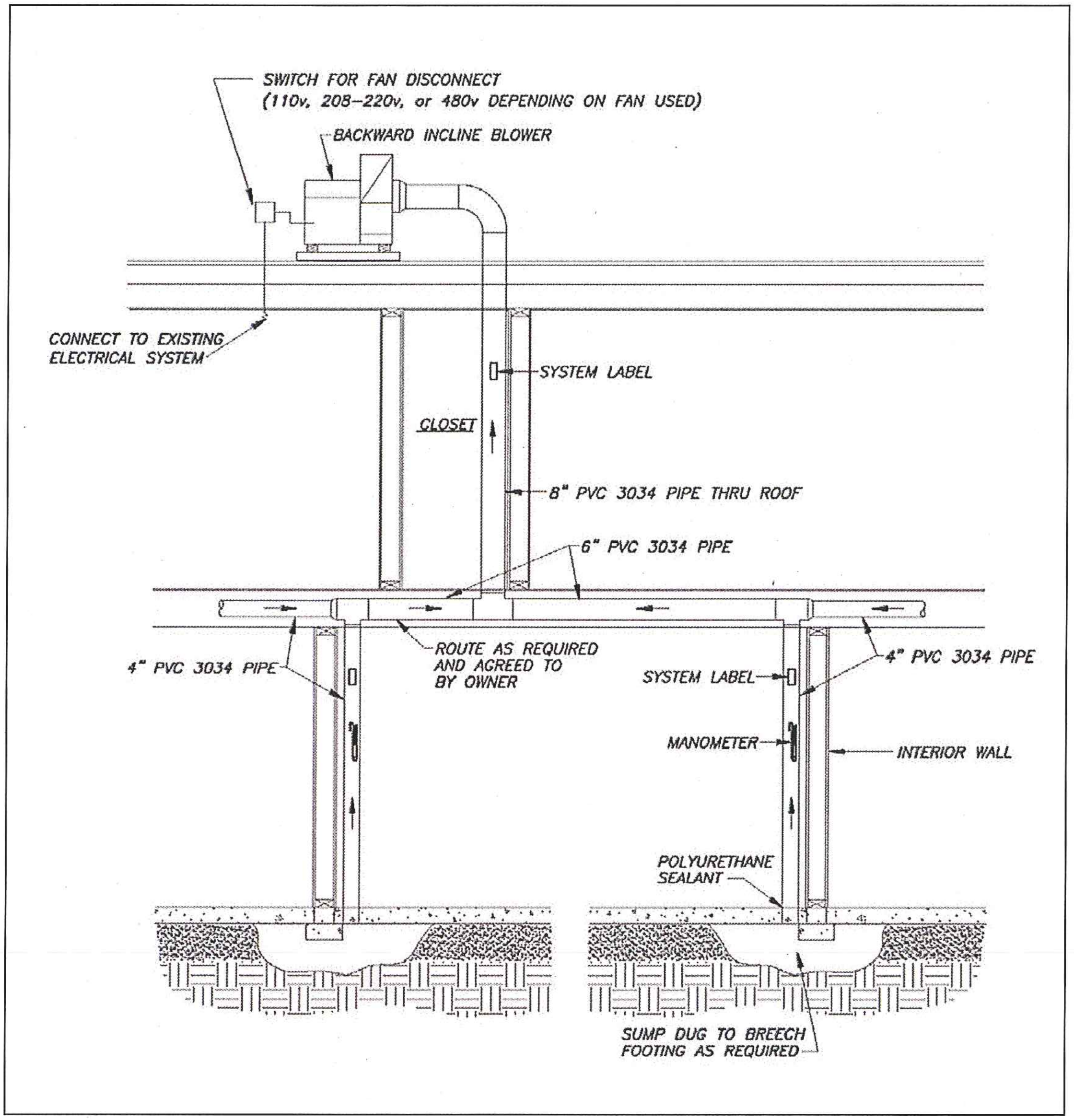
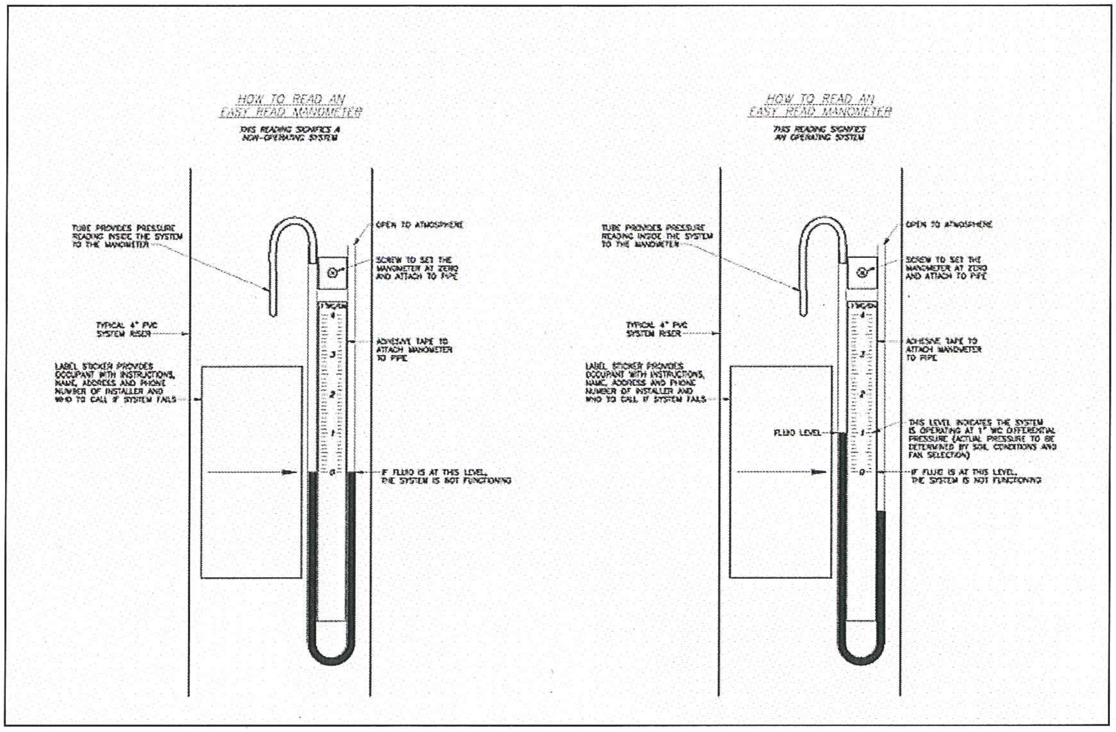


Figure 2-5
Cross-Sectional View of a Typical Commercial SSD System



(Note that 3" risers will be used instead of the 4" risers depicted in this picture, and that risers will be tied together above the roof instead of in-between floors)

Figure 2-6
Diagram of U-Tube Manometer



APPENDIX A

APPENDIX A
AS-BUILT SSD SYSTEM INSTALLATION REPORT
OUTLINE

FOR

1231 S. Director Street
Seattle, Washington

Prepared for:

Precision Engineering, Inc.
1231 S. Director Street
Seattle, Washington

Prepared by:

PIONEER
TECHNOLOGIES CORPORATION

ADVANCED RADON TECHNOLOGIES INC.

October 2008

TABLE OF CONTENTS

SECTION A-1 – INTRODUCTION

This report presents documentation of the SSD system installed by Advanced Radon Technologies (ART) in the Precision Engineering, Inc. (Precision) facility located at 1231 S. Director Street, Seattle, Washington.

SECTION A-2 – SSD SYSTEM INSTALLATION

2.1 Overview of System Installation

The SSD system at the Precision Building was installed in three main stages. The first stage consisted of diagnostic testing, where the basic design needs of the system were identified. The second stage consisted development of the SSD system design, and the third stage was the final installation of the SSD system. These stages are described separately below.

2.1.1 Diagnostic Testing

2.1.2 SSD System Design

2.1.3 Construction of the Depressurization System

Table A-2.1: Components of the SSD System

SSD System Component	Design Components
System Piping:	<u>Inside Warehouse</u>: <u>Roof</u>: <u>Pipe Supports</u>: <u>Exhaust Pipe</u>:
Fan:	
Electrical System:	
Other Information:	<u>Sealants and Glues Used in the System</u>:

2.1.4 Overall Timeline for Construction of the SSD System

The timeline for installation of the SSD System is presented in Table 2-2.

Table A-2.2: Timeline of SSDSystem Installation

Date	Activity
	Diagnostic Testing
	Submitted Proposed Design to Building Owner
	Submitted System Design Plan to City of Seattle for Construction Permit
	Received Approved Construction Permit
	Completed SSD System Installation
	Completed Electrical Work
	City of Seattle Approved System Wiring
	City of Seattle approved IM system installation
	Performed Post-Installation Negative Pressure Readings

2.1.5 Specifications for Determining SSD System Performance

Post-Installation Pressure Differential Measurements

Following installation of the SSD system, pressure differential measurements were collected at each of the test holes. Results of these measurements are presented below in Table 2-3. This table shows the negative pressure field extension in each of the test holes, as compared to the design criterion of –0.005 " wc.

Table A-2.3 Post–Installation Pressure Differential Measurements

Test Hole	Pressure Differential (inches wc)
P-1	
P-2	
P-3	
P-4	

Instantaneous Indication of Fan Function

A U-Tube Manometer was installed on the pipe run in the warehouse for an instantaneous indication of SSD system function. The manometer reading associated with effective system function is indicated below.

U-Tube Manometer Reading Associated with Effective System Function: _____

If the manometer indicates that the SSD system is not functioning appropriately, building occupants should call the following number:

Contact Name:___________________________
Contact Phone Number:_____________________

<u>Air Sampling</u>

Indoor and ambient air sampling will also be used as verification testing of SSD system effectiveness, and will be conducted 4-6 weeks after approval of the final installation.

2.1.6 Maintenance Schedule for SSD System

<u>Fan Maintenance Schedule</u>

<u>Maintenance of Other System Components</u>

•

SECTION A-3 – PHOTOGRAPHS OF SSD SYSTEM

3.1 Photographs of Interior Components of SSD System

3.2 Photographs of SSD System Components on Roof

SECTION A-4 – REFERENCES

ATTACHMENT 1 – SSD SYSTEM DESIGN

ATTACHMENT 2 – ELECTRICAL INSPECTION AND CONSTRUCTION INSPECTION APPROVAL DOCUMENTS

ATTACHMENT 3 – FAN MAINTENANCE MANUAL

APPENDIX B

APPENDIX B

SUB-SLAB DEPRESSURIZATION SYSTEM: ANNUAL INSPECTION FORM

Date: ________/________/________

Time: ________________________

Address: ____

Part 1- Documentation of Condition of System Components

1.1 Sub-Slab System:

Exterior Pipe Free of Cracks	Y	N	N/A
Interior Pipe Free of Cracks	Y	N	N/A
Fan Running Appropriately (no excess vibration or noise)	Y	N	N/A
Caulk on Floor Penetrations in Good Condition	Y	N	N/A
Manometer In Good Condition	Y	N	N/A
Roof Flashing in Good Condition	Y	N	N/A
Significant floor cracking, or new openings in the floor	Y	N	N/A
Significantly different manometer readings	Y	N	N/A

1.2 Structural Changes:

Any Significant changes to the building's HVAC System	Y	N	N/A
Any new vents or openings in the roof/walls, less than 10' away from the stack (and < 2' below it)	Y	N	N/A
Any new buildings near the mitigated building close enough that stack gasses could contaminate their indoor air	Y	N	N/A
Have there been any *significant* earthquake events	Y	N	N/A

Part 2- Other Observations/Comments

Inspected by: ______________________________

(Print Name and Sign)